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Globalization, the bioscience industry and local environmental responses

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Abstract

Recent controversy over the introduction of genetically modified crops and their subsequent incorporation into foods has led to major popular debate and discussion. Despite this, there has been relatively little academic discussion of the background to these developments. In this paper it is argued that such developments need to be seen in the context of restructuring activity within the new 'biosciences industry' and closely linked to the globalization of such corporate activity and the drive for the liberalization of trade. By contrast, the reaction to genetically modified foods and seeds has typically been national or local in scope, and limited in its effectiveness.

Keywords: Globalization; Biosciences; Genetic modification; Corporate restructuring

1. Introduction

Recent years have seen the rise of two key debates — that around the existence and consequences of the globalization of the world economy and that around the need for greater attention to environmental issues at a variety of spatial scales from the local to the global. However, these have rarely been examined in conjunction despite the important connections between the two (although see Redclift and Benton, 1994; Sklair, 1999a; Yearley, 1996). In this paper I examine the interrelationship between these two phenomena by reference to the recent development of the biosciences industry and some reactions to it. In particular, I take a preliminary look at the one of the most visible signs of such developments in recent years — the production of genetically modified (GM) foods and seeds. In so doing, the intention is to examine the globalization processes at work and also to highlight some of the resistance to such globalization processes at national and local levels which frequently focuses upon the environmental consequences of GM products. The structure of the paper is as follows. In the next section academic debates around globalization are explored and the role of free trade agreements examined, especially in relation to the lack of environmental provisions within these. Following this, the development of the biosciences industry and the key area of genetically modified seeds and crops are outlined. An important issue here is the way in which the development of GM products is dependent upon gaining global market share and competitive advantage through patenting. The next section examines resistance to the introduction of GM crops and seeds. In a final section I attempt to link the discussion back to the academic debates around globalization. This illustrates that although the biosciences industry neatly illustrates points about the development of global markets, encouraged by trade agreements and 'globalizing politicians, bureaucrats and transnational business', it also indicates the complexity of globalization through its creation of new forms of resistance and protest.

2. Globalization, free trade and the environment

At its most basic, the concept of globalization reflects a perception that developments in one part of the world can have important consequences for the life chances of individuals and areas in other parts of the globe (Held et al., 1999). One of the key arguments within accounts of globalization is over the role and powers of the state. It is argued that there has been a decline in national

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- Non-discrimination – foreign investors must be subject to the same treatment as domestic companies;
- No entry conditions – national and local governments cannot restrict foreign investment in either sectors (except defence) or forms (e.g. privatized companies);
- No conditions – national and local governments cannot impose 'performance requirements', so as to ensure local employment, control currency speculation or require a minimum period for investment. Such conditions are prohibited even if they apply to both domestic and foreign companies.

Fig. 1. Key principles of the Multilateral Agreement on Investment.

sovereignty such that global economic processes are becoming more powerful than nation states, national economies subsumed into a global economy, and distinct national management regimes of labour rights, social policy, fiscal and monetary policy are subordinate to international financial markets and transnational companies. For advocates of globalization, traditional nation states have lost their capacity to shape politics and economics and are subject to the logic of a global market and global competition (Ohmae, 1995). Conversely, two of the critics of the 'rhetoric of globalization' have been at pains to point out that even if the world economy is becoming, in their terms, more internationalized, the nation state retains certain key governance functions (Hirst and Thompson, 1995, 1996). In such sceptical accounts "rather than being out of control, the forces of internationalization themselves depend on the regulatory power of national governments to ensure continuing economic liberalization" (Held et al., 1999, p. 5). From a different perspective, Jessop (1994) argues that the nation state has been 'hollowed out', with powers passing upward to supranational bodies, downward to local and regional scales and horizontally to new networks cross-cutting national boundaries. In this account as with others (see, for example, Giddens, 1990) the powers of the nation state have not vanished, but have been reconstituted and restructured as states seek to develop coherent strategies to deal with a globalizing world. Moreover, the work of Sklair (1998, 1999b) suggests that we should not see states and their constituent actors as monolithic. Sklair's work starts from the recognition of the reach and global power of transnational corporations. In addition, he proposes that there is a 'transnational capitalist class' composed of globalizing politicians, globalizing bureaucrats, consumerist elites and transnational (TNC) executives. This group identifies with, and are key advocates of, economic globalization. However, there will be tension and struggle both within and across nation states between this group and those bureaucrats, politicians and others who are opposed to globalization (Mander and Goldsmith, 1996).

A key site for such struggles and tension has been the drive towards free trade as an integral part of globalization. For example, proponents of NAFTA within the US Congress based their argument upon the need for the US to embrace the irreversible logic of globalization. While employment would be lost through trade-driven restructuring, this was seen as an inevitable process, with or without NAFTA. The solution was to go for economic liberalization and the creation of a larger free trade market, which would boost trade, sales and, ultimately, employment (Churchill and Worthington, 1995). The formation of the World Trade Organization (WTO) in 1995 was driven by a desire to reduce non-tariff barriers to trade and differences in trading conditions between countries, whereby greater trade liberalization is assumed to lead to greater wealth creation. More recently, (failed) attempts to introduce a Multilateral Agreement on Investment (MAI), would have further liberalized global trade and investment practices (see Fig. 1).

