Co-existence of GM and non GM crops: current experience and key principles

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October 2004

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Executive summary

What is co-existence?
Co-existence refers to the economic consequences resulting from adventitious presence of material from one crop in another and is related to the principle that farmers should be able to cultivate freely the crops of their choice using the production system they prefer (GM, conventional or organic). It is not therefore a product/crop safety issue but relates solely to the production and marketing of crops approved for use.

When is co-existence an issue relating to GM crops?
It becomes an issue only when there is a distinct, preferential demand for a crop grown without the use of GM technology. If there is no distinct, non GM demand, there is no (GM) co-existence issue.

Co-existence of different agricultural production systems is nothing new
Farm level practices (eg, separation of crops by space and time, communicating with neighbours, use of good husbandry, planting, harvest and storage practices) to enable successful co-existence have been practiced by many farmers (eg, seed producers and growers of specialist crops) for many years.

Commercial experience to date
The key findings of research into co-existence of GM and non GM crops in two distinct regions (North America and Spain) are:

1. GM crops have been, and continue to co-exist successfully with conventional and organic crops in North America (where GM crops account for the majority of plantings of important arable crops like soybeans, oilseed rape and maize) and Spain;
2. Claims by anti GM groups that GM and non GM crops cannot co-exist in North America or Spain are greatly exaggerated, given the on-farm experiences since 1995 and 1998 respectively;
3. The market has developed practical, proportionate and workable co-existence measures without government intervention. Where isolated instances of adventitious presence of GM material have been found in non GM or organic crops, and are reported to have resulted in economic losses, these have usually been caused by poor implementation of good co-existence practices (eg, poor segregation of crops in storage and transport, not using certified (and tested) seed). In addition, where necessary, some operators have implemented revised measures to further minimise the chances of adventitious presence occurring. For example, the seed industry has found very low levels of GM adventitious presence in non GM seed of some crops like maize. As a result of this, co-existence practices have been revised to reduce further chances of adventitious presence occurring (eg, by increasing separation distances for foundation level seed crops of maize).

Co-existence requires co-operation
Successful co-existence of different agricultural production systems requires mutual respect and shared responsibilities by all parties. Responsibility for implementation of co-existence measures should involve both GM and non GM growers implementing appropriate management practices.

There are five key principles to good co-existence practice:

1. **Context**: It is important to determine the relative commercial and agronomic importance of different crop production systems based on planted area, production

and economic value. These properties are important considerations when assessing the likelihood of adventitious presence of material from one production system affecting another and the potential economic impacts. Context is particularly important to the third principle of proportionality – see below

2. **Consistency**: Producers and those overseeing the integrity/purity of crops/derivatives should be consistent in their behaviour towards the adventitious presence of all unwanted material, including GM derived material. It is unrealistic to expect 100% purity for any crop/product and this is why thresholds are set for adventitious presence of unwanted material. These (thresholds) should be proportionate to the risks attached to the presence of the unwanted material:

   - for the adventitious presence of (unwanted) material that pose known health and safety risks (eg, mycotoxin levels in cereals), it is appropriate to operate to very low threshold levels (eg, the limit of reliable detection);
   - for adventitious presence of (unwanted) material that affect product integrity, purity, quality and functionality (eg, impurities, weed/plant material, seeds/grains of off types[1]), wider thresholds are appropriate. Whilst these (thresholds) vary by crop and use, they are typically set at levels between 1% and 5%[2].

   In respect of the adventitious presence of GM material (which has been given regulatory approval for use[3]) in non GM crops, the threshold set, by the EU's GM labelling legislation, at 0.9% falls into the second category referred to above.

   Against this background, there are notable inconsistencies in the practices of some organic certification bodies relating to the treatment of adventitious presence of GMOs compared to the treatment of adventitious presence of other excluded products (see section 7.2).

3. **Proportionality**: All co-existence measures established should be proportionate, non discriminatory and science-based.

4. **Equity (fairness):** The issue of economic liability provisions that compensate non GM growers for adventitious presence of GM material is often raised in the co-existence debate. Historically, the market has adequately addressed economic liability issues relating to the adventitious presence of unwanted material in any agricultural crop[4] by placing the onus on growers of specialist crops (eg, seed, organic) to take action to protect the purity of their crops (such growers usually being rewarded by higher prices for taking such actions). If legislation was to be introduced that created new economic liability provisions for any negative economic consequences of adventitious presence of unwanted GMO material, it is reasonable to argue that the same principle should apply to all farmers regardless of their chosen production methods. On equity/fairness grounds, GM growers should have equal access to compensation for any negative economic consequences arising from the practices of neighbouring conventional or organic farmers (eg, loss of quality premia for adventitious presence of non GM material in GM crops or losses from the spread of pests and weeds from neighbouring farms with poor levels of pest and weed

[1] For example, grains of dent maize found in waxy maize
[2] For example, the threshold for impurities in most cereals is typically 2% (see section 5.1)
[3] In other words has been given approval for use and consumption on health, safety and environmental grounds
[4] The concept of economic liability should not be confused with environmental liability, which is a separate issue and which is addressed through the regulatory approval process

control). No one sector should be able to veto another – access and choice work both ways

5. **Practicality**: all co-existence measures should be based on legal, practical and scientific realities.

