

Strategy Unit Study on the Costs and Benefits of GM Crops: Seminar on “Shocks and Surprises”

(Seminar held on Thursday 3rd April at Kirkland House, 22 Whitehall)

List of Attendees

<i>External Stakeholders</i>	
Dr Simon Bright – Syngenta	Bernard Marantelli – Lexington Communications
Neville Craddock - Neville Craddock Associates	Dr Sue Mayer - Genewatch UK
Professor Phil Dale - John Innes Centre & Public Debate Steering Board	Peter Melchett - Soil Association
Sue Davies - Consumers’ Association	Archie Montgomery – NFU
Emily Diamand - Friends of the Earth	Professor Vivian Moses – Cropgen
Professor Jim Dunwell – Reading University	Dr Doug Parr – Greenpeace
Professor Robin Grove-White - University of Lancaster & Public Debate Steering Board	Dr Bruce Pearce - Elm Farm Research Centre
Beth Hogben – NFU	Professor Alison Smith – John Innes Centre
Anna Hope - English Nature	Dr Jeremy Sweet – NIAB
Dr Brian Johnson - English Nature	John Turner – FARM
Jill Johnstone - National Consumers’ Council	Roger Turner - British Society of Plant Breeders
Gary Kass - Parliamentary Office of Science and Technology & Public Debate Steering Board	Rachel Wilson - Sainsbury’s
Peter Lundgren – FARM	Professor Brian Wynne – University of Lancaster
<i>Government Stakeholders</i>	
David Calpin – DEFRA	Chris Savage – DOENI
Natalia Davie – DTI	Huw Jones – Welsh Assembly
Liz McCullough - DOENI	Adrian Butt – OST
<i>Strategy Unit</i>	
Vicki Bakhshi	Matthias Kempf
Ian Coates	Halima Khan
Adam Heathfield	Jamie Rentoul

“Shocks and Surprises” and the Objectives of the Strategy Unit Seminar

1. The Strategy Unit GM Crops team held its seminar on “shocks and surprises” on Thursday 3rd April. Attendees are listed in the above table. The seminar had an important role to play in helping the Strategy Unit to explore and to take into account the issue of “uncertainty”, and its implications for the GM Crops study.¹
2. For the purposes of its work in the GM Crops study, and for the purposes of this seminar in particular, the Strategy Unit has defined “shocks and surprises” as:
 - Positive or negative events (i.e. “shocks and surprises” can produce beneficial or adverse impacts);
 - Not necessarily captured by any of the Strategy Unit’s scenarios²;
 - Which – if they arose – could have a very significant impact across some or all of the scenarios.
3. By their very nature, “shocks and surprises” will often be perceived to have a low and / or uncertain probability of occurring – but this probability may also be disputed among different groups of stakeholders.
4. In the light of this definition, the objectives of the seminar were:
 - To draw up a wide range of shocks and surprises that are illustrative and indicative of the kinds of events that the Strategy Unit needs to take into account;
 - To obtain an indication of different stakeholders’ views of what would make these shocks more or less likely, and more or less important;
 - To assess in detail the likely impact of four specific “shocks and surprises” prepared by external stakeholders – focusing in particular on how these impacts might be different under each of the Strategy Unit’s scenarios.
5. It is important to be clear about the limitations of the seminar. “Shocks and surprises” are inherently unpredictable, and there was no sense in which the seminar was meant to try to predict what will happen. The seminar focused on what could happen as a result of some “shocks and surprises” that can currently be specified. This was interesting in its own right. But the seminar was also highly informative in illustrating the types of “shocks and surprises” that might arise given a wider series of currently unspecifiable events, and the issues that might need to be faced in dealing with them. The detailed analysis of the four specific “shocks and surprises” also provided a template for analysis of the wider set of “shocks and surprises” identified on the day.

¹ For further information on the Strategy Unit’s assessment of “uncertainty” in the context of GM crops, see the “Overview Methodology Paper” available from the Strategy Unit website at www.strategy.gov.uk.

² For further information on the background to the Strategy Unit’s scenarios, see the “Overview Methodology Paper” (op cit).

