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Segregating GM crops: Why a contentious ‘risk’ issue in Europe?

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Abstract

Since the Europe-wide ‘risk’ controversy over GM crops in the late 1990s, an extra issue has emerged: the prospect that GM material would become inadvertently mixed with non-GM products, which consequently may require a ‘GM’ label under EU law. The stakes for segregating non-GM crops were framed in contending ways. Agbiotech proponents sought to licence a biotechnologised nature as an eco-efficiency benefit, while framing admixture risks as an agronomic management problem which needs rules for co-existence. By contrast, biotech critics have foreseen a dangerous disorder of ‘GM contamination’, while framing this prospect as an ever-wider ‘risk’ issue, encompassing threats to human health, the environment and even democratic accountability. These contending frames intensified disputes over the appropriate rules for segregating GM crops from other agricultures. At stake were different visions of the socio-natural order, expressed by different accounts of risk, freedom and desirable futures. Conflicts of accountability took the form of disputes over market freedom versus coercion and unfair burdens on farmers; these concepts framed expert evidence and thus made it more contentious for any ‘science-based policy’, featuring disputes about whether specific management proposals were based on ‘politics rather than science’. For these reasons, biophysical admixture per se cannot entirely explain why the segregation problem became such a contentious ‘risk’ issue; a comprehensive explanation lies in contending policy frames, expressing different accounts of the socio-natural order.

Key words: biotech, coexistence, admixture, segregation, Europe

Introduction

Since the late 1990s agbiotech has remained controversial in Europe. Conflicts have continued over the safety of GM crops, especially for their use in food and feed products. Moreover, an extra issue emerged: the prospect that GM material would become inadvertently mixed with non-GM products, which consequently may require a ‘GM’ label under EU law. Such admixtures could cause practical difficulties and conflicts for operators in the agro-food chain, especially farmers. The mere presence of GM material lay beyond any ‘risk’ evaluated in the EU regulatory framework for agbiotech.

To address the admixture problem, there were various proposals for how to keep GM crops segregated from non-GM crops. In particular the European Commission elaborated a policy framework for the ‘coexistence’ of GM, conventional and organic crops – which could be segregated into separate agri-food chains. Yet these proposals generated further conflict over appropriate rules and aims for segregation measures, amidst a ‘risk’ controversy about ‘GM contamination’.

This paper analyses conflicts around the ‘coexistence’ policy framework, by discussing these questions:

Why/how did ‘coexistence’ become a contentious ‘risk’ issue?

What distinctions were made between un/necessary segregation measures to limit admixture?

How did the debate involve different accounts of technology, nature and the relevant knowledge?

What roles were played by expert advice?

As this paper will argue, the ‘coexistence’ controversy originated in practical issues of segregation and GM labelling, but also in definitional struggles around agbiotech vis à vis alternative futures for European agriculture. Stakeholders framed the admixture problem according to their general stance towards agbiotech – e.g., as efficiently ordering nature for societal progress, or as a dangerous disorder of ‘GM contamination’. From the latter perspective, agbiotech opponents turned an agronomic management problem into an ever-wider ‘risk’ issue, even a potential crisis of the agri-food chain; they advocated stringent measures or even ‘GM-free zones’ to protect vulnerable environments. These contending frames intensified disputes over the appropriate rules for segregating GM crops from other agricultures (see relation between Tables 1a and 1b).

That conflict was mediated by the European Commission through its ‘coexistence’ policy for producer-consumer freedom to choose GM, conventional and organic crops. This policy aimed to keep ‘market forces’ free, thus naturalising market competition for efficient commodity production. Within this policy framework, the political-economic power to impose GM crops (or to counterpose alternative agricultures) took the form of arguments about dis/proportionate segregation measures and thus il/legitimate constraints on free choice, respectively. Amidst those conflicts, expert studies and advice aimed to inform a ‘science-based framework’ for coexistence policy but could not avoid policy assumptions. Expertise provided agronomic-economic evidence about whether or not GM admixture would jeopardize the market value of non-GM crops – understood as the sole legitimate grounds to burden GM farmers with segregation measures. In those ways, Commission policy and its advisory expertise became extra arenas for conflict over the admixture-segregation issue.

To develop that argument, the paper analyses the following aspects in turn:

- Drivers of the GMO admixture-segregation issue
- Agbiotech framed as socio-natural dis/order
- Accountability and wealth in conflict
- Policy-based expertise

Each section starts with a sub-question of the main questions above and then concludes by drawing on relevant analytical perspectives. These points provide a basis to answer the overall questions in the Conclusion.

Drivers of the admixture-segregation issue

Questions: How was the admixture problem defined in various ways – and turned into a ‘risk’ issue?

Developments since the mid-1990s raised the stakes and mass-media profile of the admixture problem. When the first US shipments of GM grain reached Europe in 1996, the ships were greeted by symbolic protests against multinational companies ‘force-feeding us GM food’, portrayed as illicit contaminants. Consumer protest demanded that all food from GM grain be labelled as such. Major food retail chains adopted voluntary rules accommodating this demand, even before EU law standardised rules for labelling the presence of any detectable GM DNA or protein. Eventually retailers excluded GM grain from their own-brand products, especially to avoid any requirement for a ‘GM’ label (Levidow and Bijman, 2001).

In 2000 European farmers were found to be cultivating seeds which contained GM material lacking EU approval. Deemed illegal, the seeds created a crisis for the EU system. This episode stimulated a wider debate – on how to minimise the presence of any GM material in non-GM products, how to assign responsibility for this task, and how to set feasible thresholds below which a ‘GM’ label would not be required for conventional seeds and agri-food products.

The Commission coined a new term, ‘adventitious’, which went beyond the problem of accidental mixing. Adventitious meant a ‘low-level, technically-unavoidable and unintended presence’ (CEC, 2001a: 29). It implied a legal-moral duty to demonstrate that the presence was truly unavoidable. According to the new law, ‘operators must be in a position to supply evidence that they have taken appropriate steps to avoid the presence of such material’ (EC, 2003: 11) Adventitious originally denoted GM material present in grain or seed imports into Europe. Later the term also meant gene flow from GM crops in cultivation, which would warrant segregation measures of some kind.

