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www.econexus.info
info@econexus.info

Hungry Corporations:

Transnational Biotech Companies Colonise the Food Chain

By Helena Paul and Ricarda Steinbrecher
with Devlin Kuyek and Lucy Michaels
In association with Econexus and Pesticide Action Network, Asia-Pacific

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Chapter 4:

Consolidation, Contamination and Loss of Diversity: the Biotech Dream Takes Hold

The last decade of the twentieth century saw the agbiotech industry consolidate. Many of these companies also moved into the seed business, buying up companies worldwide. The increased integration of the agrochemical and seed industries into emerging biotech giants represented one aspect of the loss of diversity; the other was the dwindling of available seeds and agrodiversity, as companies dropped varieties from their catalogues. At the same time, however, biotech giants began projecting themselves as 'life science' companies – until it became clear that their new products were taking longer to come to market than had been hoped. Watching the companies merge, demerge, and create alliances is like watching poker players swap cards. Those outside the casino are entitled to wonder whether their needs are best served by this process. As the consolidation process continued, a new threat emerged, that of genetic contamination, as the constructs of the genetic engineers began to move through the food chain (see 'Starlink – GM corn', p. 92) and the environment, posing particular threats to centres of diversity. The first such incident was the discovery of GM contamination of maize in its centre of origin, Mexico. The ensuing row brought contamination of an intellectual nature, with scientists allowing their judgement to be clouded by their dependence on funding. It has become apparent that the industry can benefit from the spread of contamination, if people feel unable to maintain their resistance in the face of a tide of pollution. Monsanto has shown how companies can directly benefit from contamination by successfully suing farmers for the adventitious presence of patented genes in their crops.

4.1 The life science concept

> *A wholesome potato that promises consumers french fries and chips with better flavor and texture. Firm juicy tomatoes with garden-fresh flavor. Fluffy white cotton bolls on a plant that can fend off damaging insects without the use of chemicals. Lush healthy soybean plants that offer growers new alternatives for controlling yield-robbing weeds.*
>
> Monsanto leaflet (*Exploring a New World of Discovery*) on Monsanto's Life Sciences Research Center (n.d.)

By the 1990s the big chemical companies had gained a very dirty reputation. Events such as Union Carbide's Bhopal disaster had made them increasingly conspicuous and unpopular. There were an increasing number of stories of toxic chemicals building up in the food chain, appearing in mothers' milk, forcing the greenhouse effect, opening up the hole in the ozone layer, or being suspected of causing cancers and immune system problems. So, in the mid- and late

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1990s, as they sought to change their identities from old chemical dinosaurs to new biotech saviours, their public relations managers devised a new concept, the 'life sciences', which could be applied to any company activity connected to life processes: notably crop and food production, and pharmaceuticals.

The title 'life sciences' summons up an image of benevolence. Its launch around 1997 was accompanied by many advertisements projecting the image of a clean and wonderful future brought by science in partnership with life. It was more than just a PR exercise, however. The agrochemical industry had been finding it increasingly expensive and difficult to develop new chemical pesticides and herbicides and also faced the prospect that some of its leading products were soon to come off patent. Moreover, their share of the revenue from the food system was dwindling as the food retailers, processers and distributors increased their share. The agrochemical industry found potential solutions in biotechnology, which gave it a whole new area of science, biology, in which to identify and patent new pesticides and technologies, based on the DNA of organisms:

> TNCs could use biotechnology to counter generic [non-patent] competition by genetically engineering plants for dependence on their brand-name pesticides. Genetically modified (GM) crops could have the added advantage of reducing regulatory costs; a new pesticide costs a company between $40–100 million to bring through the regulatory process while it cost less than $1 million to bring a new plant variety to market.[1]

This explains why almost all of the early GM crops were engineered for herbicide tolerance – and indeed still are (see Table 8.3, p. 187). It made good business sense to do so, helping companies to keep commercial control of products which were coming off patent through making them part of agricultural packages containing patented seeds and tied to contracts. In addition, the companies dreamed of using agricultural biotechnology to create and patent new designer crops that would find ready markets in the food and feed industry: for example, crops with additional or altered oil, protein and vitamins.

The companies therefore sought to counter images of poisoned land, water and people with promises of crops that would need fewer applications of pesticides or that would produce their own. They borrowed from concepts such as Ayurveda, an ancient system of health and nutrition in India, claiming that they would produce crops with added vitamins and minerals or medical properties (see 'Golden Rice', p. 135). They promised new developments that are a long way from being realised and may not be amenable to genetic engineering, such as drought- or salt-resistant crops. These promises helped to intensify investor hopes for profitable synergies between the different divisions specialising in pharmaceuticals, nutrition and agriculture. Trying to find the right combinations fuelled mergers, acquisitions and spin-offs during the late 1990s. But this optimism, accompanied by grandiose name changes and advertising campaigns, proved premature.

The life science concept on hold

> *The unravelling of life sciences comes as no surprise to cynics who saw it less as a business strategy than a pretty label to stick on what was left of companies once they evolved by disposing of their low-margin, cyclical chemicals assets.*
>
> 'Green and Dying', *Economist*, 16 November 2000[2]

During 1999, pharmaceuticals divisions commanded high premiums, mostly due to a few top-selling drugs, whilst agribusiness divisions took serious downturns. This was due partly to the general trend of depressed prices in the global agricultural commodity market, but also to campaigns in Europe against GM crops. Mid-term profits slumped and job losses were announced. Brokerage houses such as Deutsche Bank advised major players in the biotech industry to spin off their ailing agricultural divisions.[3]

By 2000 the widely trumpeted 'life sciences industry' experiment seemed to be coming apart at the seams. With the agrochemical market in a period of slow growth and the transgenic seed market still relatively small, many commentators called for the more profitable pharmaceutical sector to be separated from the agriculture sector. Companies appeared very eager to distance themselves from the stagnating agribusiness sectors, as indicated by the demerger of Aventis CropScience from Aventis or the Novartis and Zeneca spin-off of their agrochemical divisions to form Syngenta. Yet agribusiness and pharmaceuticals were still seen to have strong potential synergies, as continuing research into engineering plants to produce vaccines, antigens and increased vitamin content indicates. However, many years of development and testing are required; methods have to be found to prevent cross-contamination between crops and seeds variously required for pharmaceutical, food and industrial purposes; and it is likely that few of these promised products will actually materialise or make it through to the market.