Purpose and Status of this Note

6. The purpose of this note is twofold:
 - Firstly, to record in “raw format” the issues discussed on the day. The majority of this material is to be found in the annexes to this note, and reproduces the material recorded on flip-charts during the course of the day. Editing has been kept to the minimum necessary in order to render the material comprehensible.
 - Secondly, to record the key themes arising from the day. The majority of this material is to be found in the main body of this note. It should be made clear that this material has been processed by the Strategy Unit team, and is therefore subject to the team’s own interpretation.
7. The seminar was held under “Chatham House Rules”, and hence none of the material in this note is attributed to any individual. The note has been sent to attendees, and they have all had the opportunity to comment. However, the note represents the thoughts and assessment of the Strategy Unit, and should not be taken to represent a view from the group as a whole.

Introductory Session

8. The Strategy Unit explained the objectives of the day, and recapped on the scenarios that would be used to frame some of the discussions. As part of this recap, the Strategy Unit explained that five scenarios would be used in the study as a whole: four scenarios defined according to the axes developed at a workshop held in December³, plus a fifth scenario incorporating an explicit decision against commercial cultivation of GM crops.
9. An opportunity was provided for questions of clarification. The following points arose:
 - The Strategy Unit confirmed that it was not trying to predict actual shocks – instead, it was trying to identify a wide range of possible shocks, to be used for illustrative purposes.
 - The Strategy Unit said that the relevant timescale for the seminar was 10-15 years from now.
 - The Strategy Unit suggested that the focus should be on shocks associated with GM crops and foods. However, shocks relating to other applications of GM technologies would also be relevant, if they were thought to have a read-across to GM crops and foods.
 - The point was made from the floor that reactions to different events could be a source of shocks, just as much as the events themselves.

³ A note of this workshop is available on the Strategy Unit website.

Brainstorm on Possible Shocks and Surprises

10. Attendees were separated into four breakout groups, which between them sought to identify shocks that could arise under four subject headings:

- Political / economic shocks;
- Health shocks;
- Innovation shocks;
- Environment shocks.

11. Details of the material produced during the breakout sessions are attached in Annex I. This material was presented back to the whole group in plenary session. The ensuing discussion raised the following issues:

- It is useful to distinguish two broad categories of shocks. Firstly, those shocks that could arise as a result of something unique about GM crops / foods (e.g. increased allergenicity; breakthroughs in the identification and manipulation of genes responsible for desirable traits). Secondly, those shocks that could arise from entirely external sources (e.g. disruptions to international relations; changes to climate patterns; food shortages).
- For any shock, the dynamics of the way in which different groups react to the shock could be just as important as the shock itself. The reaction of governments and regulatory authorities will be important, as will the reactions of different “publics”.⁴ One potential weakness of the Strategy Unit scenarios is that they assume broadly stable socio-economic trends over the 10-15 year scenario period, and hence do not incorporate the potential for different sorts of reactions to occur.
- Some shocks will have only a temporary effect, and will soon be forgotten. Other shocks will have a more permanent effect, particularly if they challenge the fundamental parameters within which organisations and individuals choose to operate. For example, environmental or health shocks could seriously undermine confidence in the regulatory authorities; technological breakthroughs could lead to a total re-think about the pace of future development.
- The timing of innovation is subject to considerable uncertainty, and could lead to shocks in either direction (i.e. either faster or slower development of new traits, compared with current expectations). Innovations could occur in GM crops, in the wider (non-GM) application of genomics to plant breeding – or in apparently unrelated fields.
- Even those shocks that appear to be positive – such as new innovations linked to GM technology – may turn out to have negative impacts if society and the

⁴ “Publics” are different groupings within the overall population referred to as “the public” – the use of the term recognises the fact that there is no single “public reaction”.

regulators are not ready for the pace of change. This is particularly relevant in the context of the ethical issues raised by new technologies.

- As the potential rewards from GM technologies increase, so also do the risks and difficulties. One valid reaction – and a shock to the Strategy Unit scenarios – would be for some countries (including the UK?) to conclude that the issues are simply too difficult to deal with, that the benefits are not sufficient and could be achieved in other ways, and to drop out. This has already happened in some countries (not the UK) in respect of embryonic stem cell research. A key determinant in this decision will be the question of whether or not innovations in bio-safety and risk assessment can keep pace with innovations in the technology.
- One category of shock not covered in the scenarios relates to the possibility of bio-terrorism. Although not currently on the agenda, it is possible that crops could be deliberately contaminated by terrorist organisations in the future.

