CHAPTER 4

Dig It Up: Global Civil Society's Responses To Plant Biotechnology

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Introduction

Global civil society's response to the introduction of plant-based biotechnology crops is unprecedented. While there has always been, and most likely always be, resistance to the introduction of new technologies—from steam trains to cars, personal computers, and nuclear weapons—the response of global civil society to biotechnology has been wider and more networked, multi-faceted, and global than to any previous innovation. Reactions to biotechnology have been intertwined with the anti-capitalism and anti-globalization campaigns, creating a heady cocktail of fear of 'Franken-foods', rejection of the globalising economy, and mistrust of both government regulators and corporate public-relations campaigns.

The technologies in question have been developed over the past 30 years. In the US in the early 1970s, research proposals for genetic engineering projects involving micro-organisms sparked fears that a deadly breed of 'supergerms' could be inadvertently created. Some civil society organisations protested loudly, but these protests were not internationally coordinated or sustained. Nonetheless, in 1974 scientists agreed to adopt strict, self-imposed guidelines for laboratory work on DNA. The US government also imposed restrictions, but lifted them in the mid-1980s because it was satisfied that the experiments were safe. The biotechnology race began. Companies started investing millions of dollars in biotechnology for both pharmaceuticals and agriculture. After much corporate lobbying, the Bush Administration in 1992 simplified the approval process for agricultural biotechnology products, dramatically reducing the required testing to the same standard as non-genetically modified foods. Under this legislation, companies are free to undertake additional testing and are not required to label products containing genetically modified (GM) products. This legislation sparked the beginnings of opposition to GM foods. In the US, Jeremy Rifkin initiated the 'pure food campaign' and called for a moratorium on GM foods. Rifkin was soon backed by a loose alliance of small farmers, consumers, and animal rights groups, first across the US and then internationally. By the mid-1990s, the stream of protests had become fierce, international, somewhat networked, and forceful, with demonstrations, protests, destruction of products and test plots, and consumer boycotts in many countries.

By the late 1990s, the movements had became more coordinated; and international anti- bio-technology leaders of NGO movements emerged: Greenpeace (URL), Vandana Shiva, Jeremy Rifkin. Grass-roots activists who took personal stands against GM but did not lead their own organisations became international heroes: José Bové, Arpad Putsei. Elite *dramatis personae* emerged: the Prince of Wales, Bob Shapiro, Gordon Conway. Despite the variety of players, voices, and views, the 'anti-biotech moment' became a forceful wave. Networks, partnerships, and websites bridged the physical gap between groups and individuals. The floodgates were opened in Europe with consumer boycotts and pressure that led to changes in supermarket and food producer policies. Within two years, the European Union placed a three-year moratorium on commercial plantings of GM crops. In the late 1990s companies were being subjected to the unavoidable attention of the media, most of whose reporting was very negative. Nor could companies conceal their operations in developing countries: what happened in India became instantly known in London, and therefore in Brazil.

Various explanations were advanced for this eruption of protest. Anger was stirred by corporate and government arrogance at trying to pass new 'impure', insufficiently tested foods on to the unsuspecting consumer. Government refusal to mandate labelling bred more distrust, being generally seen as a result of heavy lobbying from the agro-science sector. Meanwhile, ecologists warned the public about the potential of genetically manipulated organisms (GMOs) to displace or corrupt natural organisms, irreversibly harming landscapes and natural biodiversity. Health advocates worried about allergenicity and carcinogenic effects. Nationalists, regionalists, and decentralists of various kinds were concerned about biotechnology as a powerful new weapon in the arsenal of American homogenisation. Professionals in developing countries and their allies in international NGOs were concerned about the possible widening of the already dramatic gaps in wealth and power between North and South. They saw the biotechnology revolution as another chapter in the continued exploitation of the South's resources by the North. Others in the South were more concerned about being bypassed by a powerful technology.

Global civil society's response to plant biotechnology is an example of the development of a truly global reaction: active participation from groups and individuals around the globe creating links across borders and time zones, and forging unlikely partnerships. In addressing this response and its likely development, this chapter first reviews the concept of plant biotechnology and its current status, then covers the key issues of concern to global civil society. It then examines four categories of global civil society groups and their actions. Finally, the chapter reaches the conclusion that biotechnology, in some shape or form, is with us to stay. It also concludes that global civil society's involvement in plant biotechnology will help shape the evolution of the growing application of biotechnology in the food chain and in medicine. The issues involved include ecological and human health safety levels, labelling and disclosure, monitoring and verification of environmental and health impacts, ethical dimensions, and trade.

This chapter addresses plant biotechnology only within the context of agriculture. Plant biotechnology is the first food product using transgenetics to be commercialised, and therefore also the first to provoke public reaction. The main focus is on crops with genetically engineered transgenes for herbicide and insect resistance because these products are currently planted and consumed on a large scale. To keep the discourse focused on the issues that have to date provoked the strongest response from global civil society, other types of non-plant, non-crop biotechnology are not considered. Nonetheless, it is important to take note of the application of biotechnology in other, related fields. Biotechnology has been used in the pharmaceutical industry for many years; for example, much of the insulin produced today is based on biotechnology. At present, issues of risk perception, choice, and information availability differ greatly as between biotechnology in medicine and in crop production. However, we can expect that as the technology advances and enters new realms of health interventions, such as vaccines genetically engineered into bananas, global civil society will pose new questions and generate fresh debates. Biotechnology is also developing in animal breeding and fisheries; for example, the US Department of Agriculture is funding research on catfish containing DNA from salmon, carp, and zebrafish, which makes them grow up to 60 per cent faster than they would otherwise. However, at the time of writing, no animal GM products had been commercialised.

Definitions and Status of Global Plant Biotechnology

Definitions

Biotechnology is a broad concept embracing an assortment of techniques used in agriculture and medicine to create or modify living organisms for human use. The selective breeding of plants and animals to promote desirable characteristics is as old as agriculture itself worldwide. For plants, traditional breeding has developed new lines and varieties over the centuries by sexual crossings and selection, usually between two varieties but sometimes between related species, in an attempt to introduce a useful characteristic from one to the other. Technically, this is known as 'plant biotechnology'. However, in common parlance, 'biotechnology' has taken on new meanings derived from recent breakthroughs in manipulating DNA. Instructions inserted into their DNA effectively tell plants how to construct themselves.

Modern plant biotechnology takes three forms:

- *tissue culture*, in which new plants are grown from individual cells or clusters of cells, often bypassing traditional cross-fertilisation and seed production;
- *marker-aided selection*, in which DNA segments are used to mark the presence of useful genes which can then be transferred to future generations through traditional plant breeding using the markers to follow inheritance; and
- *genetic engineering* (GE), in which one or more genes are transferred from one organism to

Box 4.1: Timeline of plant biotechnology development

1973: Genetic engineering (GE) invented by Cohen and Boyer. Demonstrations against GE in the United States.

1974: Asilomar conference in California, scientists agree to adopt strict, self-imposed guidelines for laboratory DNA manipulation. Building blocks of understanding DNA (Late Cot and Rot curves) develop. It emerges that plants contain a complex set of nuclear RNAs and that only 25 per cent of this complexity has been previously understood. As well, many genes are active in plant cells and are highly regulated in the plant life cycle. In sum, it becomes clear that plant cells resemble animals cells, but it remains unknown how individual genes are regulated or how sets of genes co-express in space and time.

1979: Dr Bedrock and colleagues in UK show plant DNA can be cloned and replicated in bacteria.

Early 1980s: Start of creating libraries of plant genomes.

1983: Group of scientists from Ghent (Belgium), St Louis (Missouri), and Washington/ Cambridge (Massachusetts) show independently that antibiotic resistance markers work. Dr Hall transfers one gene from French bean into sunflower cells, 'Sunbean' plant created. Cover of *New York Times* and *Time* Magazine.

Early 1990s: Dr Feldman and colleagues discover for the first time a relatively simple way to clone plant genes associated with interesting mutant phenotypes. This greatly speeds up the technology process.

1992: US regulation simplifies approval process for biotechnology products and confirms that no labels are required on products.

1994: First crop released and planted in small quantities in Canada.

1996: First significant commercial plantings in the US. Plantings also in China, Argentina, and Canada.

1998: Consumer boycotts in Europe gather speed; test plots destroyed in Europe and India.

1999: First significant anti-biotechnology demonstrations in US (Boston); first commercial plantings in Europe; farmers gather in India and try to burn down Monsanto headquarters.

2000: First plant genome sequenced, the Arabidopsis. Three-year moratorium in Europe for commercial plantings; biotechnology industries launch 'Biotech Council' information campaign in the US.

2001: The genome of rice sequenced; Japan, Australia, New Zealand, and many other countries regulate labelling; demonstrations in the Philippines against planting of GM crops.

Compiled from Goldberg (2001) and EC (2000).

another without sexual crossing. This may include transgenes—the moving of one gene from one species into another or the rearranging of one species' own genes (commonly referred to as 'genomics').

In the debate, these three forms are often confounded. This chapter focuses on the second and third. The terms 'genetically engineered' and 'genetically modified' are often interchanged, and are used in references to GE and GM crops and plants. These are all 'genetically modified organisms', a term that refers to any organism, plant or animal, that has been somehow modified at the genetic level.