The *Economist* reported in 2000:

> As Michael Pragnell, head of Syngenta, points out, keeping agriculture and pharmaceuticals together provides synergies in basic research, but these soon evaporate when it comes to further development and marketing. Moreover, such benefits are easily diluted by the strain of having to manage two very different businesses.[4]

Another 5–10 years to wait for the pay-off?

Some of the manoeuvring that we have seen the companies engage in since 2000 arises from the fact that they still believe that there may be huge potential profits in the life science combination of agriculture/pharmaceuticals/ genetic engineering. As explained above, however, it will be some time before these are realised, so the companies have to work out how to maintain their potential stake in the gold field while retaining the confidence of lenders and investors who do not like to wait too long for good news.

A market analyst expressed it well in November 1999, although he was still premature in his forecast of the upturn in the fortunes of the life sciences, especially in view of the general downturn in the stock market in recent years:

> The agribusiness sector is, at the moment, in a turbulent state, but we believe that we are probably close to the bottom of the depression. The psychological climate cannot deteriorate much further nor can the industry's economic conditions…. The future should be brighter providing that life-sciences companies correctly manage the crucial issues …. We, therefore, believe that the timing should soon be right to invest in life-sciences companies given their current valuations. It may be sensible, however, to bide one's time for the coming wave of consolidation in order to have a clearer picture of the industry and be able to spot the future winners. It is also worth remembering that we do not expect the real economic pay-offs stemming from plant genetic engineering to filter through for 5 to 10 years. So, as far as GMOs alone are concerned, investing in life-sciences shares requires a long-term approach to investment, with each investor carefully assessing the opportunity cost of such an investment over such a long period.[5]

In addition to the tensions described above, the industry now has to deal with the fact that some of the disadvantages of the technology are emerging in the form of contamination, which has already affected Canada and the US quite seriously.

4.2 Consolidation in the agrochemical industries

> *We expect that only five or six major agrochemical businesses will be left by 2002; at present the top nine represent approximately 85 per cent of sales.*
>
> 'Challenging Climate for Agrochemicals', Lehman Brothers analyst report, 17 January 2000

The process of corporate consolidation is complex and can be confusing. What follows is the briefest possible outline to help elucidate the tables below. Further information can be gained from corporate websites and those of organisations that analyse corporate activities.[6]

Monsanto has long been the company everyone loves to hate, boldly pushing in where others have not dared to tread and bringing hundreds of cases against farmers for alleged violation of its patented genetic traits. That is not surprising, because in 2001 Monsanto traits were present in 91 per cent of GM crops grown worldwide. Having purchased a global spread of seed companies (nearly $10 billion spent since 1996), it sought an alliance with another company, and became a subsidiary of *Pharmacia* in 2000. It was spun off in 2002, however, and could now be extremely vulnerable to market vagaries and predatory suitors.

Its patent on the best-selling herbicide ever, the glyphosate-based RoundUp, expired in 2000 and Monsanto is beginning to feel the effects. Notwithstanding its patents on GM crops tolerant to RoundUp and producing their own pesticides,[7] and despite its use of growers' contracts and its dominant position in the GM seed market, Monsanto's income was sliding by late 2002. It had also failed to make progress in Brazil or Europe and had to hold back its release of GM wheat because of opposition campaigns. It did, however, manage to achieve restricted commercial release of some varieties of Bt cotton in India and Bt corn in the Philippines in 2002.

Monsanto's agreement in April 2002 with *DuPont* means that it will share certain of its technologies with DuPont's *Pioneer Hi-Bred International Inc.* DuPont and Monsanto are number 1 and 2 in seeds and between them hold up to 40 per cent of all significant agricultural biotechnology patents. However, their agreement avoided the need for monopoly scrutiny.

In December 1999 Swiss-based *Novartis* (formerly *Sandoz* and *Ciba–Geigy*) announced plans to merge its agrochemical and seed division with *AstraZeneca's* agrochemicals division (UK) to form a combined company called *Syngenta*, which ranked number 1 in agrochemicals and number 3 in seed sales in 2001. Syngenta is a less high-profile operator than Monsanto, with a strong interest in accessing genetic resources. In December 2002 it announced a proposed biotechnology Research and Development alliance with *Diversa* to seek commercially valuable molecules. In the same month it was forced to pull out of a proposed deal with an Indian university that would have given it access to a massive rice germplasm collection. In the same year, its foundation became a member of the CGIAR (see Chapter 5).

In late 2002 Syngenta discreetly circulated in the US a report about resistance to glyphosate appearing in weeds. Although Monsanto is still dominant in glyphosate, Syngenta markets its own version of the herbicide, Touchdown. In fact, gene flow and the appearance of resistance to glyphosate looks set to increase steadily. With the added complication of multiple resistance to more than one kind of herbicide, extra agrochemicals (which Syngenta can provide) or changes in farming practice would be required.