For food and feed products, a draft regulation required labelling of GM products containing more than 1% adventitious presence of GM material, regardless of its detectability (CEC, 2001a). By contrast, previous rules covered only detectable GM material, so the new rule would apply to more products than before. The European agbiotech industry attacked the proposal for unfairly stigmatising GM products; indeed, they feared that consumers would perceive a GM label as a ‘skull and crossbones’, thus extending commercial blockages of GM ingredients. As a compromise with the Parliament, eventually the threshold was set at 0.9% (EC, 2003). This criterion would later become controversial as a basis for adequate segregation measures.

Organic crops in particular raised the stakes for ‘contamination’, economic loss and thus conflict among farmers. According to the EU Organic Standards Regulation 1804/1999, organic crops could not ‘use’ GM seeds but had no statutory threshold for any GM material which may be inadvertently present. According to the Commission, the labelling threshold therefore would be 0.9% – i.e. the same as for conventional crops – thus allowing small amounts of GMOs in organic crops. Given that GM maize had EU approval for commercial cultivation and so could plausibly spread its pollen to organic maize, organic farmers feared losing their premium price for organic maize.

More generally, a ‘GM’ label could mean a relatively lower market price, even for conventional grain. Given the price differential, admixture would be anyway an agronomic management problem, potentially generating claims for liability. In this commercial context, segregation measures would be necessary to avoid economic losses and legal disputes across the agro-food chain.

There were also deeper reasons why the admixture issue became so contentious. The commercial context was already a result of anti-biotech campaigns, which had successfully stigmatised GM crops as ‘pollutants’ and intensified public suspicion. GM labelling rules and market differentials responded to popular demands for ‘free choice’; consumers could make their own judgements about whether to trust safety claims and what agriculture to support through product purchases. From those origins, moreover, political protest further turned the admixture problem into an environmental risk issue.

Insert Tables 1a and 1b

European policy actors framed the admixture problem according to their general stance towards agbiotech, as shown in the relation between Tables 1a and 1b. According to

agbiotech proponents, admixture would be merely an economic problem, and GM material would not necessarily lower market prices for non-GM products. Good agricultural practices would suffice to limit admixture. Thus coexistence was possible, even necessary in order to diversify agricultural production. From its environmental management frame, the European Commission likewise regarded admixture as merely an economic problem but warranting special rules to ensure the ‘coexistence’ of diverse agricultural systems and farmers’ choices among them; appropriate rules would depend upon knowledge about gene flow in realistic commercial contexts.

Through apocalyptic discourses, protest stigmatised agbiotech as pollutants and so turned admixture per se into a wider risk issue. Agbiotech opponents warned that ‘GM contamination’ would deny consumers a choice to buy non-GM products, as well as aggravating uncertainties about environmental and health risks. This stigma became a potential means to block or delay commercialisation. Accommodating public concerns, some member states demanded that segregation rules be put in place before new GM products could be permitted for commercial use. To avoid further blockages, the EU system needed to broaden and/or supplement safety regulation, through clearer rules assigning responsibility for segregation.

In sum, admixture was turned into a risk issue by challenging the official categories of Commission policy. The admixture problem was initially driven by GM labelling rules, which could result in a lower market price for ‘GM’ grain. Commission policy distinguished between admixture as a merely economic-agronomic problem of products approved as safe, versus potential environmental risks of GM products not yet approved. That boundary was soon contested and blurred by anti-biotech activists stigmatising agbiotech. They constructed the admixture problem as a ‘risk’ issue by conflating economic and environmental issues. Their discourses resonated with wider public concerns – about freedom of choice, uncertainties in safety claims and hazards of agri-industrial production methods (see again Table 1a). Through these links, government came under greater pressure to broaden the regulatory framework. At stake were competing visions of the social order, as discussed next.

Agbiotech framed as socio-natural dis/order

Questions: In the agbiotech controversy, how were links drawn between natural characteristics, cultural meanings, social order and future agriculture?

Stakeholders disputed the meaning of environmental damage and gene flow from GM crops. GM material had different discursive frames linking the natural and social order. These frames could justify proposals to licence, discipline or block uses of GM products (see again Table 1a).

For proponents, agbiotech offers essential tools for a knowledge economy. As eco-efficient tools, GM crops minimise agrichemical usage and thus reduce environmental damage. Agbiotech provides a clean, precise, laboratory simulation of benign natural characteristics, capable of protecting agriculture from threats of wild nature (Levidow, 1996). As a remedy for unsustainable agriculture, GM crops facilitate ‘the sustainable intensification of agriculture’, according to Novartis (cited in Levidow, 2005).

In a similar vein, the admixture problem was readily manageable. Through genetic detection technologies, field tests had tracked patterns of gene flow for each crop, finding no difference between GM crops and their conventional counterparts. According to the industry, gene flow was normal, scientifically predictable, agronomically controllable and

socially acceptable, at least from GM crops which already had safety approval. As Europabio declared, 'Don't stigmatise GMOs: Protect the Environment.'

By contrast, opponents framed GMOs as a dangerous disorder, from which a vulnerable environment needs absolute protection. Environmental NGOs stigmatised GM crops as dangerous unnatural contaminants, whose safety claims could not be accepted or trusted. For example, German activists attacked *Gen-Müll*, i.e. GM garbage, referring to GMOs spreading freely in the environment.

In this apocalyptic frame, agbiotech was also stigmatised as a dangerous industrialisation of agriculture, being driven by commercial forces and imposing uncontrollable, unknowable risks. GM food was linked with past food crises resulting from unnatural methods. Drawing an analogy to the BSE scandal, GM food was linked with the unknown, untestable risks of CJD spreading from animals to humans (Greenpeace, 1997). By emphasising agro-industrial hazards and scientific ignorance about them, NGOs sought to undermine public confidence in safety claims for GM products.

For their Europe-wide campaign, NGOs adopted a honeybee logo to symbolize 'unwitting agents of genetic pollution'. This emphasised inherent limits of control over gene flow. Pollen was framed as naturally unpredictable and uncontrollable. Planting GM crops became an immoral, irresponsible activity which threatened the environment and undermined democratic accountability, amongst other metaphorical meanings of 'GM pollution' (Levidow, 2000). With this pollution language, environment was framed as a vulnerable victim of GM crops.

Since the late 1990s, moreover, NGOs have attacked agbiotech as 'unsustainable agriculture' and have counterposed alternative agri-food futures. Along with the Soil Association, representing UK organic farmers, Greenpeace launched a 'Campaign for Pure Food' in 1999. Organic products were contrasted with impure ones. The organic market increased, partly as an alternative to GM food. As the alternative to biotech, organic was eventually superseded by a broader category: 'green, quality' agriculture (e.g. FFA, 2005; see later sections).