Developing good co-existence in your locality

The tools exist to facilitate good co-existence. These practices have been successfully enabling co-existence of GM and non GM crops (including organic) in North America (and Spain) for many years without government involvement. If you apply the five key principles and adapt these to local circumstances on a crop by crop basis, effective co-existence practices can be developed.

1. Introduction

One of the main subjects of current debate about the use of genetically modified (GM) crops relates to the economic and market implications of GM and non GM crops being grown in close proximity (ie, co-existing). Within this co-existence debate, anti GM groups often claim that GM and conventional (including organic) crops cannot co-exist without causing significant economic harm/losses to conventional and organic growers.

This paper[5] examines these issues, based on real world experience and puts forward five key principles for delivering workable co-existence management practices. These can be applied in any country, region or locality. These are based on, and drawn from four papers written by Brookes G & Barfoot P (2003 & 2004) on: co-existence of arable crops in North America, the non GM and organic market context in Europe, arable crops in the UK and maize in Spain[6].

2. What is co-existence?

Co-existence as an issue relates to '*the economic consequences of adventitious presence of material from one crop in another and the principle that farmers should be able to cultivate freely the agricultural crops they choose, be it GM crops, conventional or organic crops*'[7]. The issue is, therefore, not about product/crop safety[8], but relates solely to the production and marketing of crops approved for use.

3. When is co-existence an issue?

Adventitious presence of GM crop material in non-GM crops becomes an issue where consumers demand products that do not contain, or are not derived from GM crops. The initial driving force for differentiating[9] currently available crops into GM and non-GM has came from consumers and interest groups who expressed a desire to avoid support for, or consumption of, GM crops and their derivatives. This has subsequently been recognised by some in the food and feed supply chains (notably some supermarket chains, many with interests in organic farming and suppliers of GM event testing services) as an opportunity to differentiate their products and services from competitors and hence derive market advantage from the supply of non-GM derived products. This has been taken furthest in the organic sector, which has opted to prohibit the use of GMOs in (organic) production[10].

It is important to recognise that co-existence is only an issue when there is a distinct demand for non GM products/crops. If there is no distinct non GM demand, there is no (GM) co-existence issue. This has been the case in relation to most GM maize grown in Spain, where farmers adjacent to each other who grow maize, some GM and some non GM, both sell their output to animal feed compounders who do not differentiate raw materials according to their production method, and hence mix both GM and non GM supplies. As a result, there has

[5] The authors acknowledge that a funding contribution towards the researching of this paper was provided by Agricultural Biotechnology in Europe (ABE). The material presented in this paper is, however the independent views of the authors – it is a standard condition for all work undertaken by PG Economics that all reports are independently and objectively compiled without influence from funding sponsors

[6] All four papers are available on www.pgeconomics.co.uk

[7] Source: European Commission 2003

[8] Commercially grown GM crops having obtained full regulatory approval for variety purity, use in livestock feed, human health and safety and the environment. The issue of environmental liability (sometimes confused with economic liability) is addressed through the regulatory approval process

[9] Generally referred to as either segregation or identity preservation

[10] This prohibition having been enshrined in legislation (eg, the European Organic Production Regulation 2092/91 (as amended) or the United States Department of Agriculture Organic Standards)

been no requirement (or need) to segregate the two crops or to minimise the chances of adventitious presence of GM material being found in the non GM crop.

Whilst market factors largely determine whether there is a distinct demand for non GM products (and this resulting in a co-existence issue), legal requirements may also contribute. Legal requirements essentially fall into two distinct categories:

- Where there are labelling requirements for products containing or derived from GMOs. These include, for example the European Union (EU) where the threshold for positive labelling of food and feed products containing or derived from GM crops is 0.9%, and Japan where positive labelling of GM content in food products is required if the GM content is 5% or more;
- Where one country has permitted the legal planting and use of a crop containing a GM trait but another country has not permitted the importation and use of crops/derived products containing this GM trait. For example, GM papaya is permitted for planting and consumption in the USA but is not currently permitted for importation and use in Japan. Also, some GM maize traits (eg, resistance to the corn rootworm pest) are permitted for planting and use in the USA but are not currently permitted for importation and use in the EU.

4 The non GM market context

The demand for non GM products is probably greatest (in a global context) in the EU. Here the non GM market is concentrated in the markets that use soybeans/derivatives and maize. The level of demand for certified non GM soy/derivatives and maize[11] is within the range of 16% to 27% of total soy/derivative use and 25%-36% of total maize usage (Table 1). In North America, the level of demand for certified non GM soy and maize is much lower and is probably equal to less than 5% of total demand[12].