In-Depth Assessment of some Specific Shocks

12. The Strategy Unit had asked four external stakeholders to prepare specific examples of possible shocks. One shock was described from each of the four categories used in the brainstorming session. The following table highlights the key elements of each shock:

Category	Key elements of the example shock⁵
Health	<ul style="list-style-type: none"> • Deaths and illnesses attributed to an allergic reaction from food consumption; • Possibility that the allergic reaction may be linked to a protein giving insect-resistance, used in some GM crops; • The protein is derived from a non-food plant, but used widely in food crops for 5+ years, both in the developed world and in developing countries.
Political / economic	<ul style="list-style-type: none"> • Anti-globalisation and xenophobia combine to create a “Fortress Europe” mentality; • Disillusionment with national governments diverts attention and power to regional and local authorities; • A series of environmental disasters add fuel to the rise of radical environmentalism; • In combination, these forces lead to authoritarian radical environmental political forces operating at a regional level; • Different regions take a different approach to GM – with grave difficulties arising at borders.
Environment	<ul style="list-style-type: none"> • General surveillance and monitoring programmes identify spread of wild brassicas in agricultural and / or semi-natural habitats; • Possibility that transgenes present in GM oilseed rape crops are conferring fitness advantages onto wild relatives – perhaps compounded by gene-stacking; • Farmers forced to use more powerful herbicides to control

⁵ These descriptions are the work of the Strategy Unit, not the work of those who presented the shocks.

	<p>wild brassicas;</p> <ul style="list-style-type: none"> • Other species displaced in semi-natural habitats and in Sites of Special Scientific Interest (SSSIs).
Innovation	<ul style="list-style-type: none"> • International regime for intellectual property rights (IPR) collapses; • One of two possible outcomes occurs; • Either there is a “free for all” in IPR, with different organisations seeking to bring existing technologies to market as quickly as possible; • Or contractual arrangements take up the slack from IPR schemes, with access to seeds etc governed by tightly defined contracts and associated technology fees.

13. It is important to recognise that these shocks are not meant to be representative of the wider range of shocks discussed in the earlier brainstorm session. The individual shocks were prepared independently by the external stakeholders in advance of that brainstorm session. As it happens, the individual shocks were all largely “negative” in their nature. However, this should not in any way be taken as an indication of the distribution of shocks that is likely to arise in practice.

Discussion of the Health Shock

14. All four breakout groups discussed this shock. The groups were asked to consider the magnitude of the effects of the shock; who would be affected; and what might be done to mitigate against adverse impacts. The group was also invited to indicate their thoughts on the likelihood of such a shock arising.

15. Details of the material produced during the breakout sessions are attached in Annex II. This material was presented back to the whole group in plenary session. The ensuing discussion raised the following key themes:

- There are some lessons to be learned from the way in which consumers, retailers, etc. have reacted to concerns about allergenicity to peanuts and kiwi fruit. However, a key difference is that both of these are widely accepted and uncontroversial foods – whereas GM foods are already “tainted” by controversy.
- In some scenarios – especially in Scenario 1, where GM crops and foods have become relatively ubiquitous – it could be extremely difficult for the affected products to be removed from sale, even as a precautionary measure. This could have very serious consequences. One important issue to address would be “who should bear the costs of product recall?”
- The public reaction to the health scare would be determined in large part by the political / regulatory reaction. Do the authorities appear to know what is going on? Are they being open about what they know? Are they taking the appropriate measures to deal with the problem?
- Another key determinant of the impact of the health shock would be the potential delay between – on the one hand – the emergence of the story into the media and – on the other hand – the ability of the authorities to respond. This

would vary between the scenarios, and could be difficult in Scenario 1. It might also be influenced by the range of different GM events used in different crops – the situation would be very different if a single event was used in multiple crops, compared with the case where many different events were used, each in a single crop.

- The effect on GM may be broadly similar irrespective of whether the deaths and illnesses could be attributed to the transgenic protein. As with other events such as the MMR controversy, much would depend on the media portrayal and on the way in which the authorities react. But even if GM was vindicated in this instance, a scare such as this would have a wider impact on already-present concerns about food safety.
- If the transgenic protein was found to be at fault, one particularly disturbing set of issues could arise if the allergenicity was found to affect a particular human genotype (e.g. one found predominately in people from a certain world region, or of a particular ethnic background).