A particular area of contention has been over the environmental impacts of globalization and associated trade liberalization. From a conventional economic growth perspective, trade allows growth and the transfer of technology, which subsequently allow environmental problems to be addressed. The process of international trade can thus have negative (and positive) impacts on the environment and related issues (see Fig. 2).

However, environmental issues are rarely at the forefront of such trade agreements. For example, while NAFTA, which went into effect in 1994, was the first trade pact to incorporate environmental provisions, this element of the pact was subject to severe opposition within the United States. Essentially, NAFTA is predicated on the belief that GNP growth equates to improved human existence, that such growth based on free trade will eventually 'trickle down' to all members of society and that growth has no limits (Churchill and Worthington, 1995). In common with other trade policies, NAFTA promotes economic growth first, while environmental concerns, if they enter into the equation at all, can be dealt with by the fruits of economic growth. As many authors have pointed out, this creates the anomaly that the clean up of pollution is actually recorded as beneficial for economies as it contributes to a growth in GDP (see for example, Lang and Hines, 1993).

Similarly, the WTO has a mandate to eliminate barriers to the free movement of goods and services. Korten (1996) has argued that it thus effectively operates as a representative of the needs of transnationals against the

- Trade creates a dependency on the ecosystems of foreign countries as goods consumed in one place are either manufactured in another or where resources are derived from another.
- The consumption of goods imported from a country will also have an environmental impact in the country in which they are consumed (e.g. through the use of energy or the creation of a waste).
- Trade itself has a direct impact on the environment, mainly through impacts associated with transportation.
- Trade can transfer technology and employment from one location to another having a social and environmental impact on host and home country.
- Trade and economic globalization has greatly expanded the opportunities for the rich to pass on their environmental burdens to the poor by exporting both waste and polluting factories.
- Trade has a secondary impact on issues of equity as it results in impacts (positive or negative) on poverty, health, employment, human rights, democracy, labour laws and self-determination.

Source: Adapted from Welford (1997).

Fig. 2. Impacts of international trade on the environment. Source: Adapted from Welford (1997).

intrusions of democratic governments, or as 'globalizing bureaucrats' in Skair's (1999b) terms. The WTO has the ability to insist that local and national standards do not exceed WTO-accepted international standards and allows for challenges if higher regulatory standards are imposed. In effect this means that if a country wishes to introduce higher environmental standards on an imported product than have been internationally agreed, it is not able to do so and must conform to WTO standards. Measures that restrict export of a country's own resources for conservation purposes, measures that require local processing of resources or give preference to local investors over foreign investors are also liable to be ruled as unfair trade practices. The interests of international trade thus take precedence over local or national laws (Korten, 1996). If sub-national governments in signatory countries take such measures then they are also bound to comply with WTO rules, even though they are not direct signatories themselves. Countries that fail to comply face financial penalties and/or trade sanctions.

Initial fears that the WTO would lead to such decisions were confirmed by a decision in 1998 by the WTO court of appeal in Geneva. This ruled that a US embargo of shrimps from India, Pakistan, Malaysia and Thailand, on the grounds that fishermen in these countries were killing large numbers of turtles though their failure to use excluder devices, was illegal. This was despite the fact that the US government argued that it was obliged to protect the turtles under the Bonn Convention on Migrating Species, the Biodiversity Convention and the Convention on the International Trade in Endangered Species (CITES). The WTO court ruled that these treaties and obligations to protect endangered species were overruled by the imperatives of free trade (Guardian, 14 October 1998).

The major beneficiaries of such free market economic models promoted by multilateral financial institutions and free trade associations have been transnational corporations. Such transnationals control more than 70 per cent of total international trade and have benefited markedly from the increase in the liberalization of global trade and capital flows from the 1980s onwards (Welford, 1997). NAFTA and the WTO aim to reduce those barriers which impede corporate access to a country's workers and natural resources. Activists have argued that these provide "corporations with a closed door setting in which to argue the details of further de-regulation in front of un-elected judges in an unaccountable, non-democratic process to which the citizens of the world have no access" (Long Island Progressive Coalition, 1997, p. 28). Similarly, in the abortive MAI, while transnational companies would have gained, there were fears that nations, regions and local authorities would have lost powers over local economic development and risk being sued under the MAI (World Development Movement (WDM), 1997). In environmental terms, transnationals would have been able to use the MAI to sue governments over any law or policy that impacted upon them more heavily than a nationally owned company. While there were proposals to include an environmental clause in the MAI, it was argued that the possibility of being sued would dissuade governments and local authorities from introducing regulations to protect the environment and local communities (WDM, 1997).