Development and status of plant biotechnology

Despite the media frenzy in Europe and growing attention in North America, most people do not realise the extent and range of biotechnology and its

Table 4.1: Products derived using biotechnology

Plant's common name	Countries where planting has been authorised	First year authorised for planting (HT / BT / other)	Approved for human consumption?	Approved for animal feed?
Carnation	Australia	Florigene, 1995 (other)	No	No
	EU	Florigene, 1995 (other)	No	No
		Florigene, 1997 (other)	No	No
Chicory	EU	Bejo Zaden BV, 1996 (HT)	No	No
	USA	Bejo Zaden BV, 1996 (HT)*	Yes	No
Cotton	Argentina	Monsanto, 1995 (HT)	No	No
	Australia	Monsanto, 1995 (HT)	No	No
	Canada	Calgene, 1994 (HT)	Yes	Yes
		Monsanto, 1995 (HT)	Yes	Yes
	Japan	Calgene, 1994 (HT)	Yes	Yes
		Monsanto, 1995 (HT)	Yes	Yes
	UK	Monsanto, 1995 (HT)	No	No
	USA	Calgene, 1994 (HT)	Yes	Yes
		Calgene, 1997 (HT + BT)	Yes	No
		Dupont, 1996 (HT)	Yes	No
		Monsanto, 1995 (HT)	Yes	No
Papaya	USA	Cornell University, 1996 (Other)	Yes	No
Potato	Canada	Monsanto, 1995 (BT)	Yes	Yes
		Monsanto, 1996 (BT))	Yes	Yes
	USA	Monsanto, 1995 (BT)	Yes	No
		Monsanto, 1996 (BT)	No	No
		Monsanto, 1998 (Other)	No	No
		Monsanto, 1999 (BT)	No	No
Maize	Canada	AgrEvo, 1995 (HT)	Yes	Yes
		BASF, 1996 (HT)	Yes	Yes
		Ciba-Geigy, 1995 (BT)	Yes	Yes
		DeKalb, 1995 (HT)	Yes	Yes
		DeKalb, 1996 (BT)	Yes	Yes
		Monsanto, 1995 (BT)	Yes	Yes
		Monsanto, 1996 (HT)	No	Yes
		Monsanto, 1996 (HT + BT)	Yes	Yes
		Mycogen, 1995 (BT)	Yes	Yes
		Pioneer Hi-Bred, 1994 (HT)	Yes	Yes
		Pioneer Hi-Bred, 1996 (HT + BT)	Yes	Yes
		Plant Genetic Systems, 1995 (HT)	Yes	Yes
		Zeneca, 1996 (Other)	Yes	Yes
	Argentina	AgrEvo, 1995 (HT)	Yes	Yes
		Ciba-Geigy, 1995 (BT)	Yes	No
		Monsanto, 1995 (BT)	Yes	Yes
		Monsanto, 1996 (HT)	No	No
		Mycogen, 1995 (BT)	Yes	No
	Japan	AgrEvo, 1995 (HT)	Yes	Yes
		Ciba-Geigy, 1995 (BT)	Yes	Yes
		Monsanto, 1995 (BT)	Yes	Yes
		Mycogen, 1995 (BT)	Yes	Yes
		Pioneer Hi-Bred, 1996 (HT + BT)	No	Yes
	EU	AgrEvo, 1995 (HT)	No	No

* Different variety

Plant's common name	Countries where planting has been authorised	First year authorised for planting (HT / BT / other)	Approved for human consumption?	Approved for animal feed?
		Ciba-Geigy, 1995 (BT)	Yes: Denmark, UK, The Netherlands	Yes: The Netherlands
		Monsanto, 1995 (BT)	Yes: UK	Yes: The Netherlands
		Mycogen, 1995 (BT)	Yes: UK, Denmark, the Netherlands	Yes: The Netherlands
	USA	AgrEvo, 1995 (HT)	Yes	No
		AgrEvo, 1998 (HT)	No	Yes
		AgrEvo, 1998 (HT)*	No	No
		Ciba-Geigy, 1995 (BT)	Yes	No
		DeKalb, 1995 (HT)	Yes	No
		DeKalb, 1996 (BT)	Yes	No
		Monsanto, 1995 (BT)	Yes	No
		Monsanto, 1995 (BT)*	No	No
		Monsanto, 1996 (HT + BT)	Yes	No
		Monsanto, 1996 (BT)	Yes	No
		Mycogen, 1995 (BT)	Yes	No
		Pioneer Hi-Bred, 1996 (HT + BT)	Yes	Yes
		Plant Genetic Systems, 1996 (HT)	Yes	No
	South Africa	Monsanto, 1995 (BT)	Yes	Yes
Oilseed rape	Canada	AgrEvo, 1994 (HT)	Yes	Yes
		AgrEvo, 1995 (HT)	Yes	Yes
		AgrEvo, 1996 (HT)	Yes	Yes
		AgrEvo, 1997 (HT)	Yes	Yes
		Calgene, 1994 (Other)	Yes	Yes
		Monsanto, 1995 (HT)	Yes	Yes
		Monsanto, 1996 (HT)	Yes	No
		Monsanto, 1997 (HT)	Yes	Yes
		Pioneer Hi-Bred, 1996 (HT + BT)	Yes	Yes
		Plant Genetic Systems, 1994 (HT)	Yes	Yes
		Plant Genetic Systems, 1995 (HT)	Yes	Yes
		Plant Genetic Systems, 1996 (HT)	Yes	Yes
	Japan	AgrEvo, 1994 (HT)	Yes	Yes
		AgrEvo, 1995 (HT)	Yes	Yes
		AgrEvo, 1995 (HT) *	No	Yes
		AgrEvo, 1996 (HT)	Yes	Yes
		AgrEvo, 1997 (HT)	Yes	Yes
		Monsanto, 1995	Yes	Yes
		Plant Genetic Systems, 1994 (HT)	Yes	Yes
		Plant Genetic Systems, 1995 (HT)	Yes	Yes
		Plant Genetic Systems, 1996 (HT)	Yes	Yes
		Plant Genetic Systems, 1997 (HT)	Yes	Yes
	EU	AgrEvo, 1994 (HT)	No	No
		AgrEvo, 1995 (HT)	No	Yes: UK
		Plant Genetic Systems, 1994 (HT)	No	No
		Plant Genetic Systems, 1995 (HT)	Yes: UK	Yes: UK
	USA	AgrEvo, 1996 (HT)	No	No

Table 4.1 continued

Plant's common name	Countries where planting has been authorised	First year authorised for planting (HT / BT / other)	Approved for human consumption?	Approved for animal feed?
		AgrEvo, 1997 (HT)	Yes	No
		Calgene, 1994 Other)	Yes	No
		Monsanto, 1999 (HT)	No	No
		Plant Genetic Systems, 1996 (HT)	No	No
Soybean	USA	AgrEvo, 1996 (HT)	Yes	No
		AgrEvo, 1998 (HT)	No	No
		Dupont, 1997 (Other)	Yes	No
		Monsanto, 1994 (HT)	Yes	Yes
	EU	Monsanto, 1994 (HT)	Yes: The Netherlands, Denmark, UK	Yes: UK, The Netherlands,
	Argentina	Monsanto, 1994 (HT)	Yes	Yes
	Canada	Monsanto, 1994 (HT)	Yes	Yes
	Japan	Monsanto, 1994 (HT)	Yes	Yes
	Mexico	Monsanto, 1994 (HT)	Yes	Yes
Sugar Beet	USA	AgrEvo, 1998 (HT)	No	No
Rice	USA	AgrEvo, 1999 (HT)	No	No
Tomato	USA	Agritope, 1996 (Other)	Yes	No
		Calgene, 1992 (Other)	Yes	No
		Calgene (Other)	No	No
		DNA Plant Technology Corporation, 1994 (Other)	Yes	No
		Monsanto, 1995 (Other)	No	No
		Monsanto, 1998 (BT)	Yes	No
		Zeneca, 1996 (HT)	Yes	No
	Japan	Calgene, 1992	Yes	
Flax	Canada	University of Saskatchewan, 1996 (HT)	Yes	Yes
	USA	University of Saskatchewan, 1996 (HT)	Yes	No
Squash	Upjohn, 1994	USA (Other)	Yes	No

Source: OECD*b* (URL).

adoption. The information is publicly available but somewhat difficult to track down. The lack of awareness partially stems from the complexity of agriculture at the global level; few non-experts grasp either the extent of international trade in commodity and other crops or the sophistication of many of the larger-scale commercial farms. It also results from the breadth of applications of this technology: few non-experts would be aware of the genetic work being done on trees, flowers, and humble vegetables. Clearly, the media, despite wide coverage in Europe, have not presented a global view.

This section provides an overview of the most important developments in terms of commercial releases. Tables 4.1 and 4.2 provide a quick global overview of which crops with which gene traits are being planted where, and whether they have been approved for human and/or animal consumption, as at the end of 1999. From carnations to squash, maize to soya and cotton, each commercialised crop is listed with reference to its genetic trait with information on GM research crops in the OECD. Data sources are scattered and often conflicting. The best source of crops data is the International Service for the

Box 4.2: Field trials in the OECD

The list includes field trials of genetically modified organisms that have taken place in OECD member countries. It also includes data from other countries provided.

Poplar	Carnation
Squash	Pea
Chicory	Fungus
Grape	Apple
Sunflower	Melon / Squash
Creeping bentgrass	Brassica
Turnip rape	Walnut
Flax	Petunia
Virus	Papaya
Canola	Carrot
Sugarcane	Brown mustard
Strawberry	Marigold
Barley	Eggplant
Lettuce	Clover
Cucumber	

Sources: OECDa (URL) and UNIDO (URL).

Acquisition of Agri-biotech Applications (ISAAA) (URL), and the following data has been taken from ISAAA and OECD publications. The aim is to give an overview of the status of GM crops; because of data biases, most of the information concerns OECD countries. To provide as complete a picture as possible, the section provides data on hectares per country, GM trait basis, commodity crop basis, and product basis.

The world area under GM crops is expanding rapidly. The OECD estimates the GM area for 2000 to plateau just above 42 million hectares (Mio ha). This development has occurred in only the last five years. Research on GM crops for uses in agriculture started in the 1980s, but sales of first commodity seeds began only in the mid-1990s. The first significant sowings of GM crops (2.6 Mio ha) took place in 1996, almost exclusively in the US. Since 1996, the areas have increased dramatically to reach 41.5 Mio ha in 1999. Adoption of transgenic crops is progressing at a much faster pace than has been the case for other innovations in hybrids (EC 2000). As shown in Table 4.2, most of the GM crops are grown on the American continent. China alone represents about 3 per cent of the 1999 world GM area, and is currently planting tobacco and cotton. Europe, on the other hand, started commercial planting only in 1999 and has very few hectares planted.

An informative way to investigate the development and status of GM crops is to look at the traits of the GM crops rather than location. Currently there are four general types of traits used as commercial GM crops, as outlined below. In the next section the health and environmental concerns of global civil society for these technologies are outlined.

1. *Herbicide tolerance* (HT). The insertion of a herbicide tolerant gene into a plant enables farmers to spray over their fields wide-spectrum herbicides, such as Monsanto's Roundup Ready or AgrEvo's Liberty Link, killing all plants except GM crops. The key intended benefit is lower herbicide use, as farmers can spray later in the season and therefore less often. As well, farmers who combine these crops with no-till or low-till technology should experience decreased soil erosion. Alleged disadvantages include the risk of

Table 4.2: Development of GM area by country (Mio ha)

	1996	1997	1998	1999	% of total GM crop (1999)
USA	1.45	7.16	20.83	28.64	69.1
Argentina*	0.05	1.47	3.53	5.81	14.0
Canada	0.11	1.68	2.75	4.01	9.7
China	1.00	1.00	1.10	1.30	3.1
Brazil*	0.00	0.00	0.00	1.18	2.8
Australia	0.00	0.20	0.30	0.30	0.7
South Africa	0.00	0.00	0.06	0.18	0.4
Mexico	0.00	0.00	0.05	0.05	0.12
Europe	0.00	0.00	0.002	0.01	0.03
Spain	0.00	0.00	0.00	0.01	0.02
France	0.00	0.00	0.002	0.00	0.00
Portugal	0.00	0.00	0.00	0.001	0.00
Romania	0.00	0.00	0.00	0.002	0.00
Ukraine	0.00	0.00	0.00	0.001	0.00
Total	**2.61**	**11.510**	**28.623**	**41.480**	**100.00**

*Following a court ruling, sowings of GM crops are not allowed in Brazil and public authorities are committed to controlling them. However, certain sources mentioned that at least 10% of the Brazilian soybean area in 1999 is GM. The GM area would be located in the south of the country and the seeds would be fraudulently imported from Argentina. The estimated GM soybean area reported here is based on figures from the Argentina's *Direccion de Economia Agraria* and from the Argentinean seed association.