Table 1: Estimated GM versus non GM soy and maize use 2002-03 in the EU (million tonnes)

Product	Market size	Non GM share	Non GM share (%)
Soy			
Whole beans	1.5	0.33	22
Oil	2.12	0.83	39
Meal	30.77	3.69-8.3	12-27
Total			**16-27**
Maize			
Food & starch	8.97	6.28	70
Feed	29.25	2.92-7.31	10-25
Seed	0.78	0.55	70
Total	**39**	**9.75-14.14**	**25-36**

Source: PG Economics, American Soybean Association, Oil World
Note: The range for the estimated share of non GM demand in the animal feed sector reflects the broad range of views and limited research in the sector

[11] This refers to the level of demand that actively requires supplies to be certified as non GM to at least the thresholds laid down in the EU labelling regulation

[12] The author has not identified any literature that has attempted to quantify the size of this market in North America. The less than 5% estimate is the author's qualitative view

5 Co-existence is nothing new

5.1 How does adventitious presence arise ?

Adventitious presence of unwanted material can arise for a variety of reasons. These include, seed impurities, cross pollination, volunteers (self sown plants derived from seed from a previous crop), and may be linked to seed planting equipment and practices, harvesting and storage practices on-farm, transport, storage and processing post farm gate. Recognising this, almost all traded agricultural commodities accept some degree of adventitious presence of unwanted material and hence have thresholds set for the presence of unwanted material. For example, in most cereals, the maximum threshold for the presence of unwanted material (eg, plant material, weeds, animal filth, dirt, insect parts, stones, seeds of other crop species) commonly used is 2% (by weight).

5.2 Dealing with adventitious presence is nothing new on the farm

Farm level practices (eg, separation of crops by space and time, communicating with neighbours, use of good husbandry, planting, harvest and storage practices) to minimise levels of adventitious presence (and hence delivering good/successful co-existence) have been in operation, by farmers, for many years.

5.2.1 Examples of long standing co-existence

a) Certified seed production

Seed production systems operate to threshold levels for the presence of non pure seed (off types). They are based on specified separation distances between the seed production plot and other plots of the same species and time intervals between a seed crop and any other crop of the same species grown on the plot. These are backed up by seed inspection and testing agencies. Failure to meet the purity standards results in seed not being certified and the relevant seed premium being lost to the grower (ie, the crop has to be sold as a non seed crop).

In relation to seed production for the main arable crops for which GM traits have already been commercialised (or are most likely to be commercialised in the EU in the next few years), the key factors considered to affect purity levels are:

- *oilseed rape:* Cross pollination and volunteers are the main factors affecting purity. To ensure purity standards are regularly met, the minimum separation distance for seed crops is 100 metres, although for hybrid oilseed rape this is increased to 300 metres. To minimise the chances of volunteers compromising seed purity, no oilseed rape crop should precede a seed crop (of oilseed rape) for five years;
- *sugar beet*: As the crop is normally biennial (produces seed only in the second year) but is harvested at the end of the first growing season, plants rarely flower. The only scope of cross pollination occurring comes from bolters (weed beet). Control of weed beet is therefore an important and accepted part of good husbandry practice in sugar beet cultivation;
- *maize*. Cross pollination from adjacent (non seed) maize crops is the main factor affecting purity. As such, a separation distance of 200 metres is typically applied to ensure maintenance of purity standards[13]. Growers also use buffer rows around the

[13] In seed production, as much as 80% of the plants in a field (the detasseled female plants) do not produce pollen. As a consequence, they are highly receptive to both, pollen from the male plant, and to adventitious pollen carried in from

seed production plot, with one row considered to be approximately equal to 10 metres of non crop separation.

The conditions applied to certified seed production systems are based on practical field experience and take due account of year to year variations in prevailing weather conditions and the activities of bees and other pollinating insects. These species-specific practices generally deliver seed to the purity standards required.

A few instances have arisen in recent years where adventitious presence of GM material has been found in some non GM seed. For example, in 2000 some maize seed lots imported into France from North America were found to have low levels of GMO presence (under 0.2%) and some spring oilseed rape varieties imported from Canada into the UK had GMO presence levels of under 1%. As a result of these instances there has been re-evaluation of conditions and procedures by seed producers to reduce further the likelihood of adventitious presence occurring. For example, in relation to maize seed production in the USA the separation distances for foundation standard seed has increased from 200 metres to 270 metres. In addition, increased testing of seed prior to planting first generation (seed) crops has also been initiated.

b) High erucic acid oilseed rape (HEAR)

HEAR varieties have desirable properties for the manufacture of industrial oils. However, the high erucic acid component of the seed oil is an anti nutritional product and should not be consumed on health and safety grounds. It is therefore most important that the cultivation of HEAR crops do not contaminate other oilseed rape (often referred to as double zero varieties) grown for uses in human food and animal feed. Contracts for growing HEAR crops usually require that only certified seed of HEAR varieties is used, seed drills are required to be cleaned prior to use, a separation distance of 50-100 metres[14] is maintained from other oilseed rape crops sown in the same season[15], all cultivation and harvesting equipment should be cleaned before use and post harvest segregation is maintained to minimise admixtures. Strict application of these procedures is promoted by contract testing and the use of penalties (including rejection of crops) if the set parameters for the oilseed fatty acid content are not met. The threshold for admixture of HEAR in other (double zero) oilseed rape is 2%[16] although recorded levels of ad-mixture are usually found to be much lower (see below).