In such ways, the benign status of agbiotech was contested in the context of industrialized agriculture and its familiar problems. Damage from chemical-intensive methods has long undermined any 'natural' status of agricultural products or processes, yet an idealised 'natural' status still has a popular appeal. As Ulrich Beck argues, nature has become an historical product: its injuries have become subject to scientific, counter-scientific and social definitions (Beck, 1992: 80-81). Indeed, stakeholders readily disputed the un/natural status of GM crops.

In contending ways, stakeholders distinguished between natural resources which bear promises or threats. As biotechnologised nature, GM crops promised a safe, precisely controllable protector of agriculture from wild nature – and thus protected the environment. As an uncontrollable disorder, by contrast, agbiotech threatened the environment; this apocalyptic discourse justified exclusion and discipline (cf. Hajer, 1995: 198). Thus nature and science were framed in ways which reorder social relations (cf. Jasanoff, 2004).

This conflict also illustrates an implicit feature of ecological modernisation. Generally its eco-efficiency agenda promotes technological progress as a dual means to minimise pollution and save costs. This policy frame reduces development issues to pollution control or reduction, thus marginalising social aspirations for alternative futures. By contrast, *reflexive* ecological modernisation deliberates choices of development models. This approach focuses on the social order in terms of how to define what constitutes pollution (cf. Hajer, 1995: 281). Through pollution metaphors of agbiotech, activists linked risk with

development issues and democratic accountability. In disputes over the ontological status of agbiotech – as a solution versus pollution – at stake were competing visions of the socio-natural order

At least at the EU level, government policy initially adopted the pro-biotech eco-efficiency storyline, legitimizing a biotechnologised nature as a promise of societal benefits. The Commission faced a difficult task: how to promote agbiotech in ways which could incorporate or marginalize opposition.

Accountability and economy in conflict

Questions: How was farmer responsibility assigned for segregating GM crops? What have been the different understandings of market freedom?

As the problematic nature of gene flow and admixture was highly contested, so was the burden of responsibility for segregating GM crops and thus clear accountability for any admixture. As described here, the responsibility was initially assigned to non-GM farmers, and then shifted to GM farmers. Even afterwards, various pressures and proposals sought to increase the burden upon them. Conflicts continued over the appropriate rules and aims for segregation measures.

Polluted farmers must pay?

When the admixture problem was raised as an extra issue beyond risk regulation, segregation measures had no clear statutory basis. In the market authorisation of a specific GM product, special conditions could be imposed – on grounds of uncertain risks– thus extending the experimental stage into commercial use (Levidow and Carr, 2007, 2010). However, admixture concerned GM products which were (or would be) approved as safe for freely circulating in the internal market. Any further restrictions had to be justified as necessary to protect the internal market. Some national authorities devised or demanded segregation measures to prevent admixture, as a general pre-condition for supporting approval of GM products or for permitting their use.

As a potential European model for coexistence, in January 2003 a Danish report based its scenarios upon the new GM labelling thresholds in EU draft laws. According to the report, ‘co-existence at the proposed threshold values is possible, as long as the measures suggested are adopted’. The report did not assume that such measures would be straightforward:

It is evident that co-existence in many cases will require good farm management and great care in the production. The group therefore suggests that a course in GM crop cultivation and handling is made compulsory for farmers – possibly as part of the farmer’s education (Tolstrup et al., 2003: 6).

This implied that significant responsibility lay with farmers who cultivate GM crops, though the issue was contentious throughout Europe.

In March 2003 the Agriculture Commissioner Franz Fischler issued advice so that each national authority could specify coexistence measures appropriate to its conditions. Authorities could develop or clarify legislation to provide liability for economic damage from adventitious presence of GM material. The Deliberate Release Directive, the main risk regulatory framework on GM crops, could not be used to regulate adventitious GM presence because it did not qualify as environmental harm, argued Fischler (2003: 5).

According to his advice, national laws could not simply impose a blanket ban to declare entire areas ‘GM-free’, as proposed by some regions. Moreover, the burden of coexistence measures should ‘fall on the economic operators (farmers, seed suppliers, etc.) who intend to gain a benefit from a specific cultivation model they have chosen’ (Fischler, 2003: 5).

Under this criterion, the burden would fall upon non-GM farmers, especially if ‘a benefit’ meant a premium price for products not labelled as GM. This criterion provoked sharp disagreement over the burden of responsibility.

Representing relatively large-scale industrial farmers, the Committee of Agricultural Organisations of the EU (COPA) welcomed this approach. COPA had expressed concern that GM material could spread irreversibly, to the point where non-GM seeds eventually become more difficult or impossible to obtain:

Farmers fear they will become the centre of a public dispute. If the thresholds are exceeded, despite farmers’ best efforts, then what?... If admixture eliminated conventional non-GM seeds, then this would go beyond a point of no return, thus ending freedom of choice (interview, COPA, 2002).

In response to the Fischler document, COPA welcomed the commitment to provide financial liability in cases of economic loss to non-GM farmers. But it wanted clearer management rules so that producers would have ‘legal security’ and so that all agricultural options would be economically viable (COPA, 2003).

By contrast, agbiotech opponents attacked the Fischler document, especially for reversing the ‘polluter pays’ principle: polluted farmers would pay through segregation measures or lower prices. According to several environmental NGOs, the Commission was ‘dodging its responsibility’ to prevent ‘genetic contamination’, given its foreseeable consequences: ‘With no hard legislation in this area, genetic contamination will soon become a *fait accompli* in EU agriculture, depriving European consumers and farmers of the right to choose’. Therefore clear, effective legislation was needed ‘to protect the agricultural assets of Europe’ (FoEE/GP/EEB, 2003). With this economic metaphor, a GM-free environment was framed as an economic investment under threat from GMOs. Along with the Coordination Paysanne Européenne, environmental NGOs demanded clear statutory rules which put the burden entirely upon GM farmers.

That demand was echoed by some politicians. According to Germany’s Agriculture Minister Renate Künast, ‘those who want to produce without GMOs in the future should under no condition be confronted with extra costs’. According to a press release by three Socialist members of the Parliament’s Environment Committee, the Commission should launch a ‘new, more ambitious proposal’ on coexistence (quoted in FoEE, 2003b).