Source: EC (2000).

developing herbicide resistance more rapidly than by conventional usage, the related risk of developing 'superweeds', and an increase in herbicide use following the introduction of the technology on a commercial scale, at least in Argentina (Pengue 2000).

2. *Insect resistance* (BT). By inserting genetic material found naturally in soil from Bacillus thuringiensis (BT) into seeds, scientists have modified crops to allow them to produce their own insecticides. BT is the only commercialised insecticide GE crop. The BT gene responsible for producing the toxin is directly inserted into the plant to produce pest-resistant varieties. For example, BT cotton combats bollworms and budworms, whereas BT maize protects against the 'European' maize borer. The intended benefits include a sharp decline in the use of pesticides, many of which are known to be very toxic to farm workers and the environment. Higher yields resulting from more efficient pest management have also been documented in some, but not all, fields. The main concern is the build-up of resistance in target insects. This is a great concern to the organic movement because application of non-GE BT is one of its key pest-management tools. Other concerns include unintended impacts on non-target insects and any tertiary negative environmental impacts.

3. *Virus resistance* (VR). A virus-resistant gene has been introduced in tobacco, the sweet potato, and the tomato. The insertion of another gene protects potatoes from a virus that causes 'leaf roll', a disease which is usually transmitted through aphids. For that reason, a significant decrease in the amount of insecticide used is expected. The introduction of a virus-resistant gene in tobacco may offer similar benefits. Very little field data is available on the impacts and benefits of this technology; the concerns are parallel to those listed above for HT and BT.

4. *Quality traits* (QT). Quality traits are engineered to bring new benefits directly to the end-consumer of the plant. Today, there are very few quality traits-crops in the ground, with less than 50,000 hectares given over to them in Canada and the USA. Current crops include high-oleic soybeans, high-oleic canola/rapeseed, and laurite canola, which all are considered to deliver 'healthier' oils to the consumer. Concerns centre on the effects of cross-breeding with natural relatives, especially rapeseed and canola, and on new health risks. Box 4.3 indicates GM crop area by the above four traits.

Issues and Objections to Plant Biotechnology

The underlying tone of global civil society's concerns about the health and environmental safety effects of GM crops is sceptical. Many of the concerns raised by global civil society are not supported by current research, but this does not allay fears. On the contrary, much of global civil society no longer believes that science is sufficiently knowledgeable about the medium-and long-term effects of these technologies. Groups are calling for studies examining the broader implications for human and animal health and ecosystem functions. The neutrality of government-and industry-supported science is also questioned. Furthermore, trust in governments' abilities to regulate and take decisions in the public interest has continued to decline over the last ten years; this is particularly true in Europe and, to some extent, India, Brazil, and South Africa. The tone of scepticism is often intangible and difficult to document, yet it is a powerful motivator for many groups within global civil society.

A review of the literature, websites, and media clippings over the past three years shows that objections and arguments about plant biotechnology fall into four general categories: human health, environment, right-to-know, and ethics. Most global civil society groups have taken actions—from public

Box 4.3: GM crop area by trait: pesticide-like crops dominate

Of the 41.5 Mio hectares sown with transgenic crops in 1999, the distribution of traits in order of importance is as follows:

- Herbicide tolerant (HT) GM crop with 69% of total,
- Insect resistant, GM with 21%, using mostly Bt genes
- GM crops containing both genes (HT + IR) represented 7%
- Virus resistant (VR) GM crop (almost exclusively Chinese tobacco) nearly 3%
- Quality traits (QT) less than 50,000 hectares in 1999 were planted.

Source: EC (2000)

Box 4.4: GM area by crop

Globally, soybeans and corn are the frontrunners. Of the 41.5 Mio hectares sown on a commercial basis in 1999, 53% were soybeans, 27% corn, 9% cotton, 8% rapeseed, 2% tobacco, and 0.1% potatoes. Commercialised GM soybeans were first sown in 1996 in two countries—the USA and Argentina—and represented respectively 1.6% and 0.8% of their total soybean area. They were largely herbicide tolerant. In 1999, GM soybean area represented nearly one third of the world total soybean area and nearly 47% of the area of countries producing GM soybeans. One result is that the world supply of non-GM soya has dramatically declined, creating a speciality market for some countries.

Development of GM soybean area worldwide (Mio ha)

	1996	1997	1998	1999	2000 (e)	GM % of total crop (1999)
USA	0.40	3.64	10.12	15.00		51
Argentina	0.05	1.40	3.43	5.50		75
Canada		0.001	0.04	0.10		10
Brazil				1.18		10
Romania				0.001		
Total	0.45	5.04	13.59	21.78	22.5	47

For every commercialised GM crop, there are scores being developed in laboratories around the world. It is close to impossible to complete an extensive list of GM crops experiments, but the list in Table 4.2 provides a good window for future developments. This is the list of crops by common name from OECD's database of field trials.

Development of GM corn area worldwide (Mio ha)

	1996	1997	1998	1999	2000 (e)	GM % of total crop (1999)
USA	0.30	2.27	8.66	10.30		36
Argentina		0.07	0.09	0.31		11
Canada	0.001	0.27	0.30	0.50		44
South Africa			0.05	0.16		5
France			0.002	0.000		0.0
Spain				0.01		0.2
Portugal				0.001		0.4
Total	0.30	2.61	9.11	11.28	10.5	28.0

Source: EC (2000)

awareness campaigns to demonstrations, consumer boycotts, and crop destruction—based on one or more of these key concerns. (see Table 4.5)

Within each of the four categories, there are sub-topics. Whereas some global civil society groups employ blanket justifications for their objections—for instance, 'GM foods are unhealthy'—many others focus on specific sub-topics—for example, GM foods may cause allergic reactions in some people. Hardly surprisingly, the latter approach has been more successful in engaging scientists (from both public and private sectors) and policy-makers. Many global civil society groups have no interest in engaging with policy-makers, industry leaders, or scientists. (The differentiating characteristics of the groups are discussed below.)

In addition to the four general categories of concern, the research found a set of specialist topics surrounding the use of plant biotechnology. Few global civil society groups publicly address these issues, however, some of those that do have had notable influence on some policy-makers. Key specialist topics covered here include intellectual property rights, the neutrality of science and ethics of communications, capacity and capacity building, and farmers' rights.

This section outlines the four main themes of human health, environment, right-to-know, and ethics, and provides some details on the sub-topics within each category. Four specialist topics are then briefly discussed. The review is not meant to be an exhaustive examination of all the concerns and issues surrounding biotechnology. Rather, it aims to frame the issues for the purpose of discussion. Readers are directed to websites and publications in the list of references for more in-depth reviews on the topics covered.

Human health

The concern is that genes inserted into GM foods may unwittingly create health problems. GM crops enter the food chain directly, as vegetables (such as tomatoes), processed cereals (such as wheat or maize), and processed ingredients (for example, sugar from sugar beet). Some of the most common sources are derivatives of soy used in process foods. GM foods also enter the human food chain indirectly through livestock and fish that have been fed GM grain (for instance, shrimp fed on GM soy, cattle on GM maize and soy).

Concern about human health was highlighted in the Starlink case, in which GM maize approved solely for animal feed in the US was found in the human food chain in the US and a few other countries. Allergenicity was the primary concern, and the US authorities quickly concluded through an expert commission that the likelihood of allergic responses to the inserted gene was present but small. The consensus of the commission was that while Cry9C, the gene in Starlink maize, 'has a "medium likelihood" to be an allergen, the combination of the expression level of the protein and the amount of corn found to be commingled poses a "low probability" to sensitise individuals to Cry9C' (EPA 2001). A few months after this report was released, 48 cases were filed at the US Food and Drug Administration claiming allergic reactions to unknowingly eaten Starlink. At the time of writing, the cases had not yet been investigated (Kaufman 2001). The main concerns are:

- *Potential risks to human health resulting from the use of viral DNA in plants and anti-biotic markers.* The question is whether the viral or anti-biotic marker genes used in GM plants will be passed directly into the human system when the food is digested. If so, will they cause any harm? Although there is no current evidence that they pose a risk, long-term studies are required, and the public no longer believes that science is sufficiently knowledgeable about its claims (May 1999).
- *Prospective implications for human nutrition.* Some groups, particularly those associated with 'holistic' views of ecology and human health, are concerned about the long-term health implications of humans consuming 'mixes of genes' hitherto unknown in the human diet.
- *Potential problems with allergenicity of GM plants for food use*. If a gene from a brazil nut is inserted into a soy plant, will people allergic to brazil nuts suffer from eating the soy? Known allergens such as nuts and pollens are not used in current research or product development, for obvious reasons. However, scientists are integrating genes previously not in the human diet, and there are new concerns about allergenicity and how to test for it.
- *The fate of DNA in the digestive system*. Will DNA be passed through the body and play havoc with our digestive systems? Is there a risk of DNA from GM foods being passed into sewer systems? This concern intensifies for the potential future use of GM plants to deliver vaccines and other pharmaceuticals. Currently there is no evidence of a potential problem. However, given the low levels of trust and scientific evidence, and the unknowns about the engineering of vaccines into plants, many groups remain very concerned and are unconvinced that sufficient research has been done.
- *The use of substantial equivalence in the risk assessment of GM food.* Currently many risk assessments conclude that a GM food is so similar to a non-GM food that it is 'substantially equivalent' and therefore requires no additional testing and scrutiny. This is the logic that led to the decisions not to label GM foods in the US and (previously) in the EU. However the general public, particularly in Europe, does not trust this scientific judgement or the conclusion that GM food needs no more testing than non-GM food.

Environmental concerns

Understanding the scope and depth of potential environmental effects of GM crops is a complex task. First, the link between cause and effect is poorly understood. Second, potential direct and indirect effects need to be distinguished. Third, the relationship between results of laboratory, semi-

Box 4.5: GM vaccines

'One day children may get immunized by munching on foods instead of enduring shots' (Langridge 2000).

The second and third generations of GM crops are maturing rapidly in laboratories around the world. A large proportion of the new generations will be 'functional foods': those which deliver a claimed consumer benefit such as taste, nutritional value, or drug delivery system.