Discussion of the Political / Economic Shock

16. Due to limitations of time, only two of the four breakout groups (A and C) were able to discuss this shock in detail, while one other breakout group (D) discussed it in very broad terms. Once again, the groups were asked to consider the magnitude of the effects of the shock; who would be affected; and what might be done to mitigate against adverse impacts. The group was also invited to indicate their thoughts on the likelihood of such a shock arising.
17. Details of the material produced during the breakout sessions are attached in Annex III. This material was presented back to the whole group in plenary session. The ensuing discussion raised the following key themes:
 - This shock is extremely useful in illustrating the potential implications of changes to existing social and political trends and structures. Issues relating to GM crops might be seen as largely irrelevant in the context of the social upheaval presented in this shock. But GM crops could act as a “touchstone” for a wider set of issues.
 - A key element of this shock is the notion of fragmentation. This would have many different implications. For some parts of the food industry, loss of international standards would be extremely costly; for other parts of the industry, it would be less relevant. At a different level, more fragmentation of responsibility might enable local and regional organisations to take positive action in pursuit of their objectives, as opposed to simply “making a lot of noise”, which might be the case at present.
 - One way in which this would come into effect would be through an increased proliferation of “no-GM” zones. However, it was noted that even though these zones are not currently legal, the power of peer pressure should not be underestimated, and such zones may well come into effect.

Discussion of the Environment Shock

18. Due to limitations of time, only two of the four breakout groups (B and D) were able to discuss this shock in detail. Once again, the groups were asked to consider the magnitude of the effects of the shock; who would be affected; and what might be done to mitigate against adverse impacts. The group was also invited to indicate their thoughts on the likelihood of such a shock arising.
19. Details of the material produced during the breakout sessions are attached in Annex IV. This material was presented back to the whole group in plenary session. The ensuing discussion raised the following key themes:
 - As with the health shock, a key issue for this shock would be the speed with which effects were detected. This would vary to some extent across different scenarios. But it might be expected that effects would be picked up in crop fields (by farmers) and in SSSIs (by the nature conservation agencies) in all scenarios. It would only really be in other semi-natural habitats (e.g. hedgerows, canals, etc.) in which there would be scope for variable degrees of monitoring.
 - Another issue similar to that raised by the health shock is that of “clear-up” – analogous to “product recall”. Public reactions might be determined by the extent to which clear-up is possible, and by the decision on who should bear the costs. Once again, clear-up might be more difficult in Scenario 1, where GM crops are relatively ubiquitous.
 - Over the longer term, a shock such as this would tend to prejudice the chances of subsequent applications for approval. It might also lead to a revisiting of the regulatory system – for example, the adoption of a hazard-focused assessment rather than a risk-focused assessment. This could lead to a form of “regulatory creep” – it is often the case that regulations are tightened when things go wrong; but it is much more difficult to loosen regulations if nothing goes wrong.
 - One interesting impact could be on tourism – would tourists be concerned about visiting natural and semi-natural habitats “contaminated” by GM weeds? A similar issue arises in respect of organic farming – would consumers accept “organic” produce from a farm “contaminated” by GM weeds?

Discussion of the Innovation Shock

20. Due to limitations of time, this shock was discussed in plenary session only. The ensuing discussion raised the following key themes:
 - One reason why this shock might occur is that the IPR system fails to keep up with the pace of innovation. The patenting process can be expensive and time-consuming. If the pace of development speeds up, companies may decide that it is more effective simply to take their innovations to market as quickly as possible, relying on speed of marketing rather than patent protection.
 - If the IPR system broke down for other reasons, the likely reaction might be a slow-down in technological development, due to the inability of any company to reap the rewards. This might be exacerbated by the nature of the approvals

process for GM crops – companies would be unwilling to submit dossiers containing information that might be used by their competitors.