This growth of corporate power, it is argued, markedly decreases the accountability of private enterprise to workers, managers and local communities. Instead, localities have to engage with the process of globalization on terms not of their own making. The extent to which such local and national economies can resist the adverse impacts of globalization has been open to much debate (Pacione, 1997). It has been proposed that the power of globalization to transcend time and space could enable

- The top 10 agrochemical companies control 81% of the global agrochemical market
- Ten life science companies control 37% of the global seed market
- The world's 10 major pharmaceutical companies control 47% of the global pharmaceutical market
- Ten global firms control 43% of the veterinary pharmaceutical trade
- Sales of the top ten transnational food and drink companies exceeded US$211bn in 1995.

Source: Rifkin (1998).

Fig. 3. Importance of the Biosciences Sector.

the development of a counter-hegemonic politics by facilitating decentralization and democratization (Agnew and Corbridge, 1995). Similarly Hall and Hubbard (1997) argue that cities are not the helpless pawns of international capital, but have the capacity to direct, if not control, their own destinies by exploiting their comparative advantages. The evidence for this is, as yet, slight, although it could be argued that recent resistance to trade agreements such as the MAI and the WTO may indicate the possibilities for change, albeit that these have rarely been place-based to date. More obvious is the unequal relationship between the local and the global, such that we have powerful forces of global disorder on the one hand and "largely reactive, and typically shallow, local responses" on the other hand (Peck and Tickell, 1994, p. 298). While some limited, local successes may be won, "the general effect of globalization is to reduce the power of local-regional states to promote progressive economic and social change" (Pacione, 1997, p. 1180).

To return to the issue of the role of nation states in relation to globalization, there appears to be little sign of such governance solutions to the 'new world economic (dis)order' and this dislocation is particularly acute with regard to trade and the environment. In total, then, the shift towards a more global economy and associated trade liberalization look set to impose severe limits on what can be achieved in environmental terms at both national and sub-national levels. Proponents of globalization and free trade assume that the free market can play the role of providing adequate environmental governance. More realistically, though, it will take a major effort of policy to ensure such effective public governance. In the absence of this, it is unlikely that global market forces and transnational corporations can ensure integration. While the globalization of the world economy may be an over-statement, in the sense of totally free markets subject to little or no regulation, the governance structures that do exist for global and supranational trade are either explicitly constructed to exclude environmental considerations or, at best, are likely to rule that free trade overrides any environmental concerns of local, regional and national governments. I now turn to an examination of these issues in the context of the biosciences industry.

3. Globalization and restructuring in the biosciences industry

Despite much hype, it has been argued that we are entering into a new 'biotech century', where information and life sciences are coming together, with computing power being used to decipher, manage and organize the huge amount of genetic information that is the raw resource of the new global economy (Rifkin, 1998). In the process, this new biotech century is being shaped by the growing power of biotech or biosciences transnational companies, seeking to operate on a global basis in search of a return on the huge investments involved in research and development (McCain, 1995; see Fig. 3). Biotechnology or biosciences are seen as a key technology for future growth and competitiveness by policy makers.[1] This complex of scientific expertise, technological capability and transnational capital accumulation has been seen as constituting a 'bio-industrial complex' or biotechnological innovation as a new regime of accumulation in regulationist terminology (McNally and Wheale, 1996). As part of their strategies to capitalize on such developments, the major transnational companies have sought to become more global, while smaller players have attempted to extend their global reach.

From the late 1970s onwards transnational corporations and venture capital firms began to invest in small genetic engineering firms and engage in joint ventures (Wright, 1996). More recently, there has been a major process of restructuring by chemicals and agrochemical companies, amongst others, to take advantage of what is seen as a potentially huge market in genetically modified organisms. The most evident sign of such a shift in corporate strategies can be found in relation to the genetic modification of seeds and foodstuffs. These genetically engineered plants will be more resistant to disease, insects, drought, pollution and herbicides. Leading com-

[1] There are important differences between biotechnology and the more recent bioscience developments based on genetic engineering. Basically, biotechnology is the harnessing of organisms, living and dead cells and cell components at the level of the complete cell or whole organism, while genetic engineering involves manipulation of genetic components (Mannion, 1992).

panies such as Monsanto (US), Novartis (Swiss) and Zeneca (UK) have all been engaged in mergers, acquisitions and joint ventures. Acquisitions have been focused on taking over small biotechnology specialists in order to gain control of advanced research (Lappé and Bailey, 1999). Mergers and joint ventures have involved pooling marketing resources in an attempt to cut company cost bases. In several cases the former conglomerate companies have been broken up into more focused firms, with substantial financial success. Other companies such as DuPont have been more circumspect about the restructuring process despite existing interests in biotechnology and despite relatively poor stockmarket performances compared to these competitors. Even so, DuPont invested US$1.7 billion for a 20% stake in the US company Pioneer Hi-Bred International reflecting a widespread belief that biosciences may be the future for these major corporations. In all cases there has been an overwhelming move towards becoming, or focusing on becoming, bioscience companies. While the promise of returns from the new technology has been an important driver of change, the slow-down in the market for more traditional agrochemicals has also been a factor.