A review of current research indicates where some of the research might bring us (Grain 2000):

- 1997: First human clinical trials of an edible vaccine; potatoes genetically engineered against E.coli.
- 1999: research at Cornell University advances use of potatoes and bananas.
- Large Scale Biology Corporation (US) is developing a patient-specific non-Hodgkins lymphoma vaccine in plants to speed up production process
- Scripps Research Institute is working on edible HIV vaccine, currently using cowpeas.
- CSIRO, Australia, has grown measles-fighting tobacco plant.

field—that is, fully enclosed greenhouses—and open-field studies is not clear. Scaling up from farm field tests to impacts of regional and national planting must include the indirect effects of farming practices as well as external environmental influences. This is hard to achieve by modelling or even empirically. In addition, we must ask whether the effects on individual organisms (plants or animals) can provoke impacts on entire communities or populations.

There is, however, another important component of the complexity: the lack of comparative data for non-GM crops. Questions are being asked of GM crops that have never been asked of conventional or organic agricultural practices, making meaningful comparison impossible.

Risk is another difficult issue. How much risk is acceptable? When do the benefits outweigh the risks? How do scientists select insects or plants to study for negative impacts?

The remainder of this sub-section outlines the key areas of potential impacts of the immediate farming and off-farm environment.

Out-crossing and GM crops 'escaping' into the wild. Out-crossing occurs when pollen from GM plants mixes with that of non-GM plants, resulting in a cross-breed. The first 'danger' is that, if the GM plant is herbicide-resistant, the new 'offspring' varieties may inherit tolerance to the herbicide, resulting in a 'super weed' that farmers cannot easily eliminate. Second, if the GM plant has an insecticide gene—BT, for example—the resulting offspring may have a weakened version of the BT gene, speeding up the process of long-term insect resistance to BT. Third, if the GM crop is planted near to wild relatives (such as potatoes in Peru, wheat in Turkey, maize in Mexico), outcrossing to wild relatives can change the genetic make-up of the wild plants. Can GM crops survive in the wild and therefore 'escape' from farmers' fields? If so, they will change the local biodiversity, possibly displacing the stock of wild relatives or other important plant species over time. A recent study indicates that herbicide-resistant GM crops are not able to survive off the field, and therefore do not pose such a threat (Crawley *et al.* 2001). However, this study does not confirm that all GM crops will die out in the wild, nor does it provide comparative data about GM crops as opposed to traditionally bred crops 'escaping'. Wild relatives of crops are invaluable to agriculture as a gene-pool. However, there are many direct and indirect factors influencing the behaviour and ecology of wild relatives and the ecology of farmers' fields.

Non-GM crops also 'outcross' and 'escape' into the wild from farmers' fields. The question is: do GM crops pose a higher risk than traditional varieties of out-crossing and provoking damage?

Impact on non-target organisms. GM crops, especially those with herbicide resistance and integrated pesticide genes, may affect other plants and animals in the immediate environment. For example, the BT genes inserted into maize target a certain type of insect. But what is the impact on non-targeted insects? Will GM crops affect below-ground life forms, such as earthworms, termites, or nematodes? Will changes in herbicide use affect other plants? These types of questions are under review by many scientific institutes, but results to date have been somewhat contradictory and mostly laboratory-based. The differences between natural interactions in a laboratory and in the open field are difficult to quantify, let alone to explain in non-specialised media. The study most covered by the media is the laboratory study that indicated that monarch butterflies are harmed by GM crops with the BT gene, from which it remains unclear what the 'real' impact in farmers' fields will be.

Additional questions need to be asked. What are the comparative effects of conventional farming methods? Certainly conventional applications of pesticides affect non-target organisms. Do GM crops negatively affect non- targets more or less than these methods under various conditions and farming methods?

Loss of on-farm biodiversity. Related to the impact on non-target organisms is the concern about knock-on effects on local ecosystems through biodiversity loss. As individual species may be harmed, will GM crops lead to the loss of biodiversity? There are two types of on-farm biodiversity concerns, one direct, the other indirect. First, crop ecosystems, despite their monoculture character, serve as a habitat for many insect and small 'weed' populations. Will GM crops endanger this biodiversity? Will the technology make the crops so strong that no weeds, wildflowers, insects, or birds will be able to compete with or consume the crops, thus decreasing biodiversity both on and off the field? This is also an issue for human welfare, since in developing countries these 'weeds' are often sources of food and medicine. Furthermore, there is *some* evidence that BT crops may promote the evolution of insect pests by provoking a change in mating behaviour over time when insects are constantly exposed to BT maize (Cerda and Wright 2000). Over time, this could lead to the development of new species. Second, will GM crops displace local varieties of crops, leading to the long-run loss of indigenous species? Again, what is the comparison with non-GM farming methods?

Resistance build-up. Transgenic plants producing environmentally benign *Bacillus thuringiensis* (BT) toxins are increasingly utilised for insect control, but their efficacy will be short-lived if pests adapt quickly. This is of particular concern because BT is the most widely used natural insecticide in agriculture and is used in organic farming. Several insects have developed BT resistance under laboratory selection, although only one—the Diamondback moth—has developed resistance in the field (Heckel 2000). Resistance management and support for farmers is in place in OECD countries, but many are concerned that in developing countries resistance build-up cannot be easily managed.

Effects on soil fertility and other unknown risks. The long-run impact of GM crops on soil fertility is unknown. There are studies that show that BT binds in soils and is present 234 days after harvest. What is it doing, what are its effects? Current studies indicate it is neither active nor affecting the below-ground environment. There is a great need for research in this area (Stotzky 2000).

This category of environmental concern brings to the fore the lack of comparative data, as little is known about the long-term impacts of current agricultural practices on soil fertility. Even less is documented for tropical soils.

Ethical issues

There are two central ethical issues: one about the technology, the other about its commercial use. For many consumers and members of global civil society, manipulation of a plant at the genetic level is simply wrong, immoral, unethical, or against human nature. Recent polls show that European consumers agree with the statement: 'even if GM food has advantages, it is against human nature' (*Eurobarometer* 2000). This opinion is held worldwide. Some critics, such as the Prince of Wales, claim GM crops are 'anti-God', that 'God did not intend us to meddle with nature'. Other critics, many of whom are non-religious, simply state that genetic engineering of plants (and animals) is anti-nature. This 'nature versus technology' debate is an interesting revision of 'rationalist versus romanticist' arguments. These types of arguments tend to rally many global civil society groups while infuriating industry scientists who constantly point out that farmers have been 'tampering' with nature for millennia. On this point alone, the gulf between the pro- and anti-biotech groups seems wide and unmoving. These 'ethical' issues are very deep-rooted, often accompanied by strong emotions, and for many groups they are the linchpin to the entire debate. Hearing scientists, policy-makers, industrialists and others disregard or dismiss their concerns only broadens the gulf and intensifies the anger and mistrust.

The second set of ethical issues focuses on the food industry's behaviour and perceived large profits. Global civil society points out that we risk the independence of our food chain if multinationals' efforts to vertically integrate their businesses and control the value chain from 'plough to plate' are not curtailed. Consumers and consumer-related global civil society groups have mobilised against this risk. For example, there have been boycotts and demonstrations at supermarkets, with groups publicly 'rewarding' supermarket chains that remove GM products from their home brands and chastising those who don't. Farmers, on the other hand, have generally been less organized. Some fear a pending dependency of farmers on products of multinational agribusinesses: once sold a herbicide resistant seed, will farmers lose their right to choose which herbicide to use? Are there boundaries to the controls farmers can develop? These concerns are only fuelled by the arrogance displayed by many captains of industry.

Consumers' rights and labelling

Loud and coordinated voices from global civil society are claiming the 'right to know' if a food product contains a GM product or by-product. This information is desired on a variety of personal, ethical, and environmental grounds, as discussed above. Many feel that industry and government were arrogant, short-sighted, and ill-advised not to enforce labelling from the very beginning. This simply fuels the fury of global civil society groups, which are seeking the mandatory labelling of GM foods worldwide as a single target action. For example, Consumers International (URL), the global federation of consumer organisations, claims: 'The use of genetic engineering is something in which there is almost universal interest amongst consumers. Consumers therefore want labelling of all foods that are derived from gene technology.'

Opponents of labelling argue that it is not straightforward. Many admit that labels may be meaningless due to the complexity of food production and the difficulty of preserving the identity of GM products through the food production chain. Furthermore, when does a food product contain a GMO? In many cases the new genes are not present in the part of the plant which ends up on the supermarket shelf or dining table. For example, refined oil extracted from GM soy does not contain any detectable remnant of the genetically modified DNA which was codified for its construction (May 1999). Conversely, in lecitihin, which is an additive derived from a mixture of unrefined acids from soya, traces of genetically modified DNA can be found if it comes from GM soya. It's safe to say the average person consumes much more refined soya oil than lecitihin, GM or not. The traceability or otherwise of DNA has serious implications for those lobbying for labelling. Should we label all products that are sourced from GM plants, or only those in which traces of the DNA can be found? The percentage of GM products allowed to go unlabelled in a food item is also hotly contested. (see Box 4.6)

Specialist issues

As mentioned above, in addition to the four general areas of concern, the research has identified four additional topic areas. These are considered specialist areas either because they require specialist knowledge and/or because only a minority of global civil society groups has publicly communicated their concerns in these areas.

Intellectual property rights (IPR). IPR is a broad term used to cover patents, designs, trademarks, plant breeders' rights, copyright, and trade secrets. These are crucial because they determine ownership and therefore who will benefit in the long run from the technology. The hottest subject within the realm of biotechnology is the use of patents. Patents[1] are used to protect the genes and technical processes required to produce a GM plant. In addition, companies have tried, sometimes successfully, to patent plant varieties such as basmati rice.

Who has access to the genes, necessary technological tools, and processes will influence the direction of research and development. This in turn will largely dictate who has access to GM crops, for good or bad, and at what prices. The issues are complex, however, two key implications of IPR and patents in biotechnology are central concerns of global civil society. First, agricultural biotechnology has largely been incubated and promoted by the private sector. Currently about 75 per cent of the

[1] *A patent is granted to the owner of the invention for up to 20 years for a monopoly of limited scope. It is effective only in the country that grants the patent. IPR laws vary from country to country, and a successful attempt to harmonise this area takes the form of a GATT Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS). Patents are used to protect the genes and technical processes required to produce a GM plant.*

Box 4.6: Labelling laws

One of the problems of labelling GM crops is that there currently no international standard on the minimum content of GM food allowed under labelling programmes. Below are a few examples of current approaches.