By contrast, the agbiotech industry sought to place all responsibility on non-GM farmers, especially those doing ‘quality’ agriculture: ‘To allow specialty operators to formulate unrealistic standards for GM in their own produce would impose impossibly high standards on other activities and would effectively bar competition and impose a ban on the choice of other producers’ (Europabio, 2003a). Despite strong support for the Fischler criterion, it was soon reversed by fellow Commissioners.

Responsibility shifted to GM farmers

In mid-July 2003 new Commission recommendations somewhat accommodated the NGO demands to shift the responsibility, as follows: ‘farmers who introduce the new production type should bear the responsibility of implementing the actions necessary to limit admixture’ (CEC, 2003a: 9). GM crops would be a new production type nearly everywhere in Europe, except some parts of Spain, so this framework would place the major burden on GM farmers. Defeated on this issue, the agbiotech industry reiterated its earlier stance about responsibility for a ‘quality standard’, though it acknowledged the responsibility of GM farmers to follow guidelines: ‘On the other hand, the question of compensation for economic loss in case of admixture must be considered where growers do not follow the guidelines for good agricultural practices’ (Europabio, 2003b).

Another contentious issue was the target threshold for coexistence measures. According to the Commission recommendations, GM farmers had a burden to keep any GM material below the 0.9% threshold for GM labelling and thus avoid any economic loss to non-GM crops (CEC, 2003a). EU labelling law specified a threshold of ‘adventitious presence’, i.e. ‘technically unavoidable’ amounts. According to the Commission, small amounts would thus be acceptable, provided they do not exceed the 0.9% threshold for GM labelling.

However, during 2003-04 some governments and regional authorities drafted coexistence rules seeking to minimise the presence of GM material in other crops. In some cases, these rules aimed to exclude GM crops, implicitly or explicitly. According to Upper Austria, its ‘ecologically sensitive areas’ would need special protection through ‘GM-free zones’. With this argument, a state authority incorporated two general features of the apocalyptic frame: blurring any distinction between environmental and economic harm; and constructing vulnerable environments which warrant special protection from GM material. In response the Commission warned that such rules contravened EU law and so would not be enforceable under national law.

Environmental NGOs advocated stringent measures to segregate GM crops: Agro-industrial operators must make efforts to minimise ‘contamination’, they have a moral responsibility to demonstrate such efforts, and segregation rules should keep GM admixture as low as possible. Earlier, coexistence was deemed impossible, perhaps even undesirable. With the new emphasis on stringent rules, environmental NGOs implicitly shifted their strategy – from total opposition, to potentially accepting GM crops.

The strategic shift also arose in a European Parliament report demanding liability rules to protect non-GM farmers, as an element of a coexistence regime (EP, 2003). The initiative came from Green MEPs, who thereby softened their previous overt opposition to GM crops:

Without legislation for liability and coexistence, we oppose GMOs. Of course, if we accept coexistence, then we accept GMOs in some form, provided that all procedures are in place and respected. The Green Group has undergone a political evolution, from opposing GM crops to demanding stringent rules.... Green MEPs from some countries – Netherlands, Spain, Germany – have relatively greater influence. This is important from a political viewpoint, so we propose the most stringent regulations possible (EP Green Group advisor, interview, February 2004).

Now ‘coexistence’ rules could be used to make GM cultivation difficult, perhaps even impossible – in the name of protecting the freedom to cultivate conventional or organic crops. Regarding the legitimate goal for segregation measures, there was a contested boundary between the GM labelling threshold versus minimisation of GM material, in the name of preventing ‘adventitious presence’.

Whose market freedom?

To minimise adventitious presence, regions and governments drafted laws which could be used to restrict or even preclude GM crops (Levidow and Boschert, 2008). Such restrictions were advocated specially to protect ‘quality’ agri-production, e.g. organic or specialty products, broadly called ‘sustainable agriculture’. Many regional authorities were aiming to set or maintain high prices for European agricultural products through local brands and identities recognised by consumers. These identities provide a basis to enhance the market value of diverse local agri-products and resources, seen as environmental assets.

The regional plans provoked arguments about whether they were politically motivated – indeed, about how to distinguish between political, economic and scientific reasons. According to DG-Environment, ‘the request for establishing GM-free zones is very often driven more by ideological concerns than by an objective assessment of the risks involved’ (ibid). By contrast, ‘This discussion [on coexistence] is not about ideology but about

practice and economics', according to Graefe zu Baringdorf, vice-chair of the European Parliament's Agriculture Committee (Anon, 2003).

Increasing numbers of regional authorities affiliated to a 'GM-free network', which held a series of high-profile Europe-wide conferences (e.g. FFA, 2005). Eventually the network gained support from the Assembly of European Regions (AER, 2005). Its 'GM-free' declaration went beyond specific measures to segregate GM crops, instead seeking to exclude them as an existential threat to local environmental assets. Regional authorities were promoting 'GM-free regions' as a rural space for green, high-quality agri-production. Symbolising environmental purity, i.e. unpolluted spaces, 'GM-free' provided a regional brand for alternative agricultures and marketing strategies. The initial agenda was ambiguous, initially asking the Commission for permission to exclude GM crops, though also seeking ways to deter or even prohibit them.

When the Commission issued a progress report on national plans for coexistence, it briefly noted the non-statutory declaration of 'GM-free zones'. It also signalled that any rules contravening EU law would be invalidated. As the only legitimate aim, 'National coexistence legislation should allow market forces to operate freely in compliance with [EU] legislation' (CEC, 2006: 3). By contrast, some 'proposed measures... appear to entail greater efforts for GM crop growers than necessary, which raises questions about the proportionality of certain measures'. The report warned against 'overly restrictive measures that go beyond the objective of ensuring coexistence, and which may make the cultivation of GM crops practically impossible' (CEC, 2006: 6, 9).

Agbiotech opponents attacked the Commission for a policy of 'permitted contamination', cast as environmental irresponsibility. Its policy would allow GMOs at levels up to 0.9%, as the basis for GM labelling and thus for segregation measures. On the contrary, any unavoidable 'contamination' must be prevented: agro-industrial operators must attempt minimisation, they have a moral responsibility to demonstrate such efforts, and segregation rules should keep GMO admixture as low as possible (FoEE, 2006).