- However, it is likely that ways would be found to circumvent the failed IPR system. One option would be the use of terminator technology or hybrids, so that farmers could not save seed. This has already been illustrated by the use of hybrid varieties of Bt cotton in countries where IPR regimes are not effective.
- Such an approach would be complementary to a contract-based system coupled with a technology fee. Some farmers would be willing to follow such an approach if they thought it would be profitable; others would reject the notion of being controlled by large agricultural supply companies.
- In the short-term, one benefit might be improved access to current technologies for developing countries and for public research institutions. Funding currently used to obtain access to IPR could instead be used to fund the research itself. However, in the longer term, there might be question-marks about the impact on developing countries and public research institutions. Private companies would be unwilling to share any of their research. And new products developed by developing countries and / or public research institutions could be picked up and taken to market by “cherry-picking” private companies, depriving the originators of any of the rewards for their innovation.
- There may be some benefit to conventional plant-breeding and organic research. It can be argued that these are currently disadvantaged by the IPR system. While GM crops can be patented, conventional plant breeders rely on less protective Plant Breeders’ Rights, and organic researchers – primarily undertaking systems-based analysis – are unable to protect their work at all. These disadvantages would be negated if the IPR system broke down.

Concluding Remarks

21. The Strategy Unit thanked all those present for their attendance and contribution to the day.

Annex I: Material produced by Breakout Groups during the Brainstorm on Possible Shocks and Surprises

Breakout Group A: Political / Economic Shocks

- The EU Commission could offer strong support for GM.
- There could be a trade war between the US and EU, in which the US might try to exempt the UK.
- There might occur a significant shift in US public opinion towards a more sceptical view regarding GM crops.
- Tensions might arise between individual EU member states over GM, similar to those over Iraq.
- Brazil could make a decision against the commercialisation / legalisation of GM crops.
- With the accession of new member states, the EU could become self-sufficient in soya.
- Sugar production in the EU becomes unsustainable due to imports from developing countries.
- Public pressure leads to increased efforts to save energy in agricultural production.
- Oil price shock lends new importance to energy production based on GM crops.
- Unilateralism/protectionism of the EU and the US lead to a crisis within WTO.
- Climate change and wars over water increase the pressure to develop alternative, renewable energy sources.
- Significant shifts could also occur in the political environment, e.g. a strengthening of the Green Party or a change in the attitude of NGOs regarding GM.
- Any “Starlink-type event” could lead to a serious setback for the biotechnology sector.
- Antibiotic resistance could lead to a major food crisis.
- The need for biodegradable waste could lead to stronger efforts to derive new materials from GM crops.

Breakout Group B: Health Shocks

- Allergenicity from GM crops, which could arise through eating to processed foods or exposure to pollen.

- Removal of allergens from existing foods via GM.
- Interactions with other pollutants that widened susceptibility to allergic responses.
- Horizontal gene flow to gut bacteria.
- Discovery of an entirely new “end point” for health effects, for example to parallel the discovery of endocrine disrupting chemicals.
- Creation of unexpected toxins in novel GM crops.
- Discovery of unexpected toxins in other products, especially those derived from non-renewable resources, such as plastics from petrochemicals, which could lead to greater attention on non-food applications of crops (including GM).
- Safety concerns that lead to ban of particular pesticides (or even whole classes of pesticide active compounds).
- Health impacts from GM-associated pesticides (herbicides).
- Evolution of new pests and diseases in response to GM crop protection mechanisms.
- Food scares from other types of agriculture – organic or conventional – e.g. fusarium contamination.
- Health scare from a medicinal GM product.
- Health impacts from other GM applications, especially GM micro-organisms. This could be allergies to products derived from GMO processing (such as vitamins or chymosin etc) or a disease outbreak from GM microbials escaping from a research laboratory.
- Contamination of food chain with products grown for pharmaceutical or industrial chemicals.
- Discovery of unanticipated environmental pathways lead to health impacts via routes not expected (e.g. radioactive pigeons at Sellafield).
- Unexpected health benefits, such as over-expression of anti-cancer compounds via GM.
- Health impacts in developing countries or those with restricted diets in developed countries from improved nutrition.
- Increased shelf life might allow low income groups to buy more fresh produce and improve nutrition.
- Increased shelf life might detract from nutritional value of fresh produce.
- Effects of GM feed on animal health could also arise.

Factors that would influence likelihood/severity of health shocks and surprises:

- Technological change could mean that future generations of GM crops were made through “cleaner” GM processes, e.g. by only using endogenous promoters, and so decrease the potential for shocks.
- Technological change could also increase the range of possible traits and applications of GM and so increase the potential for shocks.
- Surveillance and detection – improved monitoring and epidemiology would increase detectability of any impacts.
- Advances in understanding nutrition and effects of composition of foods would have an impact on health shocks, as would changes in eating habits, diet or nutritional requirements.