Aventis CropScience was the result of the merger of *AgrEvo* and *Rhone–Poulenc Agro*, the agrochemical and crop-science divisions of *Hoechst* (Germany) and *Rhone–Poulenc* (France) respectively. AgrEvo was itself the result of a previous joint venture between Hoechst and *Schering*. Poor performance in the agriculture sector and the StarLink contamination incident (p. 92) meant that Aventis CropScience was placed on the market in 2000.

Bayer, an agrochemical giant in its own right, did not participate in GM crops during the 1990s. However, in April 2002, Bayer's bid to buy Aventis CropScience was cleared by the EU and US monopolies investigators. As a result, Bayer CropScience is now global number 2 in pesticides, so changing the rankings of the tables on page 84. It is particularly strong in insecticides and fungicides.

BASF has indicated that it intends to participate in the next generation of GM crops, projected to have more direct benefits for consumers, and thus, it is hoped, more likely to overcome their resistance. Its purchases of *MicroFlo* and *American Cyanamid* in 1999 and 2000 made it the world's fourth largest agrochemical company.

Dow Agrosciences has manoeuvred to become one of the top ten seed companies, with interests in multiple-trait, insect-resistant crops such as cotton and sugar cane.

> The top two companies control 34 per cent of the global agrochemical market; the top 10 control 84 per cent. The world agrochemical market was valued at US$ 29,880 million in 2000.[8]

In 2001, GM accounted for 12 per cent of the global $31 billion crop protection market and 13 per cent of the $30 billion commercial seed market.

Table 4.1: World Crop Protection

Company	Ranking			Revenue in US$ million			Share of world market 2000
	1998	2000	2001	1998	2000	2001*	
Syngenta (Novartis & AZ)	--	1	1		6,100	5,385	20%
Aventis (AgrEvo + Rhone Poulenc)	1	3	2	4,676	3,400	3,842	11%
Novartis	2	--	--	4,152			
Monsanto (Pharmacia in 2000)	3	2	3	4,032	4,100	3,755	14%
DuPont	4	5	7	3,156	2,500	1,917	8%
AstraZeneca	5	--	--	2,897			
Bayer	6	6	6	2,273	2,100	2,418	7%
American Home Product	7			2,194			
Dow AgroSciences	8	7	5	2,132	2,100	2,612	7%
BASF & Cyanamid from 2000	9	4	4	1,945	3,400	3,105	11%
Makhteshim-Agan	10	8		801	675		2%
Sumitomo		9			625		2%
FMC		10			575		2%
TOP 7 Sales:				23,380	23,700	23,034	

* including Cyanamid

2000 figures: ETC Group - (formerly RAFI) "Globalization, Inc.- Concentration in Corporate Power: The Unmentioned Agenda" published September 2001 – see http://www.rafi.org - based on data provided by Allan Woodburn Associates cited in Agrow.
2001 figures: *Global Pesticide Campaigner* (Vol.12, No. 2) August 2002 – based on Agrow data

4.3 Consolidation in the seed industry

With all the fanfare over GM crops, it is often forgotten that corporations only supply a fraction of the world's agricultural seed. African farmers utilise seeds from within their own communities for around 90 per cent of their seed needs. In India and the Philippines, farmers are responsible for 60 and 80 per cent of the annual seed supply respectively.[9] Even in industrialised countries, farm-saved seed still constitutes a principal source of seed for a number of major crops, such as wheat and soybeans.

It was only in the twentieth century that centralised, off-farm plant breeding began to play a major role in agriculture. In northern industrial countries, especially those with colonies, such formal plant breeding was largely carried out by the public sector. Plant breeders collected and combed through the wealth of plant varieties of farmers in the South to develop varieties suited to the climatic conditions and industrial interests of their respective countries. The US soybean crop, for instance, which has become the most important crop in the US next to corn, was developed by public researchers in the post-war period working with a collection of nearly 5,000 soybean lines brought back from a 1929–31 collection mission to China.[10] The varieties developed through such public programmes served as the basis for the development of the private seed sector.

A similar process is under way in the South. The green revolution breeding programmes displaced on-farm crop development to the laboratories of the CGIAR and the national research centres. And now the private sector, through various World Bank and US Agency for International Development (USAID) seed projects, is stepping in to take over where it senses potential for profit. In Asia, for example, several companies are now pursuing hybrid rice seed markets, building on research carried out by IRRI and certain national agricultural research centres in Asia.[11] (For World Bank involvement in seed projects in Africa, see Chapter 5.)

Up until 30 years ago, most European and North American seed companies were small, family-owned businesses. Since that time, the seed industry has changed dramatically. In 2000, according to research by the Action Group for Erosion, Technology and Concentration (ETC Group) (see Table 4.3), ten seed companies controlled almost one-third of the $24.7 billion commercial seed market. Indeed, two companies – Monsanto and DuPont (with Pioneer) – controlled almost 15 per cent, and corporate market share is much higher in specific seed sectors and for certain crops. For example:

- Forty per cent of US vegetable seeds come from a single source.
- The top five vegetable seed companies control 75 per cent of the global vegetable seed market.
- DuPont and Monsanto together control 73 per cent of the US seed corn market.
- Just four companies (Monsanto, DuPont, Syngenta, Dow) control at least 47 per cent of the commercial soybean seed market.[12]

Concentration within the seed sector is likely to continue. Most of the largest seed companies are also the largest pesticide companies and agbiotech companies (see Table 4.2). To date, most of their

Table 4.2: Global Ranking 2001 by Sector : agrochemicals, seeds & pharmaceuticals
- based on 2000 revenues.

