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THE DEBATE ON GENETICALLY MODIFIED ORGANISMS: RELEVANCE FOR THE SOUTH

Genetically modified organisms (GMOs) are at the centre of extraordinary controversy. The implications of these debates must be addressed by policy makers in the South. Concerns about GMOs include environmental impact, food safety, the control of agricultural technology, and the direction of agricultural change. Some of these issues require a strengthening of current regulatory systems while others can be addressed by well-informed agricultural policy and legal reform. But adequate regulatory and policy responses depend upon the generation and utilisation of good quality information.

The debate over the future of genetically modified organisms (GMOs) in agriculture has captured a wide audience. GMO foods are widely available on grocery shelves in many countries, but their use is such a politically sensitive issue that they are banned from the restaurants of the House of Commons in the UK. The majority of agricultural scientists have welcomed the advent of the new technology, but the public remains sceptical. Corporate advertising promises bountiful harvests, but environmental activists have destroyed field trials of GMOs in several countries.

Although the debate has been conducted largely in the North, there are significant implications for policy in the South. This Briefing Paper begins with a review of the nature of GMO technology, the major concerns with its development and utilisation, and concludes with some observations on regulatory and research policy.

The Technology

A wide range of GMOs has been developed in the past few years. The first GMO utilised on a large scale was a virus-resistant tobacco variety developed and now widely grown in China. The first GMO to achieve major commercial utilisation in the North was a tomato with longer shelf life. In the past two years GMOs have accounted for a significant proportion of the maize, soyabean, cotton and rapeseed grown in North America. Most of these are varieties with pest resistance or herbicide tolerance. Only a few other countries have begun to grow GMOs (Box 1).

GMOs are just one product of the rapidly growing field of biotechnology. New techniques have been developed that make it easier for plant breeders to monitor the outcomes of conventional crossing and selection; allow useful genes to be identified and cloned; and make it possible for genes from the same species to be utilised more quickly and precisely than do the methods of traditional plant breeding. But most attention has been focussed on new techniques that allow genetic transfers between species. The products of these transfers (‘transgenic crops') are often referred to as GMOs.

GMOs incorporate genes from another plant species, an animal, a bacterium, or a virus. Although this represents a significant change from conventional plant breeding, excessive emphasis in the debate on ‘alien genes' is not particularly useful. The genetic code is universal, and even distantly related species share a large proportion of their genes. When farmers or plant breeders select a new variety it usually includes novel genes. These may have been transferred from a related variety or species; or may be mutations that occurred ‘naturally' in the field or were induced artificially in the laboratory. For many years, plant breeders also have had access to techniques that allow the production of interspecific and intergeneric crosses, so that a wheat variety may benefit from the disease resistance genes of a wild grass, for instance (Tudge,1988). The new genes, regardless of their source, are responsible for certain changes in the new variety's metabolism. The unique characteristic of a transgenic crop is that its genetic makeup allows it to mimic an aspect of the metabolism of an unrelated species and often introduces this capacity to a new environment.

GMOs have attracted significant investments from multinational companies, but they are also the focus of attention for public research organisations and universities in the North and the South. Although most current GMOs offer herbicide tolerance or insect resistance, the technology offers possibilities for a wide range of products (Box 2). Many plant breeders believe that GMOs offer significant opportunities for agriculture in the South, including reducing the reliance on dangerous pesticides, promoting soil conservation through the rational use of herbicides, and, eventually, the development of varieties that can withstand environmental stresses such as drought (Box 2).

However, although GMOs are products of the evolution of plant breeding, they are not necessarily a vanguard of the benign progress of scientific research. The development and introduction of GMOs raises a number of legitimate technical, political and ethical concerns. The following section reviews some of the most important of these, including environmental protection, food safety, corporate control of agriculture, and the future direction of farming.

The Concerns with GMOs

Environmental Protection

Cultivated crops are capable of crossing with related wild species growing in the same environment. One of the principal concerns about the release (or even the restricted field testing) of GMOs is the possibility of this type of genetic interchange. Interbreeding between new crop varieties and their wild relatives is certainly not unique to GMOs. But it is usually assumed that such crosses confer no competitive advantage and are subsequently eliminated by selection pressure in the wild population. Some GMOs, on the other hand, might provide traits (such as herbicide tolerance) that allow the recipient

Box 1: Area in GMOs, by country and year

Area (millions of hectares)

Country*	***1996***	***1997***	***1998***
USA	1.5	8.1	20.5
Argentina	0.1	1.4	4.3

plants to compete successfully and to displace related species. This could have serious consequences for wild plant populations and for biodiversity. In addition, some GMOs themselves might become weeds (Rissler and Mellon, 1996).