Breakout Group C: Innovation Shocks

- Trait breakthroughs could include: fungal resistance in cereals; drought tolerance; nitrogen fixation.
- Some might be surprises in timing, coming sooner than expected, rather than the trait itself being a surprise.
- A further shock would be if organic farmers were persuaded to use GM if they saw these as beneficial to them.
- Synergies across technologies (e.g. with nanotechnology).
- Transfer of human genes to crops giving strong benefits (e.g. personalised transformations for producing personalised immunotherapy to counteract cancer etc) – big ethical issues.
- Doubling of yield through use of haem genes to improve efficiency of oxygen use?
- Creation of “designer plants”, e.g. through chromosome assembly – an application of genomic knowledge (and not necessarily GM).
- Forestry applications – e.g. coniferous trees which could produce hardwood.
- A number of political and social influences on innovation (and vice-versa): adaptation of systems of government; new configurations of NGO/stakeholder groups; ability of regulatory authorities to cope with the increasing pace of technological innovation (a breakdown could lead to social turbulence).
- Societal reactions to GM animal innovations could impact on perceptions of all GM technologies, including crops.

- Geographical issues: shift in agricultural powerbase towards E Europe; possible divergence between countries taking up a technology vs those who reject it; applications may not be available to meet local needs if they are developed elsewhere in the world.

Breakout Group D: Environment Shocks

- Superweeds
- Pests (climate change)
- Climate change → different crops
- Many pesticides banned
- Climate change does not exist → discredits environmental movement
- Legal judgement re: tobacco liability → reasoned
- Biodiversity improves
- Illegal imports → invasive species
- Regulations re: biodiversity
- Changes in IPR regime → different research
- UK farms primarily for environment with food secondary
- Farm income → reduced environmental measures
- Entry level scheme fails to halt wildlife decline
- GM contamination of animal food chain
- GM contamination of natural species (all)
- GM contamination of seed production
- Plant breeders quit UK
- Greater understanding of soil microbiology
- DEFRA understands sustainable agriculture
- Potential advances in conventional production lost
- DEFRA puts in a comprehensive monitoring scheme
- CAP abolished
- Changes in farming structure

- WTO challenge to regulations successful (e.g. labelling)
- Part of EU goes GM free → UK has to import more food → breakdown of EU (?)
- Wales goes GM free
- UK goes GM free
- Monsanto goes GM free
- US goes GM free
- US goes pesticide free
- GM becomes obligatory in US
- Environmental or health disaster in another country e.g. Latin America through illegal use of GM

Annex II: Breakout Group Discussion of the Exemplar Shock to Human Health

Breakout Group A

- The shock implies considerable uncertainty regarding the precise cause of the allergic reactions.
- In view of the serious health implications of the shock, it would be irresponsible for the authorities not to act quickly.
- However, in scenario 1, responding to the shock may be difficult because of the lack of regulations.
- In addition, consumers would find it difficult to avoid GM products because of the lack of labelling.
- The media would play an important role regarding consumers' perception of the shock.
- The introduction of a labelling regime would cause major problems in the catering sector.
- An important question would be as to whether there exists any acceptable level of food-related health problems.
- Customer-complaint systems of supermarkets could make it possible to find out more about the nature of the shock.
- Scenario 1 implies a certain level of public acceptance regarding GM crops so that a shift to scenario 5 because of the shock would be unlikely.
- Reactions to the shock in the US would also have an impact on the product chain in the EU/UK (consumer perception, litigation).

Breakout Group B

Likelihood

- Likely - Public had doubts, so if the crops were approved and subsequently linked with allergic response, suspicions would rapidly return.
- Unlikely - Safety testing and investigation is getting better, although still not 100%. There may be an additional peak in safety concerns when 2nd generation GM crops were developed.
- There was some discussion about the ability to detect the health impacts and attribute them to the specific GM protein.
- The capacity to be able to deal with recall, traceability and labelling would be crucial.

- Avoiding expressing protein in given areas of plant might reduce the likelihood of the shock occurring.