Adherence to the contractual requirements and in particular the separation distances, comes (where applicable) by voluntary arrangements between adjacent farmers, although in many instances there is no need to involve other farmers, as separation distances can be adequately dealt with on-farm (eg, 50 metres is less than the width of an average field). Farmers growing HEAR usually discuss cropping plans with their neighbours, identify and set rotation patterns by mutual agreement.

Evidence from Germany suggests that the applied 100 metre separation distance delivers more than 95% of double zero seed lots with an erucic acid level of below 0.2% and only a

neighbouring fields by the wind. Also because of inbred depression, the male parent plant usually produces less pollen than other maize, and this pollen is usually produced with a lack of synchrony towards the female maturity. In order to ensure a high degree of purity of the hybrid seed (usually 99.5%), strict growing conditions are respected. These include, for example large separation distances from neighbouring fields (eg, 200 metres). In contrast, maize grain grown for direct use (food, feed, industrial) contains 100% fertile parent plants. The amount of pollen present and its competitivity are much higher than in seed production fields, so the influence of adventitious pollen from neighbouring fields is smaller. Therefore maintaining a degree of purity in a grain maize field (where this is a desired outcome, for example, a non GM crop located near a GM crop) requires the application of less strict measures (eg, separation distances) than in the case of seed production

[14] 50 metres UK, 100 metres Germany

[15] It is not necessary to have separation distances between crops sown in different seasons, eg winter sown double zero and spring sown HEAR

[16] To breach the 2% threshold for erucic acid in the oil would require a 4% cross pollination of seed

few seed lots contain more than 0.5%. Research conducted in the UK by Kings[17] in 1993-95 which planted HEAR varieties in plots adjacent to double zero varieties (maximum distance between plots was 9 metres) found that the level of erucic acid found in double zero crops was less than 0.5%.

5.2.2 Examples of GM and non GM crop co-existence practices

a) North America
In relation to the implementation of co-existence practices (where relevant) for the planting of GM and non crops in North America, this has involved actions being taken by both GM and non GM growers.

All suppliers of GM seed to farmers in North America provide farmers with 'Technology Use Guides' or 'Crop Stewardship Guides'. These provide recommendations for use of the GM products (eg, herbicide use for weed control recommendations) and some advice on 'co-existence issues' that target maintaining the purity of non GM crops growing on GM crop planting farms, on nearby farms, in storage or when supplied to buyers. Issues covered include:

- Pollen movement: ways of minimising the chances of cross pollination through the siting of crops in relation to prevailing wind directions, use of buffer crops and barriers, timing of plantings, varieties planted (with different flowering times), separation distances and removal (ie, separate harvesting and segregation) of outer strips of crop in a field (eg, some speciality corn crops require the removal of the outer 9 metres (30 feet) of a crop to ensure the removal of impurities from adjacent (non speciality) corn crops);
- Holding discussions with neighbours about planting intentions;
- Holding discussions with grain buyers to ensure that contractual requirements are identified (eg, whether GM traits not yet approved for importation into the EU are accepted).

All farmers of herbicide tolerant crops are also provided with advice on managing volunteers in subsequent crops[18]. This advice covers aspects of an integrated weed management system, the majority of which is equally applicable to non GM varieties of these crops, and includes crop rotation, rotation of herbicides, rotation of herbicide tolerant traits, rotation of timing of herbicide applications, rotation of timing of tillage and use of certified seed.

Equally non GM growers, especially those in the organic sector are provided with advice on similar measures from some of their advisors and certifying bodies.

b) Maize in Spain
Spain is the main EU country where commercial planting of GM crops takes place (insect resistant maize since 1998). Here, as in North America, farmers planting GM maize are advised by seed suppliers about possibilities of adventitious presence of GMOs from their crops being found in neighbouring non GM crops and how best to minimise this occurring. This advice focuses on ensuring that farmers take into consideration prevailing wind directions, flowering dates of different varieties and the planting of border rows in bands between the GM crops and neighbouring non GM crops that might be destined for sale into a

[17] The leading supplier of HEAR seed in the UK
[18] See for example CropLife Canada, Controlling herbicide tolerant volunteers in a succeeding crop: a best practice guide. www.croplife.ca

usage sector that specifically requires the maize to be certified as non GM or organic. At least four rows of conventional maize planted between GM crops and 'vulnerable' non GM crops are recommended.

c) *UK: GM farm scale trials (FSEs)*
In the UK, no commercial plantings of GM crops have occurred to date. However, extensive FSEs (260) have been conducted for some GM herbicide tolerant arable crops. All of the FSEs were required to comply with the Supply Chain Initiative on Modified Agricultural Crops (SCIMAC) guidelines. These guidelines specified practices for storage and planting of seed, crop management, harvesting, storage of harvested crops, neighbour notification, monitoring and record keeping and separation distances to be adopted when growing GM (herbicide tolerant) crops.

The SCIMAC separation distances (Table 2) were based on a combination of current seed production legislation, established practice for producing specialist crops like HEAR and seed crops, knowledge of pollen distribution and cross-pollination and 'best' available current scientific knowledge. They were set using a precautionary approach and with the intention that review would take place in the light of experience. The application of this precautionary approach resulted in the separation distances for non seed crops (including organic) being significantly greater than the distances required to comply with the EU labelling threshold of 0.9%. For example, a 25 metre separation distance (or the application of four rows of buffer crop) is widely considered to be sufficient to meet the 0.9% labelling threshold for maize[19] yet greater separation distances were applied in SCIMAC.