European Union	Labelling required for consumer food items that contain more than 1% GM product.
Japan	Nearly 30 biotechnology food items will be subject to labelling if they contain more than 5% GM products.
Australia, New Zealand	Labelling for less than 1% after 2001.
Indonesia, Korea, Saudi Arabia, and Switzerland	In the process of setting labelling standards.

developments in agricultural technology flow from research undertaken by the corporate sector (ISAAA 1999), which is self-reinforced by patents (discussed below). As a result, most current research and development (R&D) in plant biotechnology reflects market- driven interests. Companies focus on meeting the needs of large-scale farms in developed regions where they can expect significant financial returns on their R&D. Products for poor farmers and those in non-lucrative markets will most likely not be developed. Hence, we have seen the development of crops for large-scale farms in developed countries, but very few technologies tailored to the needs of poor and small-scale farms in developing countries.

In addition, there is a related 'double brain drain': many of the best young plant scientists go directly to the private sector, while established public sector scientists rely on corporate funding and thus steer their efforts towards potential commercial applications.

Second, the 'IPR imbalance' is self-reinforcing. The more patents are developed in the private sector, the more difficult it is for the public sector to carry out biotechnology R&D. While experimental use of patented products and processes is not usually an infringement of the rights of the patent owner, patents can prevent a new invention from easily reaching the public domain. Furthermore, public research institutes lack the experience and expertise to untangle the complex web of intellectual property held on parts of products or processes required by their research. One strategy, albeit still fairly infrequent, has been for multinational corporations to donate intellectual property to public-sector research groups. However, outside the US, it is not a well-rehearsed procedure, and most research institutes in developing countries do not know how to obtain required intellectual property clearance or donation from private sector owners.

Information and communications: 'Waiter, there's a gene in my soup.' In a recent survey, only 11 per cent of respondents in Europe reported that they felt adequately informed on biotechnology (*Eurobarometer* 2000). It is assumed that this figure is loosely representative of most of the OECD, but it would be much lower for developing countries.

There are two related problems. There is an 'asymmetry of knowledge' between scientists and the general public on scientific knowledge and understanding of the technology and its functions. This is compounded by a 'symmetry of ignorance' among scientists, policy-makers, and the public about each other's real aims and concerns. As long as scientists maintain that they will consider only 'objective truths' without any regard for the public's subjective fears, there can be no real communication. This is particularly true of the 'ethical' issues involved. Equally, if the opponents of biotechnology are seen to be 'scare-mongering', communication and understanding likewise falter. Quality information, from all points of views and spectrums, along with a sincere effort to describe the technology in lay terms, is difficult to find. It is particularly scarce in developing countries.

Three types of public information are cited as most required to meet the communications needs of global civil society (Meridian Institute 2000):

- *Media coverage*. In the North, particularly in Europe, there is widespread criticism of the media for their role in framing the current debate as extreme, frightening, and difficult to understand. In developing countries the power of the media is even greater, given the generally limited access to the Internet and dialogue venues. Global civil society groups seem united in the call for more quality media coverage that offers a broader diversity of opinion and expertise about plant biotechnology.
- *Internet-based resources*. Many global civil society organisations rely on the Internet to facilitate global and local information exchange. Biotechnology information list servers, NGO and public research institute websites, and dialogue spaces have all played a critical role in shaping the current debate. The major concern is the reliability of information posted on the web. In addition, for global networking it has become a critical organisational tool as well. However, in developing countries access is often severely limited.
- *Credible scientific review*. There is a tremendous need for credible and transparent processes for answering important scientific questions. Many global civil society groups simply do not accept the neutrality of current science because of the interconnections between research institutes and corporations. As a result, some global civil society groups are not willing to accept 'scientific findings' on the human or environmental effects of GM crops. Most groups recognise the need for more transparent processes to address the difficult issues, and often call for independent panels, academic conferences, and stakeholder dialogues to bring scientists and concerned members of the public together. Some global civil society groups will never accept scientific views. For example, deep ecologists reject the reductionist approach of molecular biology on principle.

Capacity and capacity building. The main capacity-building issue concerns developing countries, which lack a public research base, political processes, and legal infrastructure to 'make up their own minds and regulate' GM technology. A nation that can confidently make decisions about whether to import and/or export GM products, develop new products domestically, or allow field trials of GM crops requires a regulatory infrastructure involving policies, procedures, technical reviews, and research. This concerns all civil society groups. For example, the Green Belt Movement in Kenya expresses concerns about whether African nations have the skill, expertise, and political will to regulate this new industry. Some bilateral and multilateral aid is addressing this issue, but most groups agree there is a tremendous amount of work to be done.

As the debate becomes more sophisticated and complex, some global civil society groups indicate that capacity building is an issue also for developed Northern countries. Biotechnology's cross-cutting reach across issues of health, environment, regulation, agriculture, fisheries, and other areas renders current government structures unable to regulate efficiently or effectively. Government agencies are traditionally 'silos' by structure, and buckle under the demands to share information, reformulate categories of food and pesticides, and so forth. One indication of the challenge is the GM BT potato that was regulated in the US under procedures for a pesticide, not a human food, because the BT gene is a registered and recognized pesticide.

Farmers' rights. 'Farmers' rights' are not a defined set of rights. The expression was coined in the mid-1990s by RAFI (URL), a nimble and creative global civil society group, to create awareness that farmers should be granted certain basic rights. Saving seed is one such right. Traditionally bred varieties produce viable seeds which farmers have saved and used for millennia. Modern agriculture introduced hybrid crops, which are ideally repurchased each year to ensure top performance. While hybrid seeds will not reproduce exactly the same characteristics season after season, farmers can replant them if they wish. GM seeds, however, are currently being sold with an obligation for farmers not to save seeds. The infamous terminator technology was devised to tackle this problem: if the technology is developed, it will render offspring seeds from biotech seeds sterile with the specific 'terminator' gene. The tremendous outcry from global civil society groups provoked at least one multinational biotechnology company, Monsanto (URL), to undertake not to commercialise seed-sterilising technologies.

Framing Global Civil Society Groups and their Positions

How has global civil society reacted to these issues? First, it is important to note that the reaction has indeed been global. It is global in a physical sense; GM crops are rapidly spreading throughout all continents. Transnational corporations and internationally networked NGOs are the key players, and the latter are particularly dependent on inexpensive global communications, that is to say, the Internet and telecommunications.

For this analysis, the following groups were included in the research:

- NGOs, NGO networks, social movements (such as Greenpeace, Friends of the Earth (URL), Confédération Paysanne;
- individuals (for example, Vandana Shiva, Gordon Conway);
- think tanks and commissions (EU-US biotechnology Consultative Forum); and media and specialised websites (websites of NGOs and think tanks as well as publicly accessible specialist list servers).

This research examined over 500 websites and scanned the international printed media for the period of January 1999–Febuary 2001. The analysis employed four general categories of groups to organise the hundreds of NGOs, websites, think tanks, and individuals considered. (See Chapter 1, pp. 7–10). It is difficult to reduce heterogeneous groups that often hold significantly differing outlooks and motivations. This exercise is accompanied by the usual caveats: not one social movement fits exactly

Table 4.3: African perspective on the potential of GM crops for African needs

Crop	Constraints	Status global	Status Africa
Maize	Disease, insect pest and drought and weed	Commercial application	
	European corn borer	Commercial application	South Africa: BT maize
Cotton	Insect pests	Commercial application	South Africa: BT cotton
Cassava	African cassava Mosaic virus	R & D	R & D
Sweet potato	Virus disease Weevil damage Vitamin A	Pipeline	Pipeline
		Pipeline	
	Virus		
Potato		Commercial application	Field trials (South Africa)
	Potato tuber moth damage		
		Commercial	Pipeline (Egypt)
	Diseases		
Wheat		Commercial application	
	Sigatoka leaf spot		
Banana	Weevil damage	Ready field testing	
	Nematode damage	R & D	
		Pipeline	
	Virus disease		
Tomato		Commercial application	Field testing (Egypt)
	Ripening		
Tomato and other fruits e.g. banana	perishability	Commercial application delayed ripening	
	Virus disease		
Papaya		Commercial application	
	Herbicide weeding		
Maize, cotton, and soyabean		Commercial application	
Maize and cotton	Herbicide tolerance		
		Commercial application	Pipeline (Mauritius)
Sugarcane	Weeding		
	Sugarcane mosaic virus	Field trials	Field trials (South Africa)
	Insect pests	Field trials	
		R & D	

Source: ISAAA (1999).

Box 4.7: Seven people, laptops, and airmiles: the new NGO power-play

The Rural Advancement Fund International (RAFI URL), soon to be renamed, is illustrative of the power of the virtual postage-stamp sized NGO. It is smart, highly wired, fast, seemingly intangible yet highly respected for its breadth of knowledge and chutzpah. RAFI works with members of the business community and governments even as it directs campaigns against them.

Headquartered in Winnipeg, Canada, RAFI has seven staff members in three countries. The group is dedicated to the conservation and sustainable improvement of agricultural biodiversity and to the socially responsible development of technologies useful to rural societies. RAFI is concerned about the loss of genetic diversity, especially in agriculture, and about the impact of intellectual property on agriculture and world food security. During its 22-year history it has run a low-cost operation with high-class knowledge management. It reaches enviable standards of efficiency and ability to market ideas.

Battling against 'unfair' intellectual property rights (IPR) on plant varieties is a main item in RAFI's workload which brings it into the centre of the plant biotechnology debates. Recently RAFI forced a private research institute in Australia to drop two patents on cow peas because it had discovered that the germ plasma originated from a public trust gene bank. This work led to the reversal of the patents and the investigation of a subsequent 147 similar patents.

One of RAFI's finest tools is its sharp tongue and a willingness to use it for or against a company. 'We are obnoxious, and that is part of our strategy. It gets us attention', explains Pat Mooney, director of RAFI. Indeed, on its website RAFI describes itself as 'smart assed enough to even tell the Vatican what to do'. Of course, its 'effectiveness' is relative to one's viewpoint. When Pat Mooney coined the term 'Terminator', it did not please members of the life-science industry. However, within weeks it was clear that his quick wit had started a public relations campaign against the seed sterilising technologies, such as that patented by Delta and Pine Land. The development of the technology has not ended, but several companies have publicly stated they will not engage in related research.

into a general 'box', social movements and groups change over time, and each group contains diverse elements (Cohen and Rai 1999). In the plant biotechnology arena, the boundaries between many of the groups are blurred on various issues. In fact, it is this blurring that has made the movements so polymorphous, dynamic, and thus fascinating. The four categories are explained below.

Rejectionists: 'GM is the problem, so is the system. We want a GMO free world.'