The excessive use of disease- or pest-resistant crop varieties (or pesticides) always involves the danger of promoting the evolution of resistant strains of pests or pathogens. Over-reliance on GMOs raises particular concerns. Many insect-resistant GMO varieties take advantage of a gene from Bacillus thuringiensis (Bt) that produces a specific toxin. As these Bt varieties become widespread it is only a matter of time until the affected insects develop resistance (Whalon and Norris, 1996). (Many Bt GMOs are sold with advice to farmers on maintaining refuge areas of a non-Bt variety, but this is difficult to control or regulate.) There are also concerns about the effects of the diffusion of the toxin on other insects and vertebrates in the food chain of the target insects.

Canada	0.1	1.3	2.8
Australia	<0.1	0.1	0.1
Mexico	<0.1	<0.1	0.1
Spain	–	–	<0.1
France	–	–	<0.1
South Africa	–	–	<0.1
Total	**1.7**	**10.9**	**27.8**

*The table does not include China
Source: James (1997, 1998).

Food Safety

There has been an exceptional amount of controversy about the food safety of GMOs. Several countries have blocked, or severely restricted, the importation or use of such crops. Some of these actions are related to fears that the GMOs might contain allergens or other harmful substances, although such arguments could be made for many conventional crop varieties.

A distinguishing characteristic of many GMOs that causes particular alarm is the presence of an antibiotic-resistance marker gene. GMOs are developed by linking the target gene (e.g. for insect resistance) to a gene of an easily identifiable (‘marker') trait. (Indeed the only exotic gene in some GMOs, such as the long shelf-life tomato, is a marker gene.) The most widely used marker gene confers resistance to a particular class of antibiotics. Although current research is moving towards less controversial markers, most GMOs currently available carry an antibiotic resistance gene. The possibility of the incorporation of antibiotic resistance in humans, or in the animals that consume GMOs as feed, causes understandable concern. (The principal fear is not that the resistance would be transferred directly to humans, but rather that it could be incorporated by bacteria in the gut.) There is sufficient uncertainty that the UK Advisory Committee on Novel Foods and Processes (ACNFP) requires a case-by-case review of GMOs containing antibiotic resistance genes.

Corporate Control

In addition to these biological questions, the advent of GMOs has elicited strong concerns about the corporate control of agriculture. The new technology is responsible for a confluence in the interests of chemical companies and seed companies. GMOs may substitute for agricultural chemicals (in the case of pest or disease resistance), be linked to chemicals (herbicide tolerance), or be engineered to produce industrial products (such as oils or pharmaceuticals). These links have motivated a number of mergers and takeovers between seed and chemical companies. Because biotechnology requires considerable investment, the companies have attempted to exercise exceptional control over the processes, genes, and chemicals. In many instances one company's protected gene is made available through licensing arrangements with other companies.

The biotechnology field has produced a remarkable scramble for patent rights and other forms of protection. Both the genes and the various techniques used for their incorporation are the subject of patent protection, so that a single GMO may have several ‘owners'. Some companies have tried to establish exceptionally broad patent protection. One company was initially successful in applying for rights to all genetically modified soyabean and cotton, although these rulings are now being challenged.

Box 2: Types of GMO

Characteristic	Examples	Rationale
Consumer or industrial qualities	Long shelf-life tomato, high-starch maize	Development of new foods or sources of industrial products
Herbicide tolerance	Various crops tolerant to specific herbicides	More efficient herbicide use and/or use of safer herbicides
Disease or insect resistance	Bollworm-resistant cotton, virus-resistant tobacco	Reduction in pesticide use
Tolerance to abiotic stresses	Research on drought-tolerant maize	Improve production in marginal areas (But involves polygenic modifications; more difficult than other GMOs)

Source: Adapted from Farmer's Link (1998)

A particularly controversial aspect of the battle for control of biotechnology is the attempt to limit farmer seed saving. The issue is not confined to GMOs, however. For instance, hybrid crop varieties have been available for more than 50 years. Seed companies have long favoured hybrids because the loss of hybrid vigour in the second generation motivates farmers to purchase fresh seed each year. A recent development affecting seed saving is the agreement on trade related intellectual property rights (TRIPs) as part of the establishment of the World Trade Organisation (WTO). Member countries must establish plant variety protection legislation. This will limit farmers' capacities to save or trade seed of protected varieties. The legislation's major current application is for conventional varieties, but the advent of GMOs has provided additional impetus.