Table 2: SCIMAC separation distance for same species

Crop type	Non-GM crops	Certified seed crops	Registered organic crops
Oilseed rape	50 metres (100 metres for varietal associations and partially restored hybrids)	200 metres	200 metres
Sugar beet	6 metres	600 metres	600 metres
Forage maize	200 metres sweet corn 80 metres forage maize	200 metres	200 metres

Notes:
1. The non GM crops were effectively working to a legal threshold of 1%, whilst certified seed and organic crops were assumed to operate to tighter commercial thresholds
2. The 600 metre separation distance for sugar beet grown for seed is of no practical relevance to the UK because there is no sugar beet seed production in the UK

6 Have GM and non GM crops co-existed successfully?

The evidence to date shows that GM and non GM crops (including organic) have successfully co-existed without causing economic/marketing problems since GM crops were first grown commercially in 1995. Specifically in relation to organic crops, which are most frequently cited as the type of production perceived to be most likely to experience co-existence difficulties with GM crops, the evidence is also clear – successful co-existence has been possible.

[19] See for example, Henry C et al (2003) Farm scale evaluations of GM crops: monitoring gene flow from GM crops to non GM equivalents in the vicinity: part one forage maize, DEFRA report EPG/1/5/138 and Mele E et al (2004) First results of co-existence study: European Biotechnology Science & Industry News No 4, vol 3

6.1 The North American experience

North America is probably the most relevant market to examine whether GM and non GM crops have co-existed successfully, given the penetration of GM crops in total plantings of some key arable crops. Figure 1 shows the relative importance of different production systems for the three main food and feed crops for which GM technology is currently commercially available to farmers. This illustrates the importance of GM technology – accounting for 60% of total plantings of oilseed rape, maize and soybeans, with conventional production accounting for almost all of the balance, and organic production accounting for a minute 0.22% of total plantings[20].

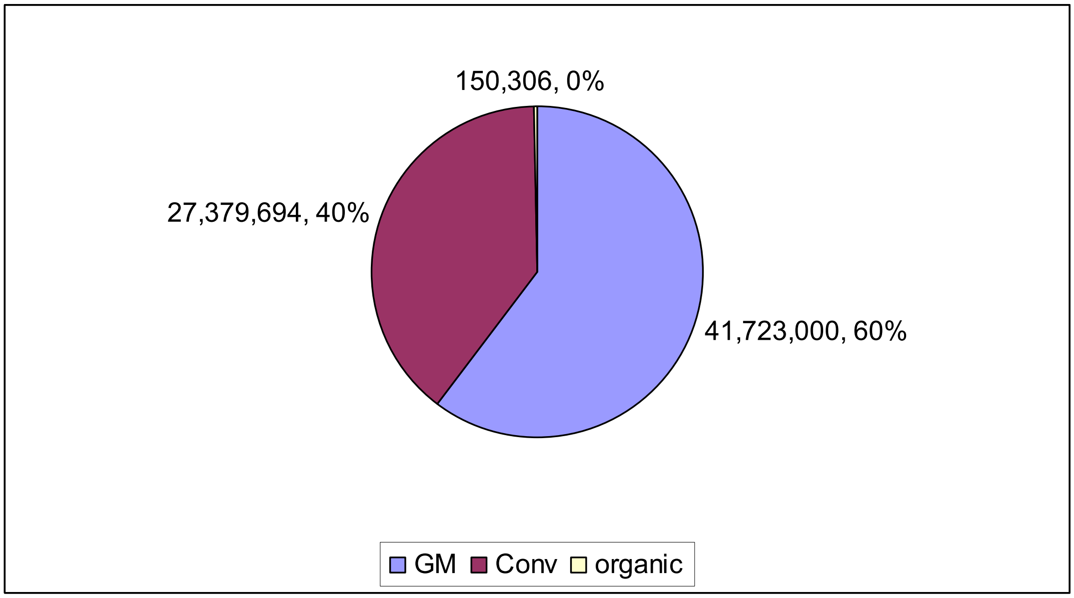

Figure 1: Share of GM, conventional and organic production systems in soybeans, maize and canola 2002 in North America (hectares)

Sources: USDA, ISAAA, University of Manitoba
Notes: Canadian organic area of soybeans and maize based on US organic shares: total share is 0.22%

The most relevant GM/organic co-existence points that emerge from analysis of the North American experience are:

- Survey evidence amongst US organic farmers (2003) shows that the vast majority (96%) have not experienced any loss of organic sales or downgrading of produce as a result of GM adventitious presence having been found in their crops. Where a small number (4%) report some losses/downgrading this has been due to a marketing decision taken by their certifying body or customer rather than any requirement under national (USDA) organic regulations[21];
- The US organic areas of soybeans and maize have increased by 270% and 187% respectively between 1995 and 2001[22], a period in which GM crops were introduced