The debate featured different accounts of market freedom. This conflict erupted starkly at an EU Presidency conference entitled 'Co-existence between GM and Non-GM Crops: Freedom to choose'. Some speakers defended Commission policy on ensuring that farmers would have all options, while others regarded GM crops per se as a threat. In the workshop on stakeholder viewpoints, health and environmental impacts of GM crops featured prominently (Gaskell, 2006). After the conference, the agbiotech industry criticised the views of some participants, including the rapporteur of a European Parliament report:

... comments by Mr Graefe zu Baringdorf MEP that farmers are being 'forced' to use GM technology are simply wrong. It does however appear there are many here today who wish to deny any choice to farmers (Europabio, 2006b).

In other words, they sought to deny the choice of GM crops and food, in the name of protecting non-GM farmers from contamination and coercion.

Market freedom was likewise defended by the DG-Agriculture Commissioner in her conference talk. Segregation rules must allow the cultivation of safe GM crops:

Where a product has been shown not to be harmful, in principle the rules of the free internal EU market apply. So, also, do WTO rules, as we have seen. The debate on co-existence must be about ensuring co-existence, not preventing it... co-existence policy is not about the safety of people, animals or the environment (Fischer Boel, 2006).

At the same conference, however, a fellow Commissioner blurred the official distinction between safe GM products and uncertain risks, and thus again between safety and segregation measures:

As an Environment Commissioner, I am keen to ensure that the environment is protected from potential risks arising from the cultivation of GMOs. Coexistence measures, on top of the benefits they provide in purely commercial terms, can play a role in this respect (Dimas, 2006).

He saw legitimate grounds to restrict 'safe' GM products, thus potentially favouring market freedoms of alternative agricultures. His comment reflects tensions among European politicians, even within the Commission, regarding how to accommodate public and commercial concerns.

Adventitious presence: linking societal bads and goods

In sum, in disputing the responsibility for segregation, market freedom was counterposed to coercion in divergent ways, corresponding to three discursive frames. According to the agbiotech industry, 'while some member states have set in place reasonable science-based rules to achieve a fair co-existence regime, others have clearly developed disabling rules that are aimed at denying choice to farmers and consumers' (Europabio, 2006). Invoking free choice in a different way, environmental NGOs attacked the Commission policy for coercion. According to Greenpeace, the Commission was trying to bully 'any country or region that wants to defend the right of farmers and consumers not to plant GMOs or eat GM food' (quoted in Lewis, 2006). Moreover, 'consumer confidence in organic food will be seriously undermined', along with EU policy to expand this sector (FoEE, 2006: 5).

From agbiotech proponents and opponents alike, then, market freedom for some farmers was denounced as coercion or an unfair burden for other farmers. Indeed, any rules would restrict some freedoms more than others, thus favouring one agricultural model over another. This conflict arose from European integration through the internal market, whereby any product approved as safe must gain free circulation – unless it jeopardises other market freedoms.

From its managerialist frame, Commission policy effectively favoured the freedom of an agri-industrial economy over 'quality' production. The latter could not be fully protected from GM products circulating in the internal market, much less from the stigma of GM material. The Commission warned that rules excessively burdening GM farmers would preclude their choice of GM crops, though more stringent rules could be justified by specific agronomic conditions (CEC, 2006). At the same time, the Commission rejected any statutory attempts to minimise the presence of GM material, on grounds that such rules would deny market freedom and distort the internal market.

Although farmers wanted clearer rules, specific proposals became aligned with different economic interests, cultural values and agricultural models. Greater burdens upon GM farmers were advocated by those promoting alternatives to industrial agriculture. In farmer accountability for segregation measures, there was a tension between minimising 'adventitious presence' versus controlling it within a specific threshold. According to Ulrich Beck,

In the risk society, conflicts over the distribution of the 'bads' produced by it are superimposed by the conflicts over the distribution of societal 'goods'... The former can be shown to be conflicts of accountability [which] break out over how the consequences of the risks accompanying commodity production... can be distributed, averted, controlled and legitimated (Beck, 1996: 28).

Through their contending frames, stakeholders intensified conflicts over appropriate rules for assigning responsibility to farmers, and thus their accountability for harmful consequences. In dispute was not simply the distribution of 'bads' – but also their definition and their link with societal 'goods'. Admixture was successively reframed and broadened: 'GM contamination' was turned into unknown environmental risks, as well as an existential threat to alternative agro-food chains as societal goods.

Thus risk and benefit were linked through contending accounts of economic wealth. In the ‘economy of quality’, the value of goods depends upon immaterial sources, so risk policy has a direct impact on the value of goods and is thus directly linked to wealth production (Allaire, 2004). Agro-industrial products derive their value mainly from the efficient production of bulk commodities, dependent on market freedom of innovation and input suppliers. By contrast, green or quality products derive their value from local brands and social identities. From the latter standpoint, any local ‘GMO pollution’ could stigmatise a local reputation and threaten its immaterial sources of wealth. The latter accounts could justify greater restrictions and economic burdens upon GM crop cultivation.

Thus market value was linked to segregation policies, for reasons beyond biophysical admixture per se. Proposed segregation rules involve competing visions of social order and economic wealth, thus intensifying conflicts of accountability for potential harm. As the legitimate goal for segregation measures, there was a contested boundary between the GM labelling threshold versus minimisation of adventitious presence. There was also a contested boundary between ‘contamination’ as a measurable biophysical presence versus a symbolic threat to local environmental assets.

Policy-based expertise?

Question: How did expert advice envisage the need for preventive measures to segregate GM crops? How did the debate draw links or boundaries between science and policy?

Scientific expertise has been central to the debate on coexistence. Along with some member states, the Commission has funded research on potential admixture and segregation measures since at least 2002. Researchers have emphasised uncertainties about gene flow, which depend on farm structure and practices – contingencies warranting studies which could inform segregation measures. The Commission sought to base its policy on expert advice, yet this remained dependent on policy assumptions. As expertise became a political weapon, it also came under criticism and pressure to accommodate different assumptions.

Challenging expert assumptions

Research has aimed to inform a science-based policy on coexistence. For example, an EU project has sought to develop ‘a science-based framework, strategies, methods and tools for assessing ecological and economical impacts of GM crops and for an effective management of their development within European cropping systems, i.e. to create a practical toolbox’ (SIGMEA, 2003). This aim implies that science could remain independent of policy assumptions. At least in the early stages, however, expert advice took for granted a policy commitment to GM agriculture, while treating other agricultures as potential casualties of admixture. These commitments and assumptions were soon contested and shifted.