Several of the major players in the sector have been through substantial changes in recent years. Monsanto has moved from being a chemicals company to becoming a biosciences company and the world's fourth largest seed company (Lenzner and Upbin, 1997). The company has invested around US$6 billion in seed operations in Africa, Asia, Central and Latin America and Europe. In the initial stages of launching GM products onto the world market, Monsanto saw its share price soar and market capitalization grew to more than US$26 billion. Large investments in in-house research have been accompanied by the purchase of other biotech companies and research patents. Acquisitions have included a majority interest in Calgene, with leading-edge technology in oilseeds (canola) and tomatoes, the W.R. Grace property Agracetus, which owns a patent on cottonseed engineering, and the acquisition of the UK firm Plant Breeding International in Cambridge for £320 million (Morse, 1996). In 1997 Monsanto acquired Brazil's Sementes Agroceres, giving the company an estimated 30% market share in the Brazilian maize seed business. In 1998 Monsanto purchased Cargill Inc.'s seed operations in Central and Latin America, Europe, Asia and Africa for £843 million with the specific aim of providing the company with "quicker access to these global markets".[2] Recent rumours have included merger talks with DuPont, the major US chemical manufacturer (Guardian, 4 March 1999). These cross-ownerships, partnership agreements and joint ventures mean a substantial investment in biosciences, which in turn require a return on investment and a market for the products. The latter thus helps to explain Monsanto's marketing campaign to try and gain public and legislative acceptance of new crops and meet concerns over consumer and environmental resistance. Monsanto's repositioning as a biosciences company has made its future highly dependent on gaining acceptance of its products (Lenzner and Upbin, 1997). The company targeted growers as the primary consumers for its first generation of engineered products — insect-resistant potatoes and cotton and herbicide resistant soyabeans and oilseed rape (canola). Such bulk commodities also have the advantage of blending with non-engineered counterparts for export and processing, thus reinforcing corporate arguments that separation is impossible or too costly.

Substantial restructuring activity has also been a feature of the industry in Europe. In 1996 Agrevo (a joint venture between Hoechst and the German drugs company Schering with 60% and 40% respectively) acquired a 75% stake, costing US$550 million, in Plant Genetic Systems, a small Benelux biotechnology company with sales of just US$5 million (Munchau, 1996). This formed part of Agrevo's bid to become one of the world's leading plant bioscience companies. Hoescht and Rhone-Poulenc merged to form the life sciences company Aventis to compete with the other major corporations in the sector. Such acquisitions are part of a broader shift from technologies that protect crops to those that improve resistance, yield and quality. Improving the yield potential of seed was traditionally the province of plant breeding and agrochemical companies, but has now become a field for bioscience companies. The size of the potential market is shown by the fact that Agrevo expects the market for plant bioscience products to grow from US$400 million in 1996 to US$6 billion by 2005. Investments in other companies and technologies are intended to make Agrevo a major player to compete with Monsanto and Novartis (the merged Ciba-Geigy and Sandoz combine). Zeneca has linked its seeds division with the Dutch firm Suiker Unie to create Advanta and has bought Mogen, a Dutch plant biotechnology firm (Blackledge, 1998).

Such developments have not been confined to the major players in developed countries. The cigarette manufacturer Empresas La Moderna based in Monterey, Mexico has bought Asgrow Seed, the world's fifth largest seed production company, from the US pharmaceuticals company Upjohn, and then subsequently merged this with the Petoseed division of George J. Ball Co. of California to form Seminis, the world's biggest vegetable seed producer (Crawford, 1997). Subsequent acquisitions have included DNA Plant Technology in California, a genetics engineering specialist, Royal Van Namen, a Dutch fresh fruit and vegetable producer, together with two leading Mexican agricultural companies, Bionova and Agricola Batiz. The result has been the creation of a vertically integrated agricultural company spanning

[2] Quote from Monsanto president Hendrik Verfaillie in the *Guardian*, 30 June 1998.

the range from genetic engineering of new plant varieties through production and manufacturing of seeds to fresh produce. Seminis now controls 38% of the US seed market and 24% of the European market (Crawford, 1997). Expansion plans are for Latin America, where sales account for less than 3% of that continent's total.