[20] The respective organic shares per crop are 0.24% for soybeans, 0.12% for maize and 0.04% for oilseed rape

[21] The USDA National Organic Standards whilst prohibiting the use of GM varieties states that 'the presence of a detectable residue of a product of excluded methods alone does not necessarily constitute a violation of this regulation. As long as an organic operation has not used excluded methods and takes reasonable steps to avoid contact with the products of excluded methods as detailed in their approved organic system plan, the unintentional presence of the products of excluded methods should not affect the status of an organic product or operation'

[22] Whilst the % change in organic plantings has shown a substantial increase, the areas planted to organic soy and maize (in 2001) remained minute at 0.24% and 0.12% respectively of total soy and maize plantings

and reached 68% and 26% shares of total plantings of soybeans and maize respectively by 2001. Also, the states with the greatest concentration of organic soybean and maize crops are often states with above average penetration of GM crops (eg, Iowa and Minnesota);

- In the case of canola (spring oilseed rape), the organic area has historically been very low (under 0.1% of total canola plantings). This very low level of planting essentially reflects agronomic and husbandry difficulties in growing organic canola and the limited nature of the market – it is not related to any co-existence problems with GM canola.

6.2 Europe

The evidence to date shows that GM, conventional and organic maize crops in Spain have also co-existed successfully. In over 90% of cases where Bt maize has been grown in Spain, neighbouring fields have either been Bt maize or a conventional maize variety being sold for feed usage, where the buyer does not differentiate between GM and non GM sources of supply. Hence there have been few occasions where co-existence measures have needed to be implemented. Isolated instances[23] of GMO adventitious presence in organic maize crops have been reported but these may be attributable to poor implementation of good co-existence practices (ie, using non organic, conventional seed that had not been tested prior to use and/or poor on-farm or post-farm segregation).

Similarly, in the UK, the 260 FSEs have successfully co-existed with conventional and organic crops. No conventional or organic crops near to the FSEs found any adventitious presence levels of GMOs that resulted in economic losses and there was no loss of organic status on any neighbouring (organic) farm.

6.3 Overall perspective

Overall, the real world experience shows that GM crops have successfully co-existed with conventional and organic crops. This is not surprising given the long history that farmers have of successfully growing specialist crops (eg, seed production, waxy corn, high erucic acid oilseed rape) for many years, near to crops of the same species (including GM crops), without compromising the high purity levels required. North American and Spanish farmers have also been successfully growing and channelling some GM and non GM crops of the same species into different markets. A small number of instances of adventitious presence of GM events have been found in non GM and organic crops (and resulted in possible rejection of deliveries by buyers or imposition of contractual price penalties) but this has usually been caused by deficiencies in application of good co-existence practices rather than any failure of the practices themselves.

7 Key principles for co-existence of GM and non GM crops

Drawing on the evidence presented above[24], five key co-existence principles can be identified.

7.1 Context

It is important to determine the relative importance of different crop production systems (GM, conventional and organic) based on planted area, production and economic value, and to examine the size of the non GM (including organic) markets. These properties are important

[23] Two, both reported in 2001

[24] For additional detail see the four co-existence papers referred to in the bibliography

considerations when assessing the likelihood of adventitious presence of material from one production system affecting another and the potential economic impacts. Of key importance here are the following points:

- If there is no distinct non GM demand, there is no (GM) co-existence issue;
- If the level of demand for certified non GM products (including organic) is small, then the likelihood of GM and non GM crops (for which the non GM status is important to buyers) being found growing near to each other will be fairly limited. As indicated in section 6, the evidence to date shows that the non GM market in crops for which GM crops have been commercialised (or may be commercialised in the EU in the next 5-10 years) is relatively small. The organic area of these crops is also minute, both in North America and the EU (less than a quarter of one per cent).

Overall, context is particularly important to the principle of proportionality – see section 7.3.

7.2 Consistency

Producers and those overseeing the integrity/purity of crops/derivatives should be consistent in their behaviour towards the adventitious presence of all unwanted material, including GM derived material. It is unrealistic to expect 100% purity for any crop/product and this is why thresholds are set for adventitious presence of unwanted material.

These (thresholds) should be proportionate to the risks attached to the presence of the unwanted material:

- for the adventitious presence of (unwanted) material that pose known health and safety risks (eg, mycotoxin levels in cereals), it is appropriate to operate to very low threshold levels (eg, to the limits of reliable detection);
- for adventitious presence of (unwanted) material that affect product integrity, purity, quality and functionality (eg, impurities, weed/plant material, seeds/grains of off types[25]), wider thresholds are appropriate. Whilst these (thresholds) vary by crop and use, they are typically set at levels between 1% and 5%[26]. Practicality and cost considerations are important factors affecting the setting of this category of thresholds because in general, the tighter the threshold, the higher the cost and greater the difficulty in meeting such thresholds.

In respect of the adventitious presence of GM material (which has been given regulatory approval for use[27]) in non GM crops, the threshold set, by the EU's GM labelling legislation, at 0.9% falls appropriately into the second category referred to above.

Against this background, there are notable <u>inconsistencies</u> practiced by some certification bodies in the organic sector. These inconsistencies fall into the following two main categories.