Expert advice was sought early on for the issue of GM thresholds in conventional seeds, i.e. the adventitious level which would warrant a mandatory ‘GM’ label. Initial discussions focused on trace material from GM varieties which could be legally cultivated in the EU. The Commission proposed to set thresholds according to the out-crossing behaviour of each crop, e.g. at 0.3% for oilseed rape and 0.5% for maize. These aimed to ensure that any GM presence in food or feed would be kept below 1%, the proposed threshold for food.

If GM crop cultivation became widespread, the proposed seed thresholds could be difficult to maintain over time, especially because oilseed rape can cross-hybridise over great distances. According to the EU’s scientific committee:

Achieving the 0.3 and 0.5% thresholds [for seeds] will become increasingly difficult as GM crop production increases in Europe. In due course the 1% threshold [for food & feed] set by the Commission may have to be increased (SCP, 2001).

Agbiotech opponents cited gene flow as grounds to challenge the feasibility of coexistence, understood by them as zero GM material in ‘GM-free’ crops. According to EU experts, however, such ‘zero tolerance does not exist’ – as grounds to permit some GM material in conventional seeds. Environmental NGOs attacked that advice as led by ‘political and commercial assumptions, rather than scientific criteria’ (Greenpeace quoted in Agence Press Europe, 26.07.01). Indeed, the expert advice did make assumptions, e.g. about persistence timescales for some species and about commercial cultivation practices, thus leading critics to challenge the putative scientific basis for policy. There was no agreement on ‘good practice for seed production’. If producers do not want to label their seeds as GM, then good practices must be defined in detail, NGOs argued (FoEE, 2001).

According to a later EU-wide study (EEA, 2002), current cultivation practices may be adequate to ensure co-existence for many crops, but extra measures would be needed for the three GM crops awaiting commercialisation – maize, beet and especially oilseed rape. The feasibility and extra costs to farmers would depend upon factors which lie somewhat beyond their control – for example, GM thresholds in non-GM seeds, and the local extent of GM cultivation. Some GM crops would pose special difficulties:

Varieties and lines containing male-sterile components will outcross with neighbouring fully fertile GM oilseed rape at higher frequencies and at greater distances than was previously thought (EEA, 2002: 56).

Agbiotech opponents cited those results to confirm their argument that coexistence would be impossible.

To explore its feasibility, scientists advocated and carried out more research on environmental-agronomic uncertainties. Their predictive models incorporated several types of knowledge, including information on seed banks, gene flow, cultivation practices, cropping systems and landscape patterns. According to their report,

All farm types producing oilseed rape or conventional maize will need significant changes to meet their thresholds... changes may involve cooperation between neighbouring farms (DG-JRC, 2002: v).

For each crop, ‘farms producing conventional certified seed would have additional costs’ of a specific percentage; likewise ‘additional costs for conventional intensive production’. These expert predictions had an explicit normative assumption: ‘In the analysis all costs are allocated to conventional or organic crop production, including those affecting primarily GMO production in case of co-operation’ between neighbouring farms. ‘All identified costs are borne by the non-GM production’, given that GM farmers had no legal obligation to minimize ‘adventitious contamination of neighbouring non-GM crops’ (ibid: vi, 13). Thus the research design assumed that a biotechnological future would impose financial burdens on other agricultures. This assumption came under widespread attack. Eventually the Commission assigned segregation burdens to the ‘new production type’, generally meaning GM crops (CEC, 2003, cited earlier).

Modelling economic burdens

EU experts adjusted their own assumptions to the official shift in responsibility. Earlier predictive scenarios presumed self-discipline mainly by non-GM farmers, who would bear the burden of segregation measures. ‘The coexistence study, completed in 2002, assumed that all costs were borne by non-GM farmers.’ By contrast, now ‘any additional measures needed and the estimated costs are allocated to GM crop growers’, according to the January 2006 report of a new study (DG-JRC, 2006: 17).

The 2006 report also investigated farm practices that could influence adventitious levels of GM material. It used computer models that can operate at landscape level by taking into account spatial patterns, agricultural practices, climate and crop rotations. These models assumed that some ‘parameters are difficult to change’, e.g. the relative size of GM and non-GM fields, as well as their relative position vis à vis dominant winds.

For more changeable parameters, the models simulated ‘three measures targeting GM crop growers in order to reduce gene flow’. These three measures were: isolation distances, buffer strips and different flowering dates. Through the computer models, all three segregation measures were simulated and ranked according to their efficiency in reducing cross-pollination, foreseen as the main source of adventitious presence.

Isolation distances could be easily implemented in areas of large farm sizes but would be more difficult where they lie in close proximity, thus restricting freedom of choice:

... isolation distances in practice affect a number of farmers that may not be able to freely choose the production type since the positions of their fields relative to other owners’ fields difficult compliance with the corresponding thresholds, even if segregation measures are taken (DG-JRC, 2006: 37).

Moreover, tighter norms could pose difficulties for some farms producing maize seed:

If the opportunity costs of increasing isolation distances are taken into account, the income losses for farmers due to the suggested coexistence measures can reach significant levels often exceeding 40% of the gross margin for maize seed production in France (ibid: 51).

This would specially arise for ‘small non-GM seed production plots and low thresholds for adventitious presence of GM material’.

Regarding buffer strips, in cases of non-GM crops near GM fields, ‘Consensus expert opinion is that [GM] farmers will manage these fields by sowing non-GM maize’ as buffer strips (DG-JRC, 2006: 11-12). This measure would be needed if the two types have a price differential, but not needed under a different assumption:

However, based on the Spanish experience growing Bt maize, it can be assumed that the GM maize grower will harvest both types of maize together and will label the total grain harvested as GM maize. This assumption would significantly reduce the non-GM buffer costs (DG-JRC, 2006: 39).

By contrast to the earlier expert report (DG-JRC, 2002), this one included extra parameters about how to predict and/or ensure compliance by GM farmers with segregation measures. For their practical relevance, the models would depend upon turning predictions into effective prescriptions for farmer practices, according to specific aims or norms for segregation measures. The 2006 expert report warned about economic burdens from more stringent norms than necessary to avoid economic loss.

Those warnings became evidence in policy debate. Citing the 2006 study, the DG Agriculture Commissioner declared, ‘The use of GMOs in organic produce is not acceptable, but we have a standard contamination threshold of 0.9% that is in line with the real world’ (Anon, 2006a). She dismissed demands for lower thresholds, especially zero tolerance for organic crops. By invoking ‘the real world’ as objective reality, she promoted a specific future.