While the technological basis for merger and formation of biosciences companies may be compelling, the business logic may be less sustainable. Some commentators have argued that this bout of merger activity is merely a fashionable stage in development and that the reported synergies are over-emphasized (Pilling, 1998). In addition there is an argument that the two constituent parts, pharmaceuticals and the agricultural sector, are entirely different markets which need different approaches. Moreover, the costs of acquiring other companies have been substantial. For example, Monsanto's need for capital to finance its own expansion and investment in agricultural and health research led to a proposed (and subsequently abandoned) merger with cash-rich American Home Products and business analysts have argued that Monsanto in particular has paid too high a price for several of its acquisitions. In consequence there is a need to sell and gain global market share in existing and new GM products. Part of the solution has been to purchase the distribution channels, particularly seed companies, in an attempt to construct integrated companies and global market advantage.

4. Developing genetically modified seeds and crops

A key first area where biosciences companies have sought to gain global market advantage is in the production and sale of GM seeds and crops.[3] There has been a substantial growth in genetically engineered crops with around 30 m acres planted worldwide in 1998 (Maitland, 1998). The global market for genetically engineered seeds is predicted to grow from US$450 million in 1995 to US$6.6 billion in 2005 (Blackledge, 1998). The aim is to produce crops with durable resistance to major insect pests and, ultimately, to fungal and viral pests using naturally occurring plant resistance genes (Leaver, 1999). Many of the first efforts by bioscience companies have been to genetically engineer resistance — in plants resistant to their own herbicides to allow farmers to kill weeds without destroying the crop. For example, Monsanto's herbicide-resistant patented seeds are resistant to its best-selling chemical herbicide, 'Round-up'. Such herbicide-resistant crops are portrayed as better for the environment on the grounds that they allow use of reduced amounts of herbicides in a more targeted manner (Levidow et al., 1997). In addition, GM technology can lead to transgenic plants synthesizing pharmaceutical proteins, enzymes for animal feed and industrial bulk enzymes. Through such processes GM is likely to result in the production of industrial oils, fatty acids and biodegradable plastics. In health fields, there are plans to use genetic manipulation for 'bio-pharming' — developing inexpensive vaccines and antibodies. The development of transgenic plants has been hailed as the advent of a new 'green revolution' in agriculture and more environmentally friendly industrial production in the form of less-toxic waste and bioremediation of wastes (Leaver, 1999). In the US, nearly one acre in seven of the soyabean harvest is grown from genetically modified seed, up from one in 50 in 1996. In China, more than 4 m acres of genetically modified tobacco and tomatoes are thought to be planted. Commercial crops are also grown in Argentina, Canada, Australia and Mexico. Europe has been an exception to this pattern and has resisted anything other than pilot trials.

Such developments pass considerable powers to the bioscience companies involved. Given that a small number of transnational corporations produce almost all the seeds used commercially, the development of GM seeds may leave farmers with little choice. A key development here has been the use of patent law to protect research investment and to establish the basis for global profits (Lehman and Krebs, 1996). In 1992 Agracetus was granted a patent by the US Patent and Trademark Office on all genetically engineered cotton.[4] Despite the patent application being based on just one method of transferring genes into cotton cells, the patent:

> "gives Agracetis rights over all transgenic cotton, irrespective of how the genes are inserted. For the life of the patent, 17 years from when it was granted, all those doing applied research on cotton should hold a licence from Agracetus. Some 250 million people worldwide depend on cotton production for all or part of their income" (McNally and Wheale, 1996 , p. 224).

In 1994, Agracetus was awarded a soyabean patent by the European Patent Office covering all genetically engineered soyabean plants and seeds until the year 2011. In 1998 the US Department of Agriculture and Delta and Pine Land Company patented the 'Terminator' technique for seeds. This consists of introducing a killer 'transgene' that prevents the germ of harvested grain from developing. The plant grows normally, but the grain is biologically sterile. In May 1998 Monsanto bought the Delta and Pine Land Company and the Terminator patent (Berlan and Lewontin, 1999). Critics saw this

[3] Given restrictions on space, this paper only covers GM seeds and crops. However, there has also been substantial development in, and patenting of, animal and human genes with attempts to gain monopoly rights. These include attempts to gain monopoly control of gene therapy treatment, as well as over the genes of indigenous peoples as a byproduct of the Human Genome Diversity Project.

[4] This patent later provisionally revoked in the US in 1994 after formal opposition.

Terminator technology as a threat to farmers, biodiversity and food security. The seed sterilizing technology threatened to eliminate the right of farmers to save seed from their harvest and jeopardizes the food security of 1.4 billion people in the South, who depend on farm-saved seed. Delta and Pine Land Company and the USDA have applied for patents on the Terminator technology in at least 78 countries. It has been argued that use of the Terminator technology would give the multinational seed and agrochemical industry a dangerous and unprecedented capacity to control the world's food supply.[5] Public outcry over the implications of this forced Monsanto to abandon development of the initial Terminator technology, but research continues into 'Terminator2' technologies by several bioscience companies, where genetic traits within seeds are controlled by application of proprietary chemicals[6] (Warwick, 2000). These technologies mean that crops will only grow if sprayed with such proprietary chemicals.