7.2.1 Testing of organic produce for the presence of GMOs

Organic certification is based on certifying the production method rather than giving an end product guarantee as to the product's freedom from GMOs or excluded products. Adventitious presence of such material can occur from circumstances beyond the reasonable control of the organic producer and therefore, the identification of such material (via end product testing) is not

[25] For example, grains of dent maize found in waxy maize

[26] For example, the threshold for impurities in most cereals is typically 2% (see section 5.1)

[27] In other words has been given approval for use and consumption on health, safety and environmental grounds

used to de-certify organic status on produce provided growers can demonstrate their adherence to the organic farming practices and rules. Whilst this pragmatic principle should apply to possible adventitious presence of GMOs[28], some organic certification bodies advocate the practice of undertaking testing for GMO presence, with all crops found to have detectible GMO presence de-certified (ie, the organic status is lost). This practice is inconsistent with the treatment of other unwanted material and with the treatment of crop protection products for which thresholds for their safe use exist[29]. This (practice) may, therefore, be unfairly penalising organic farmers whose crops are found to contain very low levels of GMOs through no fault of their own. Furthermore it is possible that 'positive' GMO presence in an organic crop might result from naturally occurring DNA (as found in the soil), from GM plant material that has not introgressed with the organic crop (ie, pollen on the surface of a crop) or be due to testing error.

7.2.2 Adoption of a de facto threshold for the presence of GMOs of 0.1%

Against a background of no organic sector-specific legal, *de minimis* threshold existing for the presence of GMOs in organic produce in both North America or the EU (ie, the 0.9% EU labelling threshold applicable to GMO presence in any product applies equally to organic produce), this is inconsistent with other thresholds and derogations operated in the organic sector. For example, the EU organic standards allow thresholds[30] of up to 5% for the presence of non organic ingredients in some processed foods, buyers of organic produce invariably operate to the same thresholds as apply to conventionally produced crops in respect of the presence of foreign material (eg, 2% for materials like dirt, weeds, stones in maize) and there are derogations for the use of:

- some pesticides such as copper-based fungicides on potatoes and Bt (bacillus thuringiensis), a bacterial fungicide used for the control of caterpillars - the Bt sprays are obtained by mass producing (using fermentation methods) the bacteria, which is then sprayed onto crops, killing caterpillars when they eat the (Bt) bacteria which contain a natural toxin to caterpillars. This naturally occurring toxin is the same element expressed in GM (Bt) maize, which is not permitted in organic agriculture;
- non organic seed;
- crop species and seed varieties derived from 'unnatural' plant breeding techniques (eg, triticale, a crop derived from the use of embryo rescue and chromosome doubling techniques);
- straw from conventional cereals can be used for livestock bedding – this is subsequently spread on organic production land as an important source of crop nutrients;
- up to 20% of ingredients used in organic animal feed can be derived from non organic ingredients[31], and
- some ingredients derived from GMOs may be allowed by certification bodies because of the lack of availability of non GM derived alternatives; this relates to possible use of some GM derived processing aids in some food products and veterinary medicines.

In all these cases, the organic status of the crop is not de-classified and consumers pay the full organic premium for these products.

[28] See for example IFOAM position paper on genetic engineering and GMOs; www.ifoam.org, page 2 and the USDA Organic Standards

[29] It is also interesting to note that all pesticides approved for use have safety-based maximum threshold levels for presence in crops. Conversely, GM crops approved for commercial use do not require the application of such thresholds for safe use

[30] There is also no requirement to label for the presence of these 'allowed' non organic ingredients/products, provided the thresholds are met

[31] Against the background of the 20% legal maximum for the use of non organic ingredients, some certification agencies apply a lower threshold of, for example 10%

Some in the organic sector seek to justify the practice of testing for GMO presence in organic produce to a 0.1% threshold as being necessary to maintain organic product integrity and consumer confidence. However, the inconsistency of this practice and the operation of wider tolerances and derogations for the use of non organic inputs/ingredients, undermines this consumer confidence argument. The more consumers are made aware of these 'allowances' for the use of non organic ingredients and inputs, the greater the potential for loss of confidence in the integrity of all organic products.

7.3 Proportionality

All co-existence measures established should be proportionate[32], non discriminatory and science-based. If highly onerous GM crop stewardship conditions are applied to all farms[33] that might wish to grow GM crops, even though the vast majority of such crops would not be located near to organic-equivalent crops or conventional crops for which the non GM status is important (see context), this would be disproportionate (and inequitable: see below). In effect, conventional farmers, who account for the vast majority of the current, relevant arable crop farming area could be discouraged from adopting a new technology, that it has been shown to deliver farm level benefits (yield gains, cost savings) and wider environmental gains (reduced pesticide use, switches to more environmentally benign herbicides, reduced levels of greenhouse gas emissions[34]).

7.4 Equity (fairness)

The issue of economic/marketing liability provisions that compensate non GM growers for adventitious presence of GM material is often raised in the co-existence debate. Historically, the market has adequately addressed economic liability issues relating to the adventitious presence of unwanted material in any agricultural crop by placing the onus on growers of specialist crops (eg, seed, organic) to take action to protect the purity of their crops (such growers usually being rewarded by higher prices for taking such actions). If legislation was to be introduced that created new economic liability provisions for any negative economic consequences of adventitious presence of unwanted material, it is reasonable to apply the same principle to all farmers regardless of their chosen production methods.