Company	Sales in US$ millions and global ranking (R)					
	Agrochemicals		Seeds		Pharmaceuticals	
	R	Sales	R	Sales	R	Sales
Syngenta	1	6,100	3	958		
- AstraZeneca					4	14,834
- Novartis					7	12,698
Pharmacia (incl.Monsanto)	2	4,100	2	1,600	8	11,177
Aventis	3	3,400	10	267	5	14,809
BASF	4	3,400	-	-		
Dupont (Pioneer)	5	2,500	1	1,938		1,630
Bayer	6	2,100	-	-	18	5,330
Dow	7	2,100	7	350	-	-

Source: data researched and published by the ETC Group (then Rafi)

Table 4.3: The World's Top 10 Seed Corporation

Rank	Company	HQ	Seed sales US$ millions			% change over	
			1999	2000	2001	1999	2000
1	DuPont (Pioneer)	USA	1850	1938	1,900	4.8	-2.0
2	Monsanto	USA	1700	1600	1,700	-5.9	6.3
3	Syngenta	UK & Switzerland	947	958	938	1.2	-2.1
4	Groupe Limagrain	France	700	622	678	-11.1	9.0
5	Grupo Pulsar (Seminis)	Mexico	531	474	450	-10.7	-5.1
6	Advanta (AstraZeneca & Cosun)	UK & Netherlands	412	373	420	-9.5	12.6
7	KWS AG	Germany	355	332	388	-6.5	16.9
8	Delta & Pine Land	USA	301	301	306	0	1.7
9	Sakata	Japan	396		[231]		[-15.1]
10	Dow (incl Cargil N.America)	USA	350	*350	[215]	0	[16.2]
	TOTAL		7542		7226		
(all sales data researched and published by the ETC group)							

research in crop development has focused on integrating their pesticide and seed businesses by genetically engineering crops for dependence on their pesticides, such as the RoundUp Ready (glyphosate) crops (Monsanto) and the Liberty Link System (glufosinate) (Aventis/Bayer), or by engineering pesticides into the crops, such as the Bt crops. The seed/pesticide conglomerates have decided to restrict the transfer of this technology and to buy up seed companies instead, in order to access germplasm and control the sale of their GM crops. Monsanto, for example, has spent more than $8 billion acquiring seed and biotech companies over the last ten years. As a result, small seed companies wanting access to the technologies have had to sell off their businesses, in whole or in part, and small seed growers have had to enter into stringent contractual agreements. Furthermore, access to germplasm of diverse domestic agricultural varieties is increasingly restricted, as they are either not grown or their seeds are not sold, often because it is no longer legal to do so.

This push towards biotechnology is the principal reason for the growing concentration in the seed sector. First, the big pesticide/seed companies (with three-quarters of the patents in agricultural biotechnology, with control over important germplasm and over the most advanced technologies through mergers and exclusive agreements with the leading genomics firms) dictate the terms under which any agricultural biotech research is done. Second, biotechnology offers the means and the incentive for these companies to move in on crops where traditionally there has been little private sector involvement. Industry analysts estimate that biotech will add 50 per cent to the value of seed markets, rescuing previously unprofitable markets such as rice or wheat.[13] Monsanto believes that the rice seed market could bring them sales of US$1,000–2,000 million a year.[14] And third, biotechnology opens the door to alliances – such as Renessen, the Cargill–Monsanto joint venture – between the upstream (pesticide/seed industry) and downstream (food and feed processers) sides of agribusiness, thus closing out competition in the seed sector and locking farmers into contract farming. Corporate concentration is bad for biodiversity. With vegetables, where (as noted above) just five seed companies control 75 per cent of the global vegetable seed market, diversity has declined dramatically, with many old varieties disappearing forever.

> If our vegetable diversity is allowed to die out, gardeners will become ever more dependent on transnational seed companies and the generic and hybrid and patented varieties that those companies choose to offer. And that means giving up our right to determine the quality of the food our families grow and consume, and also the ability of gardeners and farmers to save their own seeds, which is the reason that much of this incredible diversity exists in the first place. (*Garden Seed Inventory*, fifth edition, p. 15, quoted by RAFI)[15]

In 2000 the Rural Advancement Foundation International (RAFI, now the ETC group) released a comprehensive report, 'The Seed Giants – Who Owns Whom?' This contains detailed information about consolidation in the seed industry and a comprehensive list of seed industry subsidiaries.[16]

4.4 Loss of agricultural diversity: Seminis and Savia

It's impossible to predict how much irreplaceable vegetable diversity is earmarked for extinction as a result of corporate cost-cutting and consolidation …. The seed varieties deemed obsolete and unprofitable by Seminis are now part of the company's private gene bank, and that rich diversity is lost to the public.

Kent Whealy, Executive Director of Seed Savers Exchange.[17]

The dramatic reduction of the availability of non-hybrid vegetable varieties, resulting in a wealth of seed diversity and germplasm being lost forever, is illustrated by the actions of Seminis,[18] the world's largest fruit and vegetable seed corporation, owned by the Mexican giant Savia. Seminis announced in June 2000 that it would eliminate 2,000 varieties or 25 per cent of its total product line as a cost-cutting measure.