As seen in the above story, a policy commitment to a biotechnological future through the EU internal market generates extra economic burdens – price differentials and/or segregation measures to avoid a lower price. In modelling these costs, experts made policy assumptions – about the distribution of risks, costs and responsibilities – which changed somewhat in favour of non-GM farmers. New expert studies opened up new options for self-discipline and economic burdens on GM farmers.

In order to validate coexistence scenarios, expert assumptions about farmer behaviour had to be turned into prescriptions for segregating GM crops while also facilitating them. In this way, expertise involves framing commitments which ‘embody models of the social world’; what begins as hypothetical assumptions about rules being rigorously followed, for example, can become increasingly prescriptive demands to be ordered into existence, in order to confirm the expert analysis (Wynne, 1996: 58). However, any prescription was criticised for

infringing farmers' freedom of choice in the EU internal market, according to each policy frame.

Consequently, expert advice became an integral part of the conflict. Although expertise sought to provide a 'science-based framework', this effort came under criticism – as based on optimistic assumptions, even as based upon politics rather than science. For 'decisions based on science', a commentator noted 'that science appears in the role of the management consultant; it tends to be accepted when it accords with prior expectations and opinions' (Gaskell, 2006).

Why such dispute over science-based policy? This can be analysed as a conflict over the science/policy boundary. Ulrich Beck notes:

Boundaries of knowledge – between un/scientific, between expert/lay, between science/politics – have been drawn in several places at the same time... The established sciences no longer have the definitive power to end disputes (Beck et al, 2003: 20).

In the agbiotech case, such boundaries were indeed established, challenged and then shifted. Policy change broadened the 'scientific' questions for experts to answer. But it would be misleading to ask whether 'the definitive power of science' was lost, as if knowledge per se had such power. Rather, for its cognitive authority and policy relevance, expertise has always depended upon power relations – in the practices under study, expert networks and wider institutional forces.

A relational analysis of the science-power interface suggests that power should be analysed as inherent in the knowledge claims and the various practices through which scientific claims gain authority and credibility (Hajer, 1995: 139).

For advice on coexistence policy, expert authority depended upon eventually incorporating different assumptions and norms – especially the responsibility of GM farmers, who thereby could maintain their market freedom. Citing such expert advice, the Commission licenced farmers' power to impose adventitious levels of GM material within EU labelling thresholds. Such power was inherent or presumed in knowledge claims about the economic burdens of more stringent segregation measures, especially in the scenario of GM crops being widely cultivated. This scenario was variously framed – as a freedom being unfairly infringed, as a self-fulfilling prophecy which inherently threatened non-GM crops, or as a 'real-world' context for relevant evidence to inform coexistence measures.

Conclusion: why a contentious 'risk' issue?

Here we return to our original questions:

Why/how did 'coexistence' become a contentious 'risk' issue?

What distinctions were made between un/necessary segregation measures to limit admixture?

How did the debate involve different accounts of technology, nature and the relevant knowledge?

What roles were played by expert advice?

Contending frames

As this paper has shown, the 'coexistence' controversy originated in practical issues of segregation and GM labelling, but also in definitional struggles around agbiotech vis à vis alternative futures for European agriculture. Stakeholders framed the admixture problem according to their general stance towards agbiotech – e.g., as more efficiently ordering nature for societal progress, or as a dangerous disorder of 'GM contamination'. From the latter perspective, agbiotech opponents turned an agronomic management problem into an ever-wider 'risk' issue, even a potential crisis of the agri-food chain; they advocated stringent measures or even 'GM-free zones' to protect vulnerable environments. These

contending frames intensified disputes over the appropriate rules for segregating GM crops from other agricultures (see relation between Tables 1a and 1b).

That conflict was mediated by the European Commission through its ‘coexistence’ policy for producer-consumer freedom to choose GM, conventional and organic crops. This policy aimed to keep ‘market forces’ free, thus naturalising market competition for efficient commodity production. Within this policy framework, the political-economic power to impose GM crops (or to counterpose alternative agricultures) took the form of arguments about dis/proportionate segregation measures and thus il/legitimate constraints on free choice, respectively.

Amidst those conflicts, expert studies and advice aimed to inform a ‘science-based framework’ for coexistence policy but could not avoid policy assumptions. Expertise provided agronomic-economic evidence about whether or not GM admixture would jeopardize the market value of non-GM crops – understood as the sole legitimate grounds to burden GM farmers with segregation measures. Yet expert advice became an integral part of the conflict, featuring disputes about whether specific proposals were based on ‘politics (or ideology) rather than science’. In those ways, Commission policy and its advisory expertise became extra arenas for conflict over the admixture-segregation issue.

This case study illustrates ‘conflicts of accountability over the consequences of the risks accompanying commodity production’ (Beck, 1996: 28). However, the conflicts run more deeply than ‘bads’ undermining ‘goods’. In dispute was how to define agri-environmental goods and bads, e.g. GM crops as wealth versus pollution – thus a definitional struggle over agricultural futures.

According to agbiotech proponents, GM products offer eco-efficiency benefits and environmental improvements by reducing agrichemical usage. Admixture would be merely an economic problem, and GM material would not necessarily lower market prices for non-GM products. Good agricultural practices would suffice to limit admixture. Thus coexistence was possible, even necessary in order to diversify agricultural production.

From their apocalyptic frame, agbiotech opponents emphasised the threat of ‘GM pollution’. This symbolised uncertain risks to human health and the environment, threats to consumer choice, free-market globalisation undermining democracy, etc. Segregation measures should attempt to minimise GM material across the production chain. Using the admixture issue, agbiotech opponents sought to impede the safety approval and commercial use of additional GM crops.

Moreover, opponents counterposed ‘sustainable’ alternatives – initially organic products, and later ‘green, quality agriculture’. Active opposition was greatly expanded – from environmental groups and *paysans*, to consumer groups and regional authorities promoting alternative agri-food chains. By 2004 a broad ‘GM-free network’ framed agbiotech as an existential threat to local environmental assets, e.g. their green and quality image. In all these ways, the admixture problem was turned into a difficult ‘risk’ issue for industry and government.