Detection

- Post release monitoring and detection. Do we have the ability to do testing? Finding effects could be hard.
- How would effects be identified? Linkage could be made easier if effects were felt in unique groups (babies) or via rare symptoms (anaphylactic shock).

Dealing with the shock

- Response: broadly speaking, public acceptance of GM would reduce; regulations would increase. The possibility of mass panic was raised.
- Company and government responses are important to determining the impact of the shock.
- Who bears the costs will also be important in determining how people respond. Hence liability is crucial. Companies might be slow to react if they were liable.
- The traceability and labelling regulations in each scenario would make a big difference to the possibility of removing food containing the protein. This would be far easier in scenarios 2, 3, and 5.
- In scenario 4, where the public was already disgruntled with GM, the shock would be catastrophic for industry.
- What if the cause proved to be GM? In scenario 1, it was possible that people might continue to accept GM crops, provided that decision-makers were not callous in cost/benefit analysis of loss of life. However, it was generally likely to create a vast move against GM.
- What if the cause was shown not to be GM? Would the biotechnology industry defend the product? In any case, the PR damage would have been done.
- Possibly analogous situations – CJD (partial or complete recall and rejection), peanut allergies (we don't ban peanuts).

Breakout Group C

- Shock was seen to be plausible.
- Would current monitoring systems pick up the problem? Kiwifruit got through the approvals process; but allergenicity problems were subsequently identified. Associations are relatively easily identified; causality is harder to prove.

- Effects would be harder to detect if the protein were present across a range of foods. But thought unlikely that the same construct would be used across a wide range. Also allergenicity depends on interactions within the genome – might only occur in a particular food.
- Other analogies might include peanuts, vCJD.
- However there are differences. There are already strong feelings around GM. So a strong public reaction likely even before GM confirmed as a cause.
- The reaction would depend on how different groups used/perceived the situation. What would the policy response be? (E.g. would supermarkets take all GM products off the shelves?) Start of BSE crisis – beef was not withdrawn, just reduced in price (and sold well).
- There is an issue around how long product recall would take – this would depend on which scenario we are in, and which crop is affected.
- The public may also worry if the allergenic product has been fed to animals (but groundnut is fed to them now).
- Also there may be worries if there is adventitious presence of the GM product in non-GM foods.
- There would be a difference between products containing the GM protein and those which do not (e.g. oils) – but would the public accept this?
- The episode would undermine confidence in global regulatory systems – particularly if there is prolonged disagreement over the cause. This would be minimised if appropriate precautionary measures were taken. If well handled could the episode actually improve confidence?
- There would be impacts on global trade.
- If GM were found not to be the cause, there might still be damage to GM products – depending largely on the stance taken by the media
- How resilient would the different scenarios be to this shock?
- Generally, the scenarios have different implications for the regulatory response to the shock.
- In Scenario 1, there are different possibilities, which depend largely on how we get to the scenario, and about what other “shocks” may or may not have happened. If the public had come to see GM as a normal part of food, there might not be a huge panic (although there would probably still be calls for a tightening of regulations). Perhaps this is what would happen if the shock happened in current-day US. But if public acceptance is grudging, Government might be seen as negligent in relaxing regulations – then there might be a panic.
- The result particularly in the second case might be a shift to Scenario 2.

- Scenario 3/5: Easier to detect the cause, and a more tractable problem. UK would be shielded from risk by the availability of alternatives.

Breakout Group D

- Debate is likely to happen
- Compare with MMR
- Response: post harvest monitoring
- Will be difficult to remove from food chain
- How will retailers react? Possible food shortage?
- FSA scrutiny / failure?
- Same reaction under scenarios 1-4
- Medical survey useful – link to premarket tests
- Human genetic diversity
- More likely from introgression
- Better for UK farming / import substitution
- Link to labelling?
- Liability?

Annex III: Breakout Group Discussion of Political / Economic Shock

Breakout Group A

- The DAs play an important role in this type of shock. The process of devolution has already created considerable tensions between the regions and central government.
- Public attitudes and regulatory environments differ across the EU (e.g. Austria compared to Spain).
- Crop trashing could become a serious problem.
- Northern Ireland finds itself in a different situation than the rest of the UK, given its border with another EU country (not necessarily same objectives; different attitudes towards R+D and bioscience industry).
- The decision of some regions not to allow the commercial growing of GM crops could lead to problems regarding the transport of GM material across the UK if parts of the public stage protests similar to those seen in the context of nuclear waste.
- GM may quickly become a “sideshow” to other major changes in the political arena.
- The political shock could lead to stronger regionalism in the UK (e.g. organic farming in Wales).
- An interesting development in the context of this shock has been Ralph Nader’s presidential candidacy in the US.
- Stronger regionalism would probably be relevant in all four scenarios considered in the SU study.