For Seminis, the most profitable seeds are currently hybrids, because gardeners and farmers do not save seeds from hybrid plants, as they do not generally breed true. Hybrid seeds thus force farmers and gardeners to buy seed every year. New varieties can also restrict the seed saving and sharing activities of farmers and gardeners, as they are generally patented or protected by plant variety protection laws:

> most importantly, the seed corporation wants monopoly control over its varieties and that means high-tech, patented varieties. Seminis is a leader in the development of genetically engineered vegetables. The company has 79 issued or allowed patents on vegetable varieties and GE varieties, and is seeking further patents related to beans, bean sprouts, broccoli, cauliflower, celery, corn, cucumber, eggplant, endive, leek, lettuce, melon, muskmelon, onion, peas, pumpkin, radish, red cabbage, spinach, squash, sweet pepper, tomato, watermelon, and white cabbage.[19]

In California alone, Seminis has tested plots of glyphosate-resistant lettuce, peas, cucumbers, and tomatoes, plus a wide variety of fungus-, insect- and virus-resistant vegetables. One of Seminis's genetically engineered products, a virus-resistant squash, is already being grown commercially. Developed by its subsidiary, Asgrow, the first transgenic squash was approved for commercial production in 1994.[20]

Seminis established a cooperative agreement – or strategic alliance – with Monsanto in 1997 to develop GM vegetables with resistance to RoundUp or with the Bt technology. According to Sergio Cházaro, Seminis also has research and production alliances with 'Zeneca, DuPont, AgrEvo, Cornell University, John Innes, five Chinese institutions, Texas A&M University, the University of California, the University of North Carolina, the University of Jerusalem, Wageningen University and 94 other universities and research facilities'.[21]

4.5 GM contamination: plot or blunder?

Don Westfall, Vice-president of Promar International, a Washington-based food and biotech industry consultancy, said in January 2001:

> The hope of the industry is that over time the market is so flooded [with genetically engineered organisms] that there's nothing you can do about it, you just sort of surrender.[22]

Contamination of food, agricultural crops and landraces with modified genes and seeds from GM crops is rapidly growing into a global problem. There are two major pathways of contamination: one is by cross-pollination of traditional crops, native varieties (landraces) and related plants by GM crops; the other is by insufficient or careless segregation of GM materials at any stage. The issue of horizontal gene transfer – of modified genes passing from GM plants asexually to other organisms such as soil and gut bacteria and fungi – is equally problematic, but has not yet become a major public issue except maybe for the use of antibiotic resistance marker genes.[23]

The last few years have seen an increasing number of incidents, warning of what is to come if GM crops variously developed for food, pharmaceutical and industrial use continue to be pushed, not only without regard to the precautionary principle but also with inadequate separation distances, segregation and safety measures. Weak regulation and careless practice, whether in the US, Canada, Europe or Asia, are jeopardising food security and agricultural biodiversity as well as food safety and consumer choice. Contaminated seed has been found in a number of countries, including the UK, France, Italy and New Zealand Actual levels of contamination are likely to be much higher than currently acknowledged, since checking seed for low levels of contamination is difficult and not routinely carried out. There are relatively inexpensive tests available for particular proteins that are produced by the inserted GM genes – for the Bt toxin, for example. These tests will only help if one knows which particular GM crop or seed one is looking for and if the protein level is high enough to be

Contaminated seed

Companies themselves have failed to keep their GM lines pure. There have been several cases when seed labelled to be one GM variety was contaminated with another variety. This will only make headlines if the contaminant is an unapproved variety, as was the case in the UK in the summer of 2002. Aventis herbicideresistant oilseed rape, planted in test trials in the UK since 1999, had an impurity of up to 2.8 per cent with an unauthorised GM oilseed rape that contained an additional gene that confers resistance to the antibiotics neomycin, kanamycin and gentamicin A and B.[24]

The *Independent* reported that the company could face prosecution with unlimited fines or five-year prison sentences if found guilty of breaching the rules.[25] Whilst sowing of winter oilseed rape was suspended, the government failed to take immediate action to clean up the fields where the unauthorised spring crops were growing. When local people tried to protect their land by removing the seed pods from the GM plants, arrests were made. Although the evidence against them was clear, nobody was charged and no prosecution followed; any case would have collapsed since the crop itself was illegal.

In a variation on the theme, European farmers planted thousands of acres with Canadian non-GM oilseed rape supplied by Advanta in the spring of 2000. This seed turned out to be tainted with GM material banned in the EU. As a result, crops were later destroyed and Advanta had to compensate the farmers.

detected. At present tests that involve testing on the DNA level, looking for the inserted DNA itself, require proper laboratory facilities and are comparatively expensive.

It is difficult to establish whether the biotech industry is concerned about GM contamination, or sees it as inevitable and non-problematic, or whether it is actually employing GM contamination as a strategy – deliberately contaminating nature and the food chain to such an extent that GM-free products become impossible and consumers apparently have no option other than to accept GM.

Suing instead of being sued

Certainly the case of Percy Schmeiser and other farmers in Canada and the US who have been sued by Monsanto for violation of the company's patent on the gene for resistance to glyphosate should serve as a warning that contamination can be a potent and profitable weapon in the hands of the companies. The judge in Schmeiser's case dismissed as irrelevant any consideration of how his canola (oilseed rape) came to contain Monsanto's resistance gene and found against Schmeiser on the basis simply of its presence in his crop. Crucially, Schmeiser and his wife had to abandon their own seed, which they had been saving for 50 years. Many countries (Argentina, for example, or most African countries) do not so far have US-style patent laws, but if they adopt them, then farmers in such countries face the prospect not only of having their crops contaminated by proprietary genes, but of then being sued for this privilege, in addition to being prevented from saving their harvested seed. This would inevitably act as an extra pressure on those farmers simply to 'roll over' and adopt the technology.