Shiva (1997) makes the interesting point that such companies readily switch between two definitions or uses of 'nature' and the 'natural' to promote GM products. For purposes of patenting and intellectual property rights GM products are defined as non-natural, whereas environmental and health fears are allayed by referring to genetic modification as a process occurring naturally and where company efforts are directed to 'giving nature a helping hand'.[7] Similarly prior developments in seed breeding by traditional farmers are not 'real' breeding, but a product of nature and thus should be free — "all prior processes of creation are being denied and devalued by defining them as nature" (Shiva, 1997, p. 51). Moreover, these developments through traditional farming practices are seen as the product of collective innovation. These are rarely given protection by Intellectual Property Rights (IPR) which are usually reserved for the products of individual creative labour. IPRs are recognized only when knowledge and innovation generate profits and not when they meet social needs (Ho, 1998; Shiva, 1997).

Perhaps not surprisingly, the development of GM foods and seeds has given rise to substantial controversy. In parts of Europe there has been considerable consumer resistance to GM foods and this is explored in more detail in the next section of the paper. Conversely, within industry, those in favour of bioengineering have pointed to the potential economic benefits to be gained and the dangers of Europe losing out. For example, EuropaBio, a European biotechnology representative body, estimates that the European market for modified crops could be Euro105bn in 2005 if allowed to go ahead. They fear that the market could be reduced to nothing if legislation opposes the introduction of GM crops and food products. In addition, there are the claimed lost opportunity costs of non-adoption — Monsanto, for example, estimates that its boll weevil resistant cotton plants save US$33 per acre through higher yields and lower chemical treatments. This positive view of developments takes the stance that genetic modifications are necessary to increase crop yields and reduce insecticide use at a time of growing world populations. In the UK the Biotechnology and Biological Sciences Research Council (BBSRC) has warned that a moratorium on GM crop planting in the UK could set the UK's farming industry back by several years, leading to increased food imports (Guardian, 17 February 1999).

5. Genetic modification, globalization and resistance

From their inceptions, genetic engineering and modification have engendered debate over the respective merits of the benefits and risks involved (Rifkin, 1998). However, a broad consensus amongst scientists and policymakers can be dated back to the international conference on genetic engineering held in Asilomar, California in 1975. At the conference the problem was steered into a reductionist discourse of technical questions of containment which, although setting high containment levels and placing the burden of proof on scientists, precluded consideration of social and ethical issues in favour of control by 'experts' (see Wright (1996) for an interesting account of the regulation of genetic engineering, also Dobson (1995)). When the commercial potential of GM became clear from the late 1970s onwards, a combination of Congressional fears of the loss of US technological advantage and transnational lobbying ensured that US regulation was substantially reduced to minimal levels. Both the US and UK underwent substantial deregulation in the 1980s as governments responded to industry lobbying. In consequence, there was little initial concern over the implications of introducing GM foods, particularly in the USA where the major developments in GM foods have occurred. Some 50 million acres in the US were sown with GM crops in 1998, much of it soyabean and maize. This acreage is expected to double within two years and grow substantially in subsequent years. The US does not require GM foods to be labelled and allows bioscience companies to police themselves. The industry has persuaded 14 US states to pass laws to prevent "the spreading of false and damaging information about food" (Guardian, 18 February 1999). It has been suggested that Monsanto's close links with the Clinton administration and the Food and Drug Administration (FDA) have assisted with gaining acceptance for GM foods and

[5] Rural Advancement Foundation International report on Monsanto and Terminator technology (http://www.rafi.ca/).

[6] In part Monsanto's backtracking on the commercial development of Terminator technologies was related to public criticism and subsequent falling share prices.

[7] See Dobson (1995) for a discussion of these issues from an ethical perspective.

with lobbying to prevent labelling legislation. Gray (1999) argues that a *"combination of wild-eyed techno-utopianism and stock market greed...together with incessant lobbying by the genetic-industrial complex, has effectively stifled debate on genetic engineering in the United States"*. The contrast with Europe is shown by Hoban (1995) who states that whereas 70% of Germans would not buy GM food products, 70% of US and Canadian consumers would do so.[8] Outside the USA, resistance has focused upon three major issues: consumer opposition to GM foods; environmental concerns over the impacts of GM crops; and opposition on the grounds of 'biopiracy' and monopoly seed markets.