More specifically, it can be argued that GM growers should have equal access to compensation for adventitious presence of material from conventional or organic crops as conventional and organic producers have from GM growers. For example, on equity grounds a case could be made for providing economic compensation/liability in the following circumstances:

- *For farmers using GM technology for adventitious presence of non GM material*: the hypothetical (future) scenario of a farmer growing a crop with a GM quality trait that loses its (quality trait) price premia because of adventitious presence of non GM material above an agreed threshold; or equally the current scenario of a grower of a

[32] See EU Commission 'Recommendations on guidelines for the development of national strategies and best practices to ensure co-existence of GM crops with conventional and organic farming', 23 July 2003

[33] For example the setting of substantial separation distances between GM crops and any conventionally grown equivalent that go beyond what is reasonably required to meet legal requirements such as the EU's labelling threshold of 0.9%

[34] These impacts of the technology have been quantified and reviewed in a number of publications, including PG Economics (2003) Consultancy support for the analysis of the impact of GM crops on UK farm profitability, report for the Strategy Unit of the Cabinet Office, Ford Runge C & Ryan B (2003) The economic status and performance of plant biotechnology in 2003: adoption, research and development in the USA, CBI Washington and Gianessi et al (2002) Plant biotechnology current and potential impact for improved pest management in US agriculture: an analysis of 40 case studies, NCFAP, USA

specialist crop (eg, conventional or GM seed) that finds adventitious presence of unwanted varieties in their crops;

- *For all conventional farmers for adventitious affliction of neighbours pests, diseases and weeds*: for example an organic potato farmer who suffers a blight attack (mainly because of the much higher risks of infection in an organic system compared to a conventional production system) and this spreads to adjacent conventional farms, causing yield losses and/or the need to apply additional sprays to curb the disease;
- *For conventional farmers for loss of the benefits of new technology*: some farmers will be interested in adopting cost saving, higher yielding and more environmentally benign GM technology but may be discouraged from doing so by costly and dis-proportionate co-existence and liability conditions.

7.5 Practicality

All co-existence measures should be based on legal, practical and scientific realities. In particular, whilst absolute purity of the segregated product is striven for, it is a fact of any practical agricultural production system that accidental impurities can rarely be totally avoided (ie, it is virtually impossible to ensure absolute purity). To expect a 100% level of purity as the expected goal is therefore unrealistic and the stance taken by some organic certification bodies and NGOs that organic produce should have a zero tolerance threshold for adventitious presence of GM material is impractical (and dis-proportionate and inconsistent: see above).

8 Co-existence requires co-operation

Successful co-existence of different agricultural production systems requires mutual respect and shared responsibilities by all parties. Responsibility for implementation of co-existence measures should involve both GM and non GM growers communicating amongst themselves and implementing appropriate management practices.

The experience of North America shows that shared responsibilities for implementing co-existence has worked (without government involvement). The traditions of farmers growing specialist crops taking responsibility for adopting measures to protect the integrity and purity of their crops (in the knowledge that they are rewarded through price premia for incurring any associated costs involved) have been blended with farmers adopting new technology (GM) adhering to responsible crop stewardship conditions.

9 Developing co-existence guidelines or rules in any region, country or locality

The key messages to be taken from this paper are that the tools exist to facilitate good co-existence. These practices have been successfully enabling co-existence of GM and non GM crops (including organic) in North America since 1995. If the five key principles presented above (section 7) are used and adapted to local circumstances on a crop by crop basis, effective co-existence practices can be developed.

References

Brookes G & Barfoot P (2003) Co-existence of GM and non GM arable crops: case study of the UK, PG Economics Ltd, Dorchester, UK. www.pgeconomics.co.uk
Brookes G & Barfoot P (2003) Co-existence of GM and non GM crops: case study of Bt maize in Spain, 1st European Conference on the co-existence of GM crops with conventional and organic crops, Denmark, November 2003. www.pgeconomics.co.uk
Brookes G & Barfoot P (2004) Co-existence of GM and non GM arable crops: the non GM and organic context in the EU, PG Economics, Dorchester, UK. , 8th ICABR Conference on public goods and public policy for agricultural biotechnology, Ravello, Italy, www.pgeconomics.co.uk
Brookes G & Barfoot P (2004) Co-existence in North American agriculture: can GM crops be grown with conventional and organic crops? PG Economics Ltd, Dorchester, UK. www.pgeconomics.co.uk
Commission of the European Communities (2003) Recommendations on guidelines for the development of national strategies and best practices to ensure the co-existence of GM crops with conventional and organic farming, 23 July 2003, Com (2003) 2624 Def
Henry C et al (2003) Farm scale evaluations of GM crops: monitoring gene flow from GM crops to non GM equivalents in the vicinity: part one forage maize, DEFRA report EPG/1/5/138
Mele E et al (2004) First results of co-existence study: European Biotechnology Science & Industry News No 4, vol 3