Seed smuggling and the rumour machine

Another channel of contamination that has affected key regions of the South is the smuggling of GM seeds. This is often assisted by exaggerated stories about the properties of the GM seeds, so that people are persuaded to go to great lengths to get them. It is understandable that farmers should wish to buy seeds that are said to have higher yields and to need less pesticide than ordinary seed, even though this is a simplification of the real issues. GM seeds, in this case Monsanto's RR soya, have been smuggled into Brazil from neighbouring Argentina. Persistent rumours of widespread GM contamination of the soya crop added to the pressure for GM crops to be commercialised. However, Brazil continued to resist, even though the contamination has been quite serious in some regions (see Chapter 8). In Eastern Europe, seed smuggling is a major problem: the sources appear to be mostly Monsanto's RoundUp seed being planted in Romania or Bulgaria, and US food aid which has been sent to the region on a regular basis recently (see Chapter 7).

In September 2002, Pakistan, also seriously affected by the practice of seed smuggling, decided to lift its ban on the import of GM seeds that have been legalised in their country of origin.[26] It apparently did so in order to encourage importers to obtain a certificate giving details of the nature, characteristics and origin of the seeds, so that the government would at least know what was coming into the country. The black market in GM seed had become brisk in Pakistan, because the seeds were rumoured to have higher yields and to require less pesticide. The US, China, and Australia were said to be the most likely sources and the most popular seed was cotton, genetically engineered to be resistant to Bt. It was reported that farmers in different parts of Pakistan who had planted Bt cotton had been affected by a previously unknown disease. Previous attempts to introduce biosafety regulations had stalled earlier. The fact that Pakistan decided to admit seeds that had been legalised in their country of origin reflects the ambition of the promoters of GM to set up a global system whereby recognition in one country means approval everywhere. Such a system would have extremely serious implications for the protection of biodiversity, especially in areas of origin of staple crops (see the *criollo* story this chapter on pp. 92–5).

Getting GM seed into the ground at any cost

There have been unsubstantiated reports from India, Thailand and even the US, where the seeds are legal, that farmers were not told they were planting GM seed, but simply that it was a new hybrid. The women's president of Canada's National Farmer's Union reported that heavy sales promotion was the factor most responsible for increased acreage.[27] The industry has been allowing rumours about the yields of the crops, the convenience of GM farming, and the reduction of costs and pesticide use to spread worldwide. Certainly, in countries where no technology fee is charged, for instance, there may be an initial reduction in costs. Farmers often do not have independent sources of information to which they can turn. This has fuelled the demand for the seeds. The rumour machine is also at work in India, where permission was given for the growing of certain Bt cotton varieties in 2002. Farmers heard rumours about the performance of the new seeds and were frantic to get hold of them. This made them vulnerable to bogus seed salesmen and also meant that they often did not get the right seed for their region or the right information about how to plant the seeds so as to reduce the speed of development of insect resistance.

StarLink – GM corn

> *StarLink has definitely set back the biotech industry, maybe five years.*

Lewis Batchelder of Archer Daniels Midland to the *New York Times* [28]

Farmers in North America, where over three-quarters of all GM seeds were sown in 2000, have been growing Aventis's GM maize, StarLink, solely as animal feed. StarLink has not been approved for human consumption because the particular Bt toxin used (a protein known as Cry9C) could trigger allergic reactions in humans. Further tests still need to be carried out. Yet this GM maize illegally entered the human food chain, initially showing up in tests of corn chips and taco shells. In fact over 300 products were pulled from US grocery stores after the discovery in September 2000. Products had to be withdrawn in other countries like Japan and the UK as well, because of illegal contamination.

This contamination has had a serious effect on US grain exports and could well cost Aventis in excess of $200 million in damages.[29] When in October 2001 Bayer announced its intention to purchase Aventis CropScience for US$6.6 billion, it refused to take on any potential liabilities arising from the controversy over StarLink GM corn. When tested for, Starlink contamination has shown up in many parts of the world, demonstrating how far and how fast contamination can spread through the food chain. Though pulled off the market altogether in the US, the StarLink Bt toxin genes seem to have contaminated other seed stock.

Japanese grain importers announced in December 2002 that traces of the banned StarLink variety were found in a cargo from the United States. US corn exports to Japan - the world's biggest importer of the grain - had only started to return to normal in 2002, while South Korean food processers have continued to shun US corn for food use.[30]

Criollo – *native corn*

> *The genie is out of the bottle. What we are confronted with now is just thousands of very different genies that are still in their bottles, and the question is this: do we want to keep those bottles closed or are we opening them?*

Ignacio Chapela, October 2002. [31]

A shock wave ran across the globe in the autumn of 2001 when researchers found that native maize varieties (*criollo*) in the Oaxaca region of Mexico are contaminated with GM material. This region is the cradle of maize, the centre of origin of all modern varieties. It is crucial to preserve the old varieties and landraces for future food security. This is acknowledged by most who understand plant breeding.

Mauricio Bellon, the director of the economics programmes at CIMMYT in Mexico, called it 'the world's insurance policy' in an interview with the *Nation* (US) regarding the contamination of maize in Oaxaca:

> The diversity of these landraces, these genes, is the basis of our food supply. We'll have great science, we'll have great breeding, but at the end of the day, the base [of this crop] is here. We need this diversity to cope with the unpredictable….
>
> The climate changes, new plant diseases and pests continue to evolve. Diseases we thought we had controlled come back. We don't know what's going to happen in the future, and so we need to keep our options open. And this [the growing of landraces] is what keeps our options open.[32]

Plant molecular biologist (microbial ecologist) Ignacio Chapela and David Quist from the University of California at Berkeley published their study on transgenic maize in the journal *Nature* on 29 November 2001.[33] Looking at landraces grown in the Oaxaca region, they had identified a genetic sequence in four out of six maize samples that was commonly used as part of the novel genes genetically engineered into plants, namely the 35S promoter from the cauliflower mosaic virus.