Members of these groups believe plant biotechnology is 'wrong' and 'dangerous' and should be abolished. They oppose it with all their might, and often refer to themselves as 'protecting the environment and consumer'. Rejectionists are against field trials, publicly funded research into GM crops, and any GM food products entering the food chain. They call for a GMO-free world. They cite a mix of ethical, moral, social, and environmental reasons, and although they may not agree on all of them, they agree on the need for a ban. This creates strong single-focus alliances. The alliances are mostly national and global, and have built active networks of knowledge and ideas for anti-GMO action. They seek 'to cram the gene genie back in the bottle', as one anonymous anti-GMO demonstrator said at the May Day protest in London. Some Rejectionists use civil disobedience and violence. Groups in this category have occasionally destroyed property. For example, activists in many countries have ripped test plots out of the ground and destroyed GE grain. In India, poor farmers were mobilised to burn down the Monsanto Plc headquarters (Shiva 1999). Many other Rejectionist groups abhor any violence or destruction of property and do not condone their peers' actions. The violence thus far experienced has been narrow in scope and more of an aberration than a *modus operandi* for the Rejectionists.

Rejectionist groups do not condone cooperation in the form of participation in stakeholder debates with industry or government. They see their views and wishes as diametrically opposed to those of the life-science industry, and therefore do not support any dialogue with them. Simply put: big business wants to make money from GE crops, Rejectionists want no GE crops at all, and never the twain shall meet.

Representative groups include Greenpeace International, Friends of the Earth, Research Foundation for Science, Technology and Ecology (India) (URL), Dig It Up (URL), Foundation on Economic Trends (US), and the Safe Food Coalition (South Africa) (URL).

Reformists: 'We need new systems'

Reformist groups hold that political and governance systems, not plant biotechnology, are 'the problem'. Although plant biotechnology might be good for humanity in the future, in its present form it is not. They want to reform the institutions and the decision-making process and to improve accountability and civil society participation. In general they seek changes in policy and law at the national and international levels that remove obstacles to dealing with current injustices and inequalities. These groups seek full consumer choice through labelling and information, the power to ban GM product imports at the national level, and public participation in establishing field trials and risk assessments. For reformists, the linchpin issue is sharing the benefits. How can we ensure that the technology actually helps the poor and excluded and not merely the wealthy multinational companies? Furthermore, how can we ensure that the technologies are truly environmentally beneficial and do not just increase the pollution caused by heavier use of chemical pesticides or genetic drift? Ingredients of the answers to these questions include intellectual property rights, patenting of life forms stewarded by indigenous communities, support for public research to counterbalance corporate scientific powers, and capacity building in developing countries in all aspects of technology development and application, including political systems to regulate it. One critical strategy for Reformists is to call for international labelling on all GM food products. The Reformists are characterised by a willingness to participate in public debate, stakeholder dialogue with 'the enemy', and any other process aimed at addressing the 'problems' of GM crop production and products in a constructive way. Representative Reformist groups include the Rockefeller Foundation, Bread for the World, Consumers International (URL), and the Consumers' Association (URL).

Supporters: 'The problem is not the technology, it's the Luddites who don't understand it and are trying to block it using Franken-scare tactics.'

The Supporters are members of civil society who promote the belief that agro-biotechnology is a very powerful tool to help increase the world's food supply while simultaneously decreasing the environmental degradation of agricultural production. They are often, but not necessarily always, close to governments and business. The Supporter groups believe that the public's ignorance and misunderstanding of science are the root cause of an unnecessary backlash against agro-biotechnology. The 'Frankenstein food' and 'superweed' scare tactics appal them. They fight for good science to be heard, understood, and disseminated by the media. These groups tend to feel that the issues are scientific rather than social or civil. However, some groups in this category argue that there are serious political and capacity-building issues in developing countries. This is important because poor capacity at the national governmental level acts as a barrier to the technologies' wider adoption. Capacity here refers to the ability to legislate for GM crops approval and establish biosafety measures. It also refers to the national capacity to fund and train scientists and farmer extension to develop and disseminate relevant GM crop technologies. Supporters are a small group and often affiliated with organisations which are not understood to be part of 'civil society', namely, business, government, and publicly funded research institutes. For example, Africabio is a technically an NGO and therefore a civil society group, yet has much interaction with and support from industry and pro-GMO research institutes.

The NGO key players in this category are the International Service for the Acquisition and Application of Agro-biotechnology (ISAAA) and AfricaBio.

Table 4.4: Key issues and responses

	Reformists e.g. Rockefeller Foundation, Bread for the World, WRI, International Consumers Association, etc.	Rejectionists e.g. Greenpeace (URL), FoE, Rafi, Vandana Shiva	Alternatives e.g. Confédération Paysanne, Soil Association (URL)	Supporters e.g. ISAAA (URL), AfricaBio
Human health	More studies under transparent conditions and broad participation in definition of 'safety'	Halt all consumption, animal and human, until more tests have been undertaken	Insist on strictest labelling to ensure ease of avoiding products containing GMOs	Sufficient studies done to meet national regulations. Update if necessary.
Environmental health	Same as above, with need for extensive field testing	Halt all test plots and commercial planting until more is understood about impacts in complex ecosystems, i.e. Five year moratorium campaign in Europe	Legislate for mandatory large distances (100–200 kilometres) to isolate all GM field trials and commercial planting to avoid any cross breeding/pollution	Need assessments of relative environmental damage/benefits to other forms of agriculture.
Right to know, transparency of process, etc.	Promote more transparency and accountability in the rules and practices governing biotechnology adoption, e.g. citizen's juries, stakeholder dialogue, support for participation in Biosafety Protocol, etc.	Mandate Biosafety Protocol to supersede WTO, thus allowing countries to ban imports of GMOs. Support for regions to become GMO free and for full labelling on all products with GMOs.	Create own food chains via local and international webs of organic and biodynamic farming communities. Do not participate in stakeholder dialogues; avoid 'co-option' by such processes.	WTO rules supported —a country cannot reject GMOs because they are substantially equivalent to non-GMO commodities. Companies will engage in stakeholder dialogue, but market forces prevail.
Ethical issues	No firm consensus on this issue, but the need to work through bioethical considerations, especially in non-Western cultures.	Genetic engineering is meddling with nature and against what God intended.	Give us the space and freedom to reject this technology and pursue and alternative lifestyle.	Rationality of science over religious or romantic notions of nature. Science is science, not religion.

Alternatives: 'We want to live in our own spaces, away from GM foods and GE agriculture.'

The primary concern of Alternative groups is to develop their own way of life and to create their own alternative lifestyle and space where they can live without the influence or effects of plant biotechnology. For the most part they reject 'conventional' agricultural development and seek isolation from GM food crops. In some instances these groups combine the anti-GM message with a call for local production and self-sufficiency of food (for example, campaigns for urban gardens, 'eat locally', 'food miles'). Others ignore the providence question and simply want GMO-free food and to live in a GMO-free environment. Not only does this category of groups demand full labelling on all products containing any GMOs, they demand large-scale physical isolation of GM crops to reduce risks of cross pollination or 'genetic pollution'. Members of these groups may or may not actively oppose plant biotechnology *per se*. The Soil Association (URL) and other organic movements are alternative groups that are anti-GM but are specifically fighting for organic food production.

Global civil society cooperation + alliances = strength

As with any set of categories, the lines between the four groups are often blurred on many of the issues. Many alliances have been formed across the groups and continents. Many Reformists want 'GMO-free space' in which to live, as do most Rejectionists. The difference is the focus of the key messages and activities. One example of a cross-group alliance is the Five Year Freeze Campaign (URL), a network of 50 NGOs calling for a five-year freeze on all field testing, planting, and importation of GMOs into Europe. Although all the groups in the coalition agree that the freeze is necessary, their reasons differ. The Rejectionists within the coalition see it as a ploy to get a permanent ban on GE crops. The Reformists cite the precautionary approach and the need for more time to debate the issue in public as justifying a temporary ban and a proposed public process to decide at the end of five years what should happen. A few Alternatives have joined the coalition, mainly to help assure them GM-free zones.

This mix of incentives and underlying goals has apparently not weakened either the message or its delivery to society at large. While internal disagreements and inter-group politics exist, the outward appearance is of a fairly united front on many of the issues. Internationally, the anti-GE campaigns continue to bring together a rich array of groups and individuals, most of whom normally would not interact. For example, in the UK the Soil Association (the UK's largest organic agriculture organisation) and environmental groups such as Friends of the Earth and Greenpeace work with local grass-roots organisations such as women's groups and similar groups in developing countries, such as the Greenbelt Movement in Kenya, consumers' associations, and Indian and Asian farmers' movements.

The unusual mix and blurring of stances on particular issues lends the anti-biotechnology global civil society movement the strength and colours of a woven tapestry. It is unpredictable, it is polyvocal; but, most importantly, it offers the movement enough representative variety so that most members of society can identify with at least one of the sub-groups. A single mother in a Parisian high-rise apartment block may not identify with an angry youth or eco-warrior working for Greenpeace, but most likely she will listen to the Baby Milk Coalition or the Consumers' Association. Likewise, farmers in France find solidarity with housewives in the UK and activists in Brazil.

Regional differences

The research shows some regional differences in civil society groups' reactions to plant bio- technology. The main difference tends to be 'volume': the extent to which groups are actively engaged in the issue, gaining media coverage, networking with other groups, and aiming to impact government and industry behaviour. Europe has been a hotbed of activity since the mid-1990s, whereas in the US only pockets of activity are evident, even today. The Philippines and India have active and vocal opposition and supporting groups, while most of their neighbours in Asia do not. In Latin America, Brazil is the most internationally networked country. This is in contrast to Mexico, which has some approved GM crops and an important presence of illegal GM maize, yet civil society groups became active only a few years ago.

Why is the epicentre of rejection in Europe, and particularly in the United Kingdom? The answer must include recent food scandals and deep-seated political and cultural attitudes of many civil society groups. Britain and Europe are still reeling from the devastating BSE crisis that struck their cattle industries. Early in the crisis the UK government denied that there was any risk to humans, a claim that sadly turned out to be untrue. BSE in animals and consequently the new variant of CJD in humans arose as an unintended effect of a new agricultural practice—the introduction of scrap animal meat and body parts into cattle feed—without sufficiently wide-ranging consultation about the possible consequences (May 1999). In addition, the UK and European governments' first attempts to halt the spread of the disease did not include public consultation. Although BSE strictly had nothing to do with genetic manipulation, the BSE debacle and government's failures taint all discussions of GM foods in the UK and in Europe more generally. Another part of the story relates to European civil society groups rejecting the 'Americanisation' of European agricultural practices and food habits. Many of the civil society groups link their rejection of the 'evil American empire' with a hatred or fear of globalisation in general. The link to the latter was made potently clear at the spring 2000 demonstrations in the Lozere, France, when protestors demonstrated against both GM agriculture and the World Trade Organisation while smashing the windows of a McDonald's restaurant. These demonstrations brought global civil society together just as they did in Seattle, Prague, and Davos. Northern NGOs supported the presence of Southern civil society groups and leaders such as Martin Khor and Vandana Shiva. The 'star' of the Lozere event was José Bové , a French farmer who was later tried with five other men for damaging the McDonald's restaurant. José Bové became an overnight cause célèbre, who speaks out worldwide against the Americanisation of culture, globalisation in general, and GM crops as a symbol of what is wrong with the world.