In addition to these legal mechanisms, a recent innovation has caused widespread concern. The so-called ‘terminator technology' is a genetic mechanism that renders the seed's progeny infertile. The technology was developed by a private company and the US Department of Agriculture (USDA). This mechanism is obviously distinct from legal protection, which can be rescinded or modified as the situation warrants. It is a biological alteration which, unlike hybridisation or gene transfer, promises no productive advantage but merely provides the company additional control over its variety. Although the technology is still in the developmental phase, it has attracted worldwide apprehension and protest.

The Future Direction of Agriculture

These controversies over the environmental implications and legal control of GMOs are often embedded in larger debates about the future of agriculture. Science is moving so fast that the public's fear of a technology out of control is easy to understand. Past experience with damaged ecologies and pesticide-

tainted crops, combined with the prospects of cloned animals and ‘Frankenfoods', makes many people wish for a simpler agriculture.

These debates over conflicting visions of the future of agriculture in the North are easily transferred to discussions about agricultural development in the South. The lack of focus in these debates is exemplified by the wildly differing interpretations of the term ‘Green Revolution'. Depending on the context and the speaker, the term can represent anything from the triumph of agricultural science to the destruction of traditional agriculture (Tripp,1996). The fact that discussions about a set of technological changes initiated over 30 years ago are still characterised by an astounding lack of clarity bodes ill for our capacity to come to terms with the complex issue of GMOs. The South needs a strategy for dealing with biotechnology. The following section discusses implications for regulation and research policy.

Implications for Policy

Regulation

Because many of the problems raised by GMOs involve environmental protection or food safety, an appeal to regulatory mechanisms is obvious. But a regulatory response is not straightforward. Problems in the regulation of GMOs have emerged in the North and the lessons of this experience are of direct relevance to the South. The following discussion focuses on the complexity and the control of the regulatory process.

Complexity

Many countries have regulatory procedures for testing and releasing conventional crop varieties, but protocols for testing GMOs are still being developed (Krattiger and Rosemarin, 1994). Field testing of GMOs in the US requires an analysis of the molecular biology of the organisms (donor, recipient, vector) used in the gene transfer, the demonstration of safeguards to prevent contamination, and an environmental analysis of potential dangers.

The requirements for testing GMOs is the subject of continuing debate. One question is whether regulation should focus on GMOs per se or on the characteristics of the particular variety. Herbicide tolerance, for instance, is a major focus for GMO research, but it could be developed through conventional plant breeding as well. The appropriate level of regulation for GMOs is also dependent on the environment where they will be used. Considerable information is required for adequate assessment of GMOs in the South, where less is understood about many of the ecologies into which GMOs might be introduced.

Regulating the food safety of GMOs also presents challenges. The novelty of GMOs is not accommodated by most food safety regulations, which focus on food additives. There is uncertainty about how much testing is required, and to what extent the testing should focus on the new genes themselves or on the substances they produce in the plant.

If there is sufficient consumer concern it is possible to label foods that contain (or that do not contain) GMOs. An example of ‘negative' labelling is provided by the certification of organic produce, to guarantee the absence of agricultural chemicals (and, more recently, of GMOs). In the UK, organic certification is administered by the Soil Association, a private body. A ‘positive' alternative, where the presence of GMOs must be acknowledged, may be the subject of public regulation. However, labelling of GMOs requires consensus on what constitutes genetic modification, and this is still a problem. A recent European Parliament law requires the labelling of foods containing GMOs, but critics contend that the law's focus on detectable genetic material or proteins allows many GMO food products to continue unlabelled.

Control

Besides the technical complexities of deciding how to regulate the cultivation and consumption of GMOs, there are serious questions about the control of the regulatory process. In theory, regulation assumes that decisions are made by an independent authority in the public interest, but the process is rarely as simple as this. The recent BSE experience in the UK illustrates how the management of regulation designed to protect consumers can easily conflict with the temptation to protect the regulated industry. This type of ‘regulatory capture' is a common occurrence as competing interests battle for control of the regulatory process (Tripp, 1997).

In the case of GMOs, there is considerable pressure from the multinationals to simplify the regulatory process. Although this is obviously motivated by commercial interest, similar pressures might well come from public sector researchers attempting to move their own GMOs through national regulatory procedures. On the other hand, those urging a more cautious approach may include not only environmental activists but also commercial agricultural interests that could lose from competition with the cultivation or importation of GMOs.

In summary, regulation of something as complex as GMOs can never be done on a purely objective, technical basis. The assessment of risk and the interpretation of data will always be affected by the values of the regulators and the political and economic pressures exerted on the regulatory process. However, progress towards more satisfactory regulation of GMOs can be made with access to adequate technical and environmental data and regulatory procedures that are as transparent as possible.