On the day their findings were published in *Nature*, a series of e-mail messages appeared on the AgBioWorld bulletin board (see pp. 70–2) asserting that Chapela could not be an objective scientist because he was an activist and on the board of directors of Pesticide Action Network North America (PANNA). In April 2002, *Nature* published a note from the editor, withdrawing the original article and stating that he had consulted with three referees before making this decision. It later emerged that only one of the referees thought the article should be retracted. The editor's note was accompanied by two letters written by people linked to the University of California who had supported a five-year 'collaborative research agreement' between Berkeley and Novartis (now Syngenta) in 1998. This agreement had generated considerable conflict at the time and Chapela had strongly criticised it on the grounds of public interest. Careful research (by Jonathan Matthews of the Norfolk Genetic Information Network, UK) revealed that some of the e-mail messages criticising Chapela were connected with the Bivings Group, a public relations firm which specialises in e-mail and Web work and which has Monsanto on its list of clients. Furthermore, some of the people alleged to have sent them did not actually exist.[34]

The University of California at Berkeley reported on Chapela's findings:

> Genes from genetically modified crops that spread unintentionally can threaten the diversity of natural crops by crowding out native plants, said Chapela. A wealth of maize varieties, cultivated over thousands of years in the Sierra Norte de Oaxaca region, provide an invaluable 'bank account' of genetic diversity, he said. Chapela added that genetically diverse crops are less vulnerable to disease, pest outbreaks and climatic changes. '*We can't afford to lose that resource*,' he said.[35]

Mexico's government seems no less concerned. In 1998 it imposed a moratorium on new plantings of GM maize to protect the centre of origin. The closest region where transgenic corn was ever known to have been planted is 60 miles away from the Sierra Norte de Oaxaca fields, where Chapela found the contamination. First rumours and then news of GM contamination caused the government to initiate an investigation into the subject and to ask its own research institutions to carry out tests for Oaxaca and the neighbouring state of Puebla. DNA tests (PCR, Southern blot and sequencing) and protein tests (strip test and ELISAs) confirmed the presence of transgenic DNA (35S promoter, for example) as well as the Bt toxin and its gene cry1A. The latter was found extensively in the landraces of Oaxaca, while cry19 was not found. In the view of Ariel Alvarez-Morales, one of the researchers, 'The changes observed are those expected when the farmers use a hybrid to "enhance" or improve their landraces, a practice that is very common among small growers in this area.'[36]

Confirming Chapela's findings of widespread contamination, the Mexican scientists sent their paper to *Nature* for publication. And once again *Nature* showed it does not know how to handle controversial scientific findings. The Institute for Food and Development Policy (also known as Food First) reported in a press release on 24 October 2002 that *Nature* had rejected the paper

> after two external peer reviewers recommended against publication for opposite reasons. One reviewer recommended rejection of the Mexican report because the results were 'obvious', while the other recommended rejection because the results 'were so unexpected as to not be believable'. A third reviewer emphasised technical issues. When asked for comment, *Nature* editor-in-chief Philip Campbell said the paper was rejected on 'technical grounds'. He added 'the conclusions of the paper could not be justified on the grounds of the reported evidence'.[37]

Yet how exactly the widespread contamination occurred remains a puzzle and nobody knows for sure what precise variety of transgenes ended up in the landraces. Dr Norman Ellstrand, Professor of Genetics at the University of California, Riverside, and a specialist on corn genetics, says that

> the corn in Capulalpan could contain any number of characteristics that have been engineered into American corn. Since corn is openly pollinated, he explains, pollen from one plant can blow or be transported in some other way to fertilise another plant. 'And if just 1 per cent of [American] experimental pollen escaped into Mexico, that means those landraces could potentially be making medicines or industrial chemicals or things that are not so good for people to eat. Right now, we just don't know what's in there.'… This year, he is researching how long transgenes will persist in native varieties – whether, in fact, they can ever be bred out of the population. This is a question that until now has not even been studied.[38]

Letting out the pharma genie

A new and potentially even more alarming source of contamination arises from the development of GM crops engineered to produce pharmaceuticals. In most cases, the 'pharma-gene' has been engineered into common crop plants, especially maize (corn), a prolific pollinator. As the physical appearance of 'pharma-plants' and seeds is the same as those of conventional plants and seeds, accidental contamination cannot be easily detected. Furthermore, any cross-pollination with food crops could contaminate food sources with drugs for years to come.

Contamination through food aid

Chapela stated that in 2000, 5–6 million tons of corn entered Mexico from the US, while Mexico had 'exactly the same amount of domestic corn rotting away, unused'.[39] Said to be 30–40 per cent transgenic, the US corn was distributed through welfare food systems through the country, heavily subsidised by the US tax payer. In the US people distinguish between seed for growing and grain for consumption – though seed and grain might be identical. In Mexico, it is different:

> How could transgenic crops have made it into the fields in this remote location in Mexico? In Capulalpan, Olga [a Mexican subsistence farmer] herself remembers buying some corn from the local store, where imported kernels are sold by the crate (and are, legally, only supposed to be ground up for food). She didn't know about the government ban on planting, and she figured she'd try some of it out in her fields. *'I planted that corn out of curiosity,' she says. 'I bought it at the government store and planted it to see if it was better than ours.'*[40]

This theme recurs in Chapter 8, where there is further discussion of the role of GM in food aid.