5.1. Consumer opposition

While there has been relatively little resistance to GM foods in the US, consumers have opposed the incorporation of GM crops and products in Europe, despite the best efforts of companies such as Monsanto to persuade them otherwise.[9] To date Monsanto has spent US$1.6 million on advertising in Europe to convince consumers of the merits of GM foods. In 1997 the European Commission proposed food labelling plans for products containing GM maize or soya to enable consumer choice (Buckley, 1997). This legislation is part of broader requirements within the EU to label 'novel foods' i.e. that the final consumer should be informed of the presence of any food properties that render a food or food ingredient 'no longer equivalent' to a existing product (Smith, 1997). Under the plans, products containing maize or soya or their derivatives, in which the presence of GM DNA or proteins could be detected, would have to carry labels. Where presence is uncertain, products would be labelled 'may contain' gene-modified materials. These plans were criticized by Greenpeace on the grounds that modified DNA cannot be detected in many products, such as vegetable oil and lecithin, which would therefore escape labelling. In a leaked internal Monsanto report the widespread public and media opposition to GM crops in the UK is highlighted.[10] In part, UK public scepticism is related to the BSE crisis and an associated loss of faith in scientists and regulatory bodies. The report particularly highlights what it sees as an 'information vacuum' in the UK which is being filled by media reporting which sees its duty to call for more regulation and government intervention. For bioscience companies the report argues that the key task is to persuade the major food retailers (given that the leading retail chains control a very high proportion of the UK market for food) and upper socio-economic and political classes to accept GM foods, rather than addressing directly public concern. This may prove to be a major barrier given that major UK food retailers such as Asda, Marks and Spencer, Iceland, Sainsbury, Waitrose and the Co-op have banned GM products from their own-brand food lines[11] (Vidal, 1999). In relation to consumer concerns, there are arguments that food made with genetically modified crops should be labelled as such and should not be permitted for sale until it is. However, in 1997 the EU approved imports of modified soybeans, a crop used in 60% of processed foods, much of which comes from the US. The European food industry has pressed for herbicide-resistant soyabean produced by Monsanto to be separated from conventional crops at source, enabling products made with it to be labelled separately. However, the US industry has refused to do this on cost grounds.

5.2. Environmental concerns

The reluctance to accept genetically modified crops is also based on environmental concerns. These include:

- the danger of creating 'superweeds' resistant to pests and herbicides;
- The impact on organic farming. Organic farmers are concerned at biosciences' adoption of the 'Bt' gene,[12] derived from a soil bacterium commonly used as a natural pesticide, and fear that insects will develop resistance to it.
- The possibility that antibiotic resistance in the insect-killing maize developed by companies such as Novartis could spread into livestock and thence into humans.
- The risk that beneficial predators of crop pests could be harmed inadvertently.

In the UK the Advisory Committee on Releases to the Environment (ACRE) has warned that GM crops may have an adverse impact upon native plant and animal species (Guardian, 19 February 1999). In particular, the report warned that:

- the persistence, invasiveness and competitiveness of new species could change the population dynamics of

[8] There is evidence though that the debate over GM foods in Europe has begun to generate similar debates in the USA and a decline in acreage planted (Bereano and Kraus, 1999; Guthman, forthcoming).

[9] Even here, it is perhaps important to note that public concern and awareness are far from uniform. In many ways concern over GM is a 'Northern' European environmental issue (i.e. with a greater awareness in countries such as Austria and Germany) rather than a 'Southern' one (i.e. Spain, Portugal, Italy, etc.). Concern in the UK is closely linked to the experience of recent food scandals over BSE, *E. coli* and salmonella outbreaks.

[10] Extracts from the report by Stanley Greenberg were published in the Guardian newspaper, 25 November 1998.

[11] Despite these high-profile moves by retailers, GM ingredients continue to be used in animal feeds in the UK thus leading to continued indirect consumption (Atkinson and Lynas, 2000).

[12] This refers to strains of the bacterium *Bacillus thuringiensis* which produce chemicals that kill insect pests and commercially produced strains that are insect pathogens (Mannion, 1992).

surrounding areas by overwhelming native plants and reducing those animal species that depend upon them for survival;
- wind or insects could transfer inserted genetic material to native plants, turning them into hybrids with selective advantages over other native plants which may then suffer;
- soil decomposition may be affected by changed nitrogen and carbon recycling processes;
- there may be a 'law of unintended effect' if GM plants unexpectedly turn out to be unpalatable to herbivores, a trait that could be transferred to native species.

This represented something of a change of attitude by ACRE from previous decisions on GM herbicide-resistant crops (see Levidow et al., 1997). In the UK, Monsanto have been fined £17,000 and ordered to pay £6,000 costs after they failed to stop the spread of pollen to other non-GM crops from a test planting of oilseed rape (canola) (Guardian, 18 February 1999). Such incidents led to calls for a minimum three-year moratorium on the commercial growing of GM crops in the UK in order to investigate the impact on wildlife and the environment. A broader grouping of religious and environmental groups, aid agencies, a frozen food chain and MPs and scientists has also called for a five-year moratorium to ensure the safety of GM crops and foods. As a response the Environment Minister, Michael Meacher and the Food Minister, Jeff Rooker, announced on 21 October 1998 new measures that included a re-assessment of herbicide and pesticide use resulting from GM crops. There was a voluntary moratorium for three years on growing insect-resistant (Bt) crops. However, this is a fairly minimal concession as there were no immediate plans to grow either of the EU-approved maizes (produced by Novartis and Monsanto). In addition, there was to be at least a one-year ban on planting herbicide-resistant rapeseed (one spring and one autumn variety). Such delays were necessary anyway because the seed registration process was not then complete. In response, Monsanto and Zeneca threatened legal action if their activities are blocked. Subsequently, field testing was introduced over a four year period before commercial planting could occur. However, the UK government has not acted to prevent the adoption of GM food and seeds and, indeed, has given support, particularly through Tony Blair, the Prime Minister (ESRC GEC Programme, 1999). Much of the response to date has been couched in terms of providing 'consumer choice' through labelling schemes for food providers, such as restaurants, bakers and fast food outlets.[13] In part this response may reflect the UK's usual subservience to US interests, but also reflect the fact that the UK is a European leader in the biotechnology industry.[14]