Breakout Group C

- This was seen as a dynamic process, rather than a “shock”, and therefore hard to fit into each of the four scenarios – instead, the increase in regionalism might mean you get different scenarios in different parts of the UK.
- There was general discussion over whether the UK would side with the US or EU in this situation. GM the least of our worries in this scenario – but could be a touchstone for bigger issues. If UK sides with EU, we might end up in something like Scenario 4. If it sided with the US, it might end up in Scenario 1. If it sided with the US, there would be immense economic issues from disconnection with the EU – particularly in the research and food industry areas.
- Regionalisation would cause big problems for the food industry, because of a loss of standardisation

- What would the impact on trade agreements be? Regional rather than global trade agreements. WTO mutates or disappears. EU would become a political entity, not a single market.
- Other international agreements would break down, eg identity preservation, Cartagena protocol.
- The issue of GM-free zones was discussed: What does “GM-free” mean – currently largely symbolic? However these decisions are having an impact, e.g. on attitudes of retailers, also the impact of Devolved Administration objections on the timing of the Public Debate.
- There would be important impacts on trade and imports
- The entry of East European economies to the EU could help the EU to be more self-sufficient in food
- Activism by environmental pressure groups could cause disruption to GM growing.

Breakout Group D

- Real plausibility: Wales and local elections; county councils.
- Location control means?? Political assumptions over implementation. Power without regulation.
- Regional may be GM+ (e.g. super potatoes) or negative (e.g. purity / regional vs. US).

Annex IV: Breakout Group Discussion of Environment Shock

Breakout Group B

Likelihood

- High: lots of Oil Seed Rape transformations coming up. These would definitely hybridise, but the genetics, survival and fertility of the hybrids were poorly understood.

Impact

- Any impacts would be noticed first in agricultural settings; they would take a long time to pick up in other habitats. Will specific monitoring be adequate/have a long enough time-scale?
- Post-market monitoring plans and resources were generally poor, but might be better in more regulated scenarios.
- Impacts weren't necessarily specific to GM oil seed rape. Evolution of new pests and diseases in response to GM crop protection mechanisms. Some herbicide resistance and other novel traits could be introduced by conventional breeding. Scenarios where GM is not regulated specifically might make the impacts worse.
- Very tight regulatory standards can be difficult to relax even if they are found not to be needed. This can impose unnecessary costs on business, but the effects can be argued both ways.
- There was a need for continued monitoring beyond the life of the crop. Such monitoring needs to consider that several different genes may be involved.
- Different scenarios will affect the amount and types of oil seed rape grown. The CAP and demand for biodeisel would also be very influential.
- How big an economic problem do these weeds represent? It depends on whether you need to take remedial action – this could be very expensive, but is a subjective judgement.
- There was a very low probability of a very large perceived problem which might lead to stopping growing oil seed rape and removing all oil seed rape from the “wild”.
- There was a higher probability of lower impact problems which might lead to changing herbicides or clearing oil seed rape from nature reserves.
- The perception varies with scenario.
- There would be a loss of confidence among farmers if problems arose. They might be more reluctant to get involved in any new environmental schemes introduced under new subsidy structures.

Avoidance measures

- Grow no oil seed rape, or at least no outbreeders.
- No approvals for products with possibility of environmental damage regardless of likelihood of spread - hazard-based regulation.
- Innovation to allow rapid identification of transgenes.

Breakout Group D

- Detection: Fast for field (farmers / advisors) and SSIs (English Nature) / Slower for canals? / Not dependent on scenario because not GM-specific.
- Mechanism(s) for selective advantage
- Remediation - SSIs from government? / Field from farming system / Canals from ?
- Regulatory response (depends on scenario) - review of authorisations with same & similar traits / review of range of crop authorisation.
- Questions: “GM weed” and organic certification? Public response would depend on scenario? Scenario 1: response to scale of problem? Scenario 3: increase in sensitisation?