The American company ProdiGene Inc. recently had a foretaste of the future. Projecting that 10 per cent of the corn crop will be devoted to 'biopharm' (pharmaceutical) production by 2010, ProdiGene has made a number of trial plantings of drug- and chemical-producing crops. Two of these tests went wrong. In the Nebraska incident in October 2002, some 500,000 bushels of harvested soybeans were contaminated by ProdiGene's pharma-corn, which re-emerged as volunteer plants after being grown on the same land in the previous season. The soybeans were seized by the USDA after harvest in October. ProdiGene was ordered in December 2002 to pay a $250,000 fine, plus an estimated $2.8 million to buy and destroy contaminated soybeans. A further $1 million must be given as a bond to the USDA to develop a compliance programme for future pharmaceutical crops.[41]

In another incident, this time in Iowa, ProdiGene was ordered to destroy 155 acres (63 hectares) in September 2002 because of potential contamination of food crops in nearby fields by the windborne pollen of the pharma-corn.[42]

Whilst ProdiGene's pharma-corn varieties were engineered to produce trypsin for diabetes and a compound to treat diarrhoea, most pharma-crops are engineered with human genes to produce specific antibodies. By the summer of 2002, the FDA had approved ten monoclonal antibodies, including the breast cancer treatment Herceptin and the rheumatoid arthritis treatment Remicade.[43] Pharma-plants are also being tested to produce human enzymes and hormones.

In the wake of the ensuing debate, in October 2002 the Biotechnology Industry Organisation (BIO) announced a 'new policy on plant-made pharmaceuticals and industrial plants' which 'excludes the planting of corn in the cornbelt. The cornbelt is defined as America's heartland in a recent map produced by the Economic Research Service of the US Department of Agriculture.' Given that StarLink corn was planted on less than 1 per cent of total US corn acreage, the resulting contamination of hundreds of food products and corn seed stock, despite the use of gene containment measures, should stand as a clear warning.

Attempting to regulate contamination – the EU battle zone

In the EU, there has been a long battle over the regulation of GM in the food chain. A major part of the struggle has been over thresholds of contamination. Industry suggested a threshold of 5 per cent while many consumers want it to be set at the level of detection and no more than 0.1 per cent. The Commission, Parliament and Council have been arguing over thresholds for GM crops according to whether they have been approved or not in the EU, settling for 0.9 and 0.5 per cent respectively in July 2003, but the process is not yet complete. At the same time the Commission tried to sidestep the vexed issue of co-existence by leaving it to member states to regulate, while many of them want EU-wide legislation to be adopted.

Industry has countered by proposing a GM-free label, while opponents point out that this would put the onus firmly on those who wish to produce GM-free products, rather than on the GM industry, and ask why those who do not want a technology should be expected to assume the burden of keeping their produce free from it. The EU has also encountered great opposition to its development of proposals on traceability, which were called unworkable by industry, including EuropaBio (see p. 60), the US and some in the EU, following the first vote in July 2002. The US warned that costs would have to be passed on to consumers. Others countered by pointing out that traceability in the meat industry following the BSE crisis was no less strict and that labelling without traceability is meaningless. Traceability is designed to enable a product to be followed right from the farm through every stage in the food chain. Without such information, it would be much more difficult to address any problems with GM products that might emerge in the future. The EU also persisted in developing proposals for labelling GM-derived products that might not any longer contain identifiable DNA.

However, although GM animal feed was included among products to be labelled, the EU stopped short of demanding that milk or meat from animals fed with GM feed should also be labelled. This is seen as a major problem by campaigners, who point out that animal feed is by far the largest use of GM products. Since much of the feed comes from countries outside the EU and since consumers are the ones with the major influence on EU legislation, this effectively means that a large part of the EU consumption of GM crops remains practically invisible to its opponents.

However, EU legislation to date demonstrates the importance of a well informed and determined public. It also shows that the EU has accepted the inevitability of contamination to some level, and only seeks to control it. The argument has been about what level of contamination is acceptable rather than about whether any contamination should be allowed, which would actually be a debate about whether GM crops should be released at all. This is a prime example of the way industry moves debates from issues of principle to technical matters which assume that the fundamental decision about whether a technology is acceptable or not has already been made.

Meanwhile, there has been almost no real progress in developing proposals on liability.

Moratorium continues

Events in Europe also shows that strong public opinion can make laws unenforceable. A *de facto* moratorium on the approval or release of new GM crops has been in force in the EU for more than four years. Denounced as illegal in many quarters, it has been the object of several challenges, all of which have foundered. Even when the revised rules on the deliberate release of GMOs (Directive 2001/18/EC) were adopted, the moratorium continued to hold. In May 2003, the US complained formally to the WTO about the EU moratorium and the countries upholding it (France, Denmark, Greece, Austria, Luxembourg, and Belgium).

Is coexistence between GM crops and other crops possible?

The discussion about whether GM crops and traditional crops can actually coexist in the same region or farming system has gradually sharpened, as contamination and the inadequacy of separation distances hit the headlines. In the EU, regulators were slow to realise the problems they faced, for example, in keeping any control over levels of GM contamination of seed. Once seed stock has become GM-contaminated, the contamination level can potentially rise with each growing cycle, necessitating the addition of uncontaminated seed to remain within a given threshold. The Agriculture and Environment Biotechnology Commission, set up by the UK government to look at issues around potential commercialisation, went to the heart of the issue in its report: 'To put it bluntly, can cross-pollinating GM and non-GM crops coexist on our small islands – and if so how? Different sectors of the agricultural industry will hold different views on this fundamental question.'[44]

This is a crucial issue. Industry spokespersons insist that coexistence is possible, while organisations opposing them point to the rapid appearance of contamination even in countries where only trials have taken place. It is certain to prove a serious headache, both to regulators and to seed producers. Furthermore, to monitor and enforce the upper limits of contamination levels set by regulatory bodies is going to be costly, and is regarded as a disincentive to the commercialisation of GM crops in Europe.

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