A third factor making for Europe's strong anti-GM crop movements is the media. Regular media coverage of issues related to biotechnology began in 1997 in most of Europe. By 1998, stories were appearing weekly. In the UK during the peak of protests in the spring and summer of 1999—when demonstrators were blocking shipments of GM crops in the Netherlands, dumping GM soy in Brussels and Paris, and ripping up test plots in the UK—a story about GM crops or research ran on the front cover of at least one newspaper almost daily. Media coverage never reached such saturation in other parts of the world, least of all in the US.

News from the South also featured in Europe, and some of the most actively networked and global players in the debate are civil society groups from the South. The motivation and focus of Southern groups tends to be very different from those of their European allies. They share concerns about health and safety based on an innate mistrust of government and industry. However, an additional issue arose early in the debate. A review of the foremost concerns of civil society groups in developing countries (Osgood 2000) showed the key issues to be:

- access to, and benefits from, biotechnology;
- issues of choice, control, and regulation;
- impact on poor farmers;
- environmental impacts; and
- ethical and moral dilemmas.

The key difference between Northern and Southern civil society groups can be simply stated. The major focus in Europe is on the potential impact of technology on consumers' health and rights and on the countryside; the farmer's voice is seldom heard, with the potent exception of the Confédération Paysanne led by José Bové. In the South, by contrast, farmers are central to the issues, and efforts are made to include their voices directly in the protests. For example, Rejectionists from the South tend to focus on the political as well as the social aspects of the biotechnology debate. Two classic Rejectionist groups are the Research Foundation for Science Technology and Ecology (URL) in India and the Third World Network (URL) based in Malaysia. The Indian organisation is run by Vandana Shiva and proactively fights GM worldwide. While it opposes agro-biotechnology for all of the reasons given above, its main focus is on the impact of the technology on poor farmers: environmental hazards of chemicals, equity issues of not saving seeds, the loss of indigenous biodiversity, the economic and social implications of buying seeds and other essential inputs from multinational companies, and the ethical or moral problem of 'playing God'. Shiva is well known for her call to end Monsanto's days in India, and she views globalisation and the growth of multinationals as a root cause of the biotechnology problem. The Third World Network, views all genetic engineering as an instrument of recolonisation, and argues that

Box 4.8: Global civil society impacts the food retailing industry

The retailing industry is the linchpin in the food market due to its proximity to consumers. In addition, over the last years, a global concentration process has increased the market power of retailers. They are in a key market position that allows them to amplify consumer preferences and relay them to the food industry. Any restrictive approach on GM food has cascading effects on the upstream side of the food chain, on domestic as well as on foreign markets.

In Europe, consumer mobilisation and negative perception of GM crops has directly affected the strategy of food retailers. Faced with growing popular pressure to phase out GMOs in the late 1990s, combined with the then legal uncertainties on GM food labelling, many retailers framed new policies on GM food. Supermarket chains first took action in the UK, and the movement spread to continental Europe. Retailers did not align on a single non-GM model. Rather, they adopted various types of action. Retailers who took a restrictive stance on GM food mainly focused on own-brands, for which they committed themselves to phase out GM ingredients. Today, where such phasing out is not possible, compulsory labelling applies, in accordance with EU legislation.

European retailers have moved to meet and further shape the demand for non-GM food, in contrast with the wait-and-see approach adopted by the bulk of North American retailers. In the meantime, food processors and grain companies have been hard-pressed to segregate GM from non-GM products and regionalise their production to avoid GM ingredients where possible.

Some retailers formed group initiatives, such as consortia or GM-free working groups. These initiatives enable group members to share the burden of reorganisation of the supply chain and give them additional weight in the food processing industry. On the other hand, individual initiatives are likely to diminish the negotiating power of the chain with regard to food processing.

the developing world holds the solutions to its own problems and should be allowed to develop these free from pressure from Northern financial interests. These two organisations often send representatives to key global events, from Seattle to demonstrations in the US and Europe, negotiations of the Biosafety Protocol, and international technical and civil society conferences on biotechnology. They are truly global players, exploiting the Internet and inexpensive air travel to cover the issues from every possible angle. The groups' leaders, Shiva and Khor, have been awarded many international awards for their work.

Reformists are also active in Southern countries. The Institute for Sustainable Development in Ethiopia is a good example. The group is not completely hostile towards GM technologies. It argues that the technology must address farmers' 'real needs', which it currently does not do in Ethiopia because it is being developed by large corporations that neither understand nor care about the reality of small-scale farming in Africa. The Institute demands that the technology be delivered in an environment where it can be monitored and regulated and where the potential for accidents is minimised. Although the Institute focuses on Africa, and Ethiopia in particular, it is representative of many Reformists from other Southern countries. Despite being highly globally linked, it has no website.

Other Reformist Southern civil society groups focus on national capacity to handle the complex issues of plant biotechnology, and link less frequently than other groups to the international debate. The concern about regulation and national capacity to monitor and verify impacts and ethical trade is crucial. In South Africa, the lack of public consultations before tests and commercial releases of GM crops has goaded South Africa's Safe Food Coalition (URL) into action.

Of the environmental issues, Reformists and Rejectionists alike are generally most concerned about indigenous biodiversity and have come to the GM issue from other civil society concerns. An example of this is *Accion Ecologica* (URL) in Ecuador, which is mainly involved in tropical rain-forest issues and the

Box 4.9: Direct action

A jury at Norwich, UK, Crown Court found 28 Greenpeace UK activists not guilty of theft after GM maize planted by Aventis at Lyng, UK, was destroyed on 26 July 1999. The activists were caught at the scene of the crop destruction, many of them photographed with plants and digging equipment. The jury failed to reach a verdict on a second charge of causing criminal damage. Prosecutors decided not to have a retrial.

Greenpeace UK executive director Lord Melchett was among the activists under trial. As Melchett promised after the trail, the campaigning to end release of GM crops in the UK continues.

The outcome of the trial encourages civil society activists to continue to take direct action and jeopardises the required crop trials which could later lead to commercial releases.

rights of indigenous peoples. It sees GM crops as a possible threat to the sensitive tropical forests and indigenous peoples, and therefore calls for strong international regulation of GE products. Similarly, the Pesticide Action Network, based in Senegal, has entered the global debate because it sees GM as an extension of excessive use of pesticides and herbicides. The Pesticide Action Network addresses these issues globally, and has offices and links in many developed countries. Another group, the International Genetic Resources Action Information (URL) in the Philippines and Spain, fights to protect farmers' rights to seeds and the maintenance of indigenous varieties. In the plant biotechnology debate, it is primarily concerned about the potential impact of biotechnology on agricultural biodiversity. Other key groups include The Green Belt Movement in Kenya, which primarily encourages rural women to plant trees. It entered the GM debate mainly to express concern about the impact on Kenyan crops and biodiversity and on African governments' abilities to regulate the technology.

There are also Supporters in the Southern countries. The most developed Supporter group is ISAAA, based in Kenya and the Philippines with offices at Cornell University in the US. Its sole *raison d'être* is to promote the use of agro-biotechnology by assisting the transfer of biotechnology 'solutions' to developing countries to increase crop productivity and incomes among resource-poor farmers. Current work includes tissue-culture bananas, multi-purpose trees, and a virus-resistant sweet potato in Kenya. In addition, ISAAA works on rice, papaya, and sweet potatoes in Vietnam, Indonesia, Malaysia, the Philippines, and Thailand. Late in 2000, ISAAA joined forces with another African-based Supporter, AfricaBio, whose purpose is to ensure that Africa can decide for Africa which agro-biotechnologies are relevant and that they are used properly.

Civil society groups which display Alternative characteristics are primarily Northern and have no visible representation in Southern countries. Alternatives may exist in countries such as Brazil, China, and South Africa, where there is substantial commercial planting of GM crops. However, their quest for isolation and peace would most likely prevent them from becoming connected to the global movement.

Global civil society actions and methods

Global civil society groups have taken various types of action during their campaigns on plant biotechnology. Demonstrations, direct action, letter writing, lobbying, and citizen's juries have all been undertaken recently on various sub-topics within the general debate. Sometimes the actions are implicitly supported by the government. For example, in the UK, the destruction of GM crop field sites by protestors was not punished (see Box 4.9). On other occasions the actions have had little influence on government or the private sector.

Table 4.5 presents a sample of the actions taken for specific campaigns and the types of groups involved over the last seven years. It is far from exhaustive. It does show that Rejectionists and Reformists often join forces, occasionally together with Alternatives.

Conclusions

Despite the protests, participation in political and industry processes, consumer boycotts, and direct action in many parts of the world, plant and agro-biotechnology are unlikely to go away. For the Rejectionists, this is a dire forecast. For the Reformists, Alternatives, and Supporters, it means an increased workload because the issues and concerns will not evaporate as the technology spreads. Although in some parts of the world its adoption may be slowed over the next few years, in the long term it is unlikely to be altogether dispensed with. There are three key reasons for this. First, the private sector has invested substantial scientific and financial resources in it, creating a momentum that would be difficult to reverse. Indeed, the current US government explicitly supports corporate investment in biotechnology and life sciences. Second, the public sector has also made significant investments; more importantly, many public research institutes and influential bodies, such as the US National Academy of Science, agree that the technology has an important role to play in meeting world food demands. Third, the next generation of GM products may be less controversial. For example, in the near future, GM products are likely to emerge that, rather than food for human consumption, are an extension of industrial biotechnology using agriculture, such as producing plastics from corn,. These products may require fewer regulatory approvals and be less controversial from a public point of view, and could therefore help to ensure the technology's survival, regardless of public opinion on GM food.

In the next five to ten years, as the technology develops and global civil society continues to engage with the issues, there are four key points to watch and consider:

1. The pace of innovation will quicken.

For example, a few months ago the sequencing of plant genomes was not part of the public's consciousness. The public vaguely knew that scientists were making progress in understanding plant genomics. At the time of writing, two plants have been entirely decoded, including rice, a major food crop for a large part of the world. Today, genomic work is under way on hundreds of plant and animal species, as is transgenetic engineering from viruses, bacteria, and animal genes. The speed of innovation has implications for health and safety and society's capacity to regulate and monitor the risks and impacts. The pace of innovation requires global civil society to consider three wide-ranging sets of questions. What are the broader impacts of the new technologies? What are the alternatives? What expert and governmental capacity is required for regulating and monitoring the developments?