From its environmental management frame, the European Commission mediated the conflicts between the other two frames, while elaborating a distinctive policy. This aimed to gain consumer-public confidence in segregation rules and governmental compliance with EU rules, thus protecting agbiotech as a key resource of the ‘knowledge economy’. As an economic problem, potential admixture warranted special rules to ensure the coexistence of diverse agricultural systems and farmers’ choices among them. Initially the Commission

assigned the responsibility for segregation to non-GM farmers; under criticism, this was shifted to the 'new production type', i.e. GM crops in most places.

Discursive boundaries

Amid the above disputes, stakeholders deployed discursive boundaries in advocating specific segregation measures, or in opposing them as illegitimate. These boundaries corresponded to less versus more restrictive measures on agbiotech, for example:

- GM crops as a benign biotechnologised form of nature which would help protect the environment – versus pollutants threatening nature and society.
- 'Contamination' as a measurable biophysical presence – versus an uncontrollable, unknowable risk, as well as an existential threat to local environmental assets for alternative agricultures.
- Admixture as merely an economic problem of safe products – versus an environmental risk, given the uncertainties in safety claims.
- 'Adventitious' as a 'technically unavoidable' presence to be pragmatically accepted – versus a burden to demonstrate and improve efforts at avoidance, especially as a basis for segregation measures.
- Segregation measures 'proportionate' to the GM labelling threshold – versus measures to minimise GM material.
- 'Freedom of choice' as a right of economic operators to enhance productive efficiency through GM crops – versus a right to protect quality products from contamination, even from stigma.

By setting or contesting those boundaries, policy actors were promoting their account of the policy problem, while seeking to discredit other accounts. Agbiotech proponents sought to licence a biotechnologised nature as an eco-efficiency benefit, while opponents sought to restrict 'GM pollution' as an environmental threat. In those divergent ways, nature was recast to reorder social relations, by licensing or blocking a contentious innovation (cf. Jasanoff, 2004). Policy actors promoted different agricultural futures; in so doing, they disputed how to diagnose the historic 'injuries of nature' from industrial agriculture, how to define the environment that needs protection, and how to propose remedies (cf. Beck, 1992).

In sum, at stake were different visions of the socio-natural order, expressed by different accounts of risk, freedom and desirable futures. As agbiotech opponents gained greater societal support, they turned admixture into an ever-wider 'risk' issue, even a potential crisis of an agri-food chain threatened by 'GM contamination'. Conflicts of accountability took the form of disputes over market freedom versus coercion and unfair burdens; these concepts framed expert evidence and thus made it more contentious for any 'science-based policy'.

Coexistence policy was originally meant to mediate the societal conflict over agbiotech, yet the policy framework and its expertise became an extra arena for contending agricultural futures. For these reasons, biophysical admixture per se cannot entirely explain why the segregation problem became such a contentious 'risk' issue. A comprehensive explanation lies in contending policy frames, expressing different accounts of the socio-natural order.

Table 1: Discursive Frames Linking Agbiotech with the Admixture Problem

<p><i>Legislators & regulators</i> Managerialist frame European Commission & Parliament; some governments; Committee of Agricultural Organisations of the EU (COPA)</p>	<p><i>Agbiotech promoters</i> Eco-efficiency frame Europabio, MEPs of European People's Party (EPP)</p>	<p><i>Agbiotech opponents</i> Apocalyptic frame Greenpeace, FoEE, Coordination Paysanne Européenne (CPE), Green Group of MEPs, Assembly of European Regions (AER)</p>
<p>Table 1a: Agri-technological policy</p>		
<p>Consider the risks of not developing technologies to remedy unsustainable agriculture (CEC, 2002: 15)</p>	<p>Technological innovation = progress; GM crops can safely sustain intensive agriculture; "Don't stigmatise GMOs: protect the environment"</p>	<p>De-intensify & re-localise agriculture; support multifunctional farms & sustainable family farming (CPE, 2001)</p>
<p>Develop the knowledge-based economy for international competitiveness of European industry (EU Council, Lisbon 2000)</p>	<p>Support aims of Lisbon summit (implying that competitiveness depends on greater productive efficiency)</p>	<p>Oppose GM agriculture as non-competitive, e.g. losing markets and jeopardising non-GM markets</p>
<p>Regulatory decisions should be based on sound science and other legitimate factors</p>	<p>Regulation should be science-based, consistent and workable</p>	<p>Regulation should be based on the Precautionary Principle (recognising uncertainties of risk science)</p>
<p>Consumer choice is essential for gaining consumer confidence</p>	<p>Consumers need a choice to buy GM or non-GM products</p>	<p>Consumers need the freedom to choose non-GM products</p>
<p>Products should be labelled as 'GM' above a threshold of adventitious presence</p>	<p>New labelling rules would impose a 'skull & crossbones', unfairly stigmatising GM products</p>	<p>Labelling threshold of adventitious GM material should be as low as possible and demonstrably unavoidable</p>
<p>Table 1b: Admixture & coexistence</p>		
<p>Coexistence is necessary and feasible; no form of agriculture should be excluded</p>	<p>Coexistence is necessary and feasible; oppose discriminatory and disproportionate measures</p>	<p>A coexistence system appears to be practically impossible (2001); coexistence needs tighter rules, even 'GM-free zones' (2003)</p>
<p>Admixture is an economic issue about how to limit adventitious presence of safe GM material</p>	<p>Admixture is about economics – distinct from safety issues; (UK: rules should not assume that GM crops will trade at a discount)</p>	<p>GM pollution (admixture) would aggravate uncertainties about environmental & health risks</p>
<p>Gene flow is contingent upon farm structures and practices, which warrant research to inform segregation measures</p>	<p>Gene flow is predictable and controllable; accept technically unavoidable traces of GM crops</p>	<p>Gene flow is unpredictable and uncontrollable, as symbolised by the bumblebee</p>
<p>Management measures should be proportionate, based on specific knowledge about agricultural systems and gene flow</p>	<p>Normal management measures will be adequate to segregate forms of agriculture; use established principles – common sense, forethought, neighbourliness and good communication</p>	<p>Management measures may never be adequate to protect non-GM crops</p>
<p>The burden should fall on economic operators who intend to gain a benefit from a specific cultivation model (Fischler, March 2003). Farmers who introduce a new production type should bear the responsibility (CEC, July 2003)</p>	<p>Growers who meet a quality standard that provides a higher value product should not expect their neighbours to bear their management costs of meeting that standard (UK: if GM or non-GM farmers are at fault, then they should bear the responsibility)</p>	<p>The polluter should pay: GM growers should have full responsibility and strict liability</p>

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