Agricultural Research Policy

There is little doubt that GMOs will become increasingly prevalent in developing country agriculture. A number of developing countries (including those that decry the predations of multinationals) have their own public (and sometimes private) biotechnology programmes. These efforts are beginning to produce their own GMOs, which will be pushed forward for regulatory approval and public acceptance. In addition, multinationals have established joint programmes with several private companies and public research organisations in the South.

The majority of commercial GMOs are currently grown in the North. It is not likely that many of these varieties, which have been bred for the environments and crop management practices of industrial agriculture, will be grown on a large scale in the South in the near future. Thus the immediate concern is not that subsistence farmers will become dependent on Monsanto maize seed and herbicide, given the cost and complexity of the technology. But the multinationals are actively developing opportunities to sell their technology in the South. The most likely targets are commercial crops such as cotton that are already subject to relatively high levels of management, or large commercial farms that can afford the technology. Appropriate policies must be in place to make sure that GMOs are not imposed upon a compliant regulatory structure but rather are judged and utilised in the interests of national agricultural development goals.

The relation between GMOs and agriculture in the South has come under further scrutiny in the light of corporate advertising that attempts to present GMOs as an essential step towards eliminating world hunger. Such public relations strategies can be quite misleading. It is true that any increase in food output may potentially lead to lowering global food prices. But it is disingenuous to argue that a technology currently aimed at US soyabean farmers is part of a strategy to address poverty and hunger in the South. National policies need to ensure that the poor have the resources to acquire their food (imported or domestically produced), and that new technology is used to promote equitable agricultural development.

Conclusions

GMOs are one product of a remarkable expansion in agricultural biotechnology. They offer the possibility of addressing some difficult problems but they also present a number of uncertainties. Their development has sparked debates about the direction of agriculture and the control of technology. These debates are partially grounded in differing values, so there is little prospect of simple resolution. This review has urged consideration of the separate aspects of the GMO debate. Examination of GMO's safety should not be linked to opinions about their most visible corporate sponsors. Similarly, concerns about industrial agriculture or input use may be independent of judgements about the potential of biotechnology. No matter how the debate is conducted, there are several areas that can benefit from policy analysis. These include legal reform, regulatory capacity, and agricultural policy.

The intellectual property protection mechanisms established for new varieties require careful examination. Companies have the right to protect their products, but the current bout of predatory patenting and legal manoeuvring threatens to deliver excessive privileges to a handful of companies. An unprepared legal system may be surrendering the potential for fostering further competition and innovation in a rapidly growing field. The current legal climate also affects the willingness of farmers and public sector plant breeders to exchange germplasm.

A nation's ability to deal with GMOs depends on its regulatory capacity. Regulation involves the careful interpretation of adequate technical data, but it is also an inherently political process. A raft of conflicting interests will affect any decision regarding the approval of GMOs. In the South, pressures will be applied from both domestic and foreign sources; these will include the interests of plant breeders, agricultural input and commodity firms, and a range of political and advocacy groups. Establishing regulatory procedures that allow transparent and representative debate is a tall order for any country.

Regulatory decisions about GMOs require access to high quality technical information about environmental interactions. This information is costly to acquire, and most developing countries do not have adequate resources for this purpose. External funding is required to support environmental studies, as well as for the broader concerns of biodiversity conservation. Overseas Development Institute, Portland House, Stag Place, London SW1E 5DP Telephone: +44 (0) 171 393 1600 Fax: +44 (0) 171 393 1699 Email: publications@odi.org.uk New techniques and insights can be shared between regulatory agencies in the South. But because of the location-specific character of environmental management, each country must be prepared to take responsibility for much of its own research. On the other hand, there are greater opportunities for linking regulatory agencies concerned with food safety. Any information developed about the food safety of GMOs should be of universal relevance.

GMOs are a challenge to several aspects of agricultural policy in the South. These include identifying the roles and complementarities of public and private sector participation in agricultural development; formulating policies that promote the contribution of commercial agricultural firms; and strengthening public sector research and extension to meet agriculture's responsibilities for poverty reduction, productivity improvement, and environmental protection.

The most pressing need is for good information. These are complex issues that cannot be debated using formulae, slogans or slick advertising. The majority of the reporting and analysis on both sides of the GMO issue has not been accompanied by adequate technical information. Until both the public and the commentators in the North are better informed it is best to be modest in giving advice to other countries. Poorly informed arguments between the supporters of high science and low inputs do little to further the development of responsible policies in the South.

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