First, global civil society needs to ensure that, as the technology and its uses advance, we also increase work on, and understanding of, integrating ecosystem and human health complexity with biotechnological developments and applications. This is particularly true for work on tropical ecosystems, in which there is even less understanding of complex ecological dynamics, and for people who are undernourished or in stressed health situations. Comparative studies are required which take into account social influences such as diets, general health and fitness, and the socio-economic realities of the target consumers. This will require broadening our view of environmental and health effects beyond the current narrow approach to encompass the ethical and social issues raised by global civil society.

At the same time, *we must be able to ask what the alternatives are*, and for this we need a better understanding of the complex ecological interactions involved in 'traditional' agriculture and food delivery. *Focusing narrowly on the impacts of GM crops will rob us of a complete understanding of our options.*

Second, the rapid advance of technology also will require accelerated capacity-building in government, societal governance, and policy research in developing countries, particularly in sub-Saharan Africa. Capacity is required for national regulatory processes as well as for international agreements and complex matters such as bio-safety. In the medium term, the private sector is likely to continue to shift its focus from Europe to Africa and other parts of the developing world such as China. This implies that these regions need legal and scientific capacity-building today as well as in preparation for future developments. In addition, the rapid development of the technology, most of which is and will remain in the private sector, means that there will be fewer and fewer experts who can be called on by government and civil society to provide 'neutral' evidence and advice about the developing technologies and their potential impacts. For example, only five expert witnesses were identified in the US to consider the Starlink allergenicity case.

For many reasons, trusted expert capacity is the most critical issue global civil society faces in the next five to ten years. Without reliable expert information, governments and civil society will be handicapped in making recommendations, judgements, and policy to guide the development of biotechnology. The obvious solution—training more scientists—will be effective only in the long term and only if the scientists have sufficient incentives to remain in the public sector. Global civil society must address this issue in a new and creative way for the short and medium term. Otherwise, its efforts will be crippled by a lack of scientific understanding. Reformists need to give top priority to capacity building for the next few years. Rejectionists and Alternatives also need to keep up with the science and the social impacts and to join forces with some Reformists to address the massive information gap about the impacts of conventional food production. Without this information, the debate cannot mature.

2. We lack trusted leadership.

For good or bad, there are no clear leaders who are trusted, respected, and heard by all sides of the debate. Each 'domain' has its key ringleaders, but the other sides do not trust them. At best they are *dramatis persona*e, but they are tainted by being viewed as biased experts in the field. More importantly, they are also involved in other work and are not perceived to be totally dedicated to the 'cause' of plant biotechnology. NGOs follow the international call leaders such as Vandana Shiva, Jeremy Rifkin, Pat Mooney, and Peter Melchett, while scientists gather around fellow scientists of international acclaim who remain in the public sector, such as Peter Raven, Norman Borlag, and Swaminathan, a Nobel Laureate and authority on the Green Revolution. *Lack of a common language and hence of agreed priorities prevents a leader from emerging, as there are few civil society leaders who 'speak science' and few scientists who 'speak society'.*

It is unrealistic to seek a figurehead for a polyvocal, often contradictory, amorphous movement. However, global civil society groups should be aware of the need for communication and leadership and foster respectful interactions between experts from all sides. Reformists, Rejectionists, Supporters, and Alternatives alike need to take up the challenge to develop a common language from which stronger leadership should develop.

3. The economics are important.

Three related economic trends will help shape the technology. First, 75 per cent of agricultural developments are currently in private sector laboratories (ISAAA 1999), and intellectual property rights (IPR) protect these investments. This implies that most developments will need to meet the financial requirements of their investors rather than those of poor farmers in developing countries. In addition, it remains unclear whether the IPR held by the private sector will hinder public-sector technology development. Second, we can expect continued investment in plant biotechnology for commodity crops. How will these developments change the *locus* and economics of production for commodities such as sugar, palm oil, and peanuts? How will this affect the poor producers of the world? Third, given the economic realities and patterns of IPR, how will the benefits be shared? The plants and genes originated in the common. Reformists and Supporters need to assume leadership, in partnership with businesses and government, in devising creative solutions that encourage and enable the private sector to re-infuse the commons and to find ways to ensure that benefits are shared as equitably as possible. These sentiments are commonplace in the language of the Convention on Biological Diversity and those who work in this domain. However, global civil society has yet to deliver workable, replicable, efficient programmes for sharing the benefits of plant biotechnology and its products. This is a major and urgent task for the next five years.

An additional noteworthy economic trend is the expectation that genetic engineering and genome work will become less expensive. Assuming IPR barriers are either porous or short, might we see a mushrooming of medium-size participants in developing countries? If this scenario develops, how will small and medium-sized technology companies be regulated in countries with inefficient regulatory practices? Most developing countries will consume their own products, thus avoiding Biosafety Protocol requirements. Global civil society, especially large Reformist organisations and Supporters, need to address *now* national capacity building for regulation and monitoring of technology development. On the other hand, if R&D does not grow in developing countries, will the convergence between research and development on genomics and traditional plant breeding squeeze out those countries that have no genomic capabilities? This is a hard question that most Rejectionists, Reformists, and Alternatives have not begun to ask. However, ignoring future trends in technology development and patterns of technology concentrations is not helpful. Reformists and

Table 4.5: Types of action

Campaign	Activity	Types of groups involved	Examples
Labelling	Direct action mainly in Europe with limited action in the US	Reformists	Dumping GM food in government doorways in Europe, boycotting food products, leafleting food stores
	Lobby UN/Codex for mandatory labelling: letters, visits, etc	Reformists, Alternatives	Letter writing/e-mail campaigns by Women Say No to GMOs (URL), several developing country NGOs, etc.
	Campaigns for regional labelling laws	Reformists, Alternatives	California Right to Know (URL), Australian and NZ NGOs strive for labelling
GM out of food supply and/or consumer boycott	Letter writing and e-mail campaign to governments and food companies	Rejectionists	Greenpeace, True Food, Einkaufsnetz (Germany), Reseau-Info-Conso (France): ban growing GM crops worldwide, pressure on food companies
	No GM foods for relief aid to India	Rejectionists	Vandana Shiva calls for no GM food in relief aid for India
	Online debates	Rejectionist vs Reformists	Prince of Wales Forum, various chat rooms on web
	Lobby governments for Consumer Charter for right to remain GM-Free	Alternatives	'Women Say No to GMOs' campaign to isolate test and crop sites
General public awareness/information	Websites, public gatherings, information handouts on general and specific details of GM; interaction with media	Rejectionists, Reformists, Alternatives	Dedicated websites against GM, 'The Organic Picnic' for 3,000 in London, leafleting supermarkets, press releases
	Consumer guides to avoid GM foods	Alternatives, Rejectionists	Greenpeace's online guide, Soil Association organic food guide, etc.
End field tests and planting GM crops in country/world	Information with no specific call to action	Reformist	GeneWatch UK publishes Internet information on field trials.
	NGOs block seeds despite no law forbidding them for import (Aerni, Anwandar, and Rieder 2000)	Rejectionists	Greenpeace intercepts seed to Philippines
		Rejectionists	

Campaign	Activity	Types of groups involved	Examples
End field tests and planting GM crops in country/world cont.	Destruction of GM field trials, commercial fields, and contaminated crops		'Dig it Up' network with GeneticSNowBall, GeneticX, Indian Farmer's Union, etc. to mobilise public to protest planting
Terminator technology and farmers' rights	Citizens' Jury	Reformists	ActionAid in India held jury of small poor farmers to decide if they want GM crops or not
	Public information	Rejectionists, Reformists	Website material, media campaign
	Lobby US governments	Rejectionists, Reformists	RAFI and others lobby to revoke patent
	Lobby board of directors of company	Reformists	Rockefeller Foundation President speaks to Monsanto's Board of Directors, resulting in promise not to commercialise sterile seeds
Intellectual property rights	Targeted communiqués to experts/NGOs/media	Rejectionists, Reformists	Internet coverage of Indian government's revoking of W.R. Grace's species patent on GM cotton
	Legal challenges and court cases	Rejectionists	RAFI challenge to Monsanto's species patent on GM soy at European patent office.
	Pressure on political leaders	Reformists, Rejectionists	End basmati rice patents: postcards to Prince of Liechtenstein to drop patent owned by company he chairs
More testing and national/international regulation	Call to test GM products as rigorously as drugs	Reformists	Friends of the Earth (URL) and networks
Company-specific activities	Demonstrations against Monsanto	Rejectionists	Demonstrations in India, Brussels, London, Boston, St. Louis, etc.

Supporters need to start bravely debating the economic and social consequences of different models of technology diffusion and development. Only then will they be able to help governments and civil society prepare for mushrooming national development, or the risk of exclusion, or the many possibilities in between the two extremes.

4. Chaos theory still applies.

While is it irresponsible to scaremonger, we need to ask whether an unexpected accident will occur in the next few years. Chaos theory, rather than unilluminated fear, predicts that it will. We know that grains are moved and commingled in processing, seeds for planting get mixed (for example, the accidental planting of unapproved Liberty Link rape seed from Canada in the UK in 2000), and the isolation of crops is not yet always assured. The Starlink case in the US is indicative of the potential and the quality of governmental and societal reaction. The products were quickly taken off the shelves, the company involved apologised and moved rapidly to repair the damage, and consumers were apparently left unscathed. It was a safe dress-rehearsal for the next mishap. But have we really seen the end of such cases? Is it global civil society's role to help the public, grass-roots organisations, local and national government, and industry learn from these accidents and to build effective systems for emergency response? This is easier in countries such as the United States. What would have happened if Starlink had been imported to India or Egypt?

All civil society groups need to blow the whistle when things go wrong. But playing a role in the prevention of accidents is even more critical. Not all groups need to take on the same role. Rejectionists and Alternatives are best suited to remain critical watchdogs. Reformists need to work with communities, industry, and government to develop long-term strategies to ensure that the environmental and social consequences of plant biotechnology are understood, accepted, monitored, and verified. And when something does go wrong, Reformists need to lead the way and collaborate with all other civil society groups to frame swift and sane responses and remedies. Supporters also have a critical role. They need to work directly with industry to help it hear and understand the public's many and changing concerns.

To work effectively, all global civil society groups need to be well versed in the subject matter and focus on solid, fair communications. The lack of a common language and respectful dialogue generates misunderstanding, spreads fear, and widens the gulf between most groups. Society leaders need to 'speak science' and scientists need to learn to 'speak society'.

What global civil society does today and how it reacts to plant biotechnology is not about Round Up-Ready Soya, and BtMaize. It is not about the growing of commercial GM crops in Europe or the diffusion of Golden Rice. It is not even about labelling. It is, however, about the future, and how future technologies will affect our environment and society. How society shapes regulation, focuses R&D, decides on benefits and access, and determines safety standards and monitoring today sets a precedent for the future. As the complexity of the technology rapidly increases, so will the complexity of the issues, economics, and potential risks. The world will require frameworks, case studies, and lessons from the past. This is what global civil society is creating here and now.

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