5.3. *Biopiracy and monopoly markets*

Outside the developed world, biosciences companies have run into criticism for their moves to patent GM technology and for the potential monopoly situation this creates. Biosciences companies argue that biotechnological products and processes must be patentable and have pressed hard to extend existing patenting laws worldwide to living organisms, if they have been genetically engineered (McNally and Wheale, 1996). Southern countries have been under considerable pressure to amend their patent protection systems into line with those of Northern countries as a condition of membership of the WTO. Conversely, Southern countries have argued that what transnational companies term inventions that can be patented, represent the pirating of their local genetic resources and the accumulated indigenous knowledge of how to use them. Such debates came to the fore in negotiations over biosafety held in Cartagena in Colombia in 1999. Although the rationale for the meeting was to produce a Biosafety Protocol, much of the discussion centred on a demand from developing nations for an accord that would give them the right to restrict or deny imports of genetically modified organisms — from pest-resistant corn, soyabeans and potatoes to cutting-edge pharmaceuticals — and make producers of such items legally liable for any environmental or economic damages. The major companies involved have countered these demands by arguing that the higher agricultural productivity from GM seeds and foods is essential to avoid loss of biodiversity that would result from converting forests and marginal lands to agriculture in Southern countries. The companies argued that the Cartagena proposals should be limited to Living Modified Organisms (LMOs) that may have an adverse effect on biodiversity, but should not cover: non-viable products of LMOs, such as processed foods and feeds; health care products and pharmaceuticals; products destined for contained use, such as for manufacturing and research; and commodities not intended for deliberate release into the environment, such as soybeans used for processing.

[13] Levidow et al. (1997) discuss such differing interpretations and national regulations on GM which are linked to discourses around product safety in the UK, sustainable development in Denmark, ethics in Norway and economic justice in Austria.

[14] The UK biotechnology industry has sales of around £4 billion in 250 firms (a quarter of the European total). The UK government recently launched its Manufacturing for Biotechnology (MfB) initiative to support and promote the industry (Department of Trade and Industry Press Notice, P/98/521). Moreover, the British science establishment together with the USA was a dominant actor in the early development of, and debates around, GM (see Wright, 1996). Biotechnology was seen as a key sector for economic success as far back as 1980 in a process of deregulation initiated by the then Labour government (Advisory Council for Applied Research and Development, 1980).

The major bioscience corporations thus argue that patent protection is vital if they are to risk financial resources and R&D to bring new and useful products to market. However, there are also key impacts that will arise through increasing oligopoly control of seed markets and the potential need for increased seed purchases as a consequence of Terminator-type seed technology. Bioscience companies have been particularly aggressive in defending their patent rights. Monsanto has placed advertisements in the US farming press pointing out the cost of planting pirated seed and reminding farmers who have planted Biotech seed (genetically modified and including a gene for resistance to Roundup, a Monsanto herbicide) that they are not entitled to keep any of the harvested grain for use as seed the following year — a process known as 'contractual sterility'. To avoid lawsuits, it is reported that farmers have had to destroy crops and allow Monsanto agents to inspect their farms and accounts (Lappé and Bailey, 1999). Similar restrictions have been placed on the use of Monsanto's genetically engineered cotton variety 'Bollgard'. Company literature states:

> "Monsanto is only licensing growers to use seed containing the patented Bollgard gene for one crop. Saving or selling the seed for replanting will violate the limited license and infringe upon the patent rights of Monsanto. This may subject you to prosecution under federal law" (quoted in Shiva, 1997, p. 37).

While this commodification of seed will have an impact upon farmers everywhere, the impacts are likely to be particularly acute in Southern countries. New seed technologies could prevent farmers in the South retaining seed for planting the following year. In many countries this is a key part of the agricultural system — in India, for example, up to 80% of seed is saved. The greater commercialization of the seed market in such countries has thus been a key focus for bioscience companies "seed thus represents capital with a simple biological obstacle — given the appropriate conditions, it reproduces itself and multiplies" (Shiva, 1999, p. 4). New seed technologies and the globalization of the seed industry is thus transforming seed from a source of renewable nourishment into a costly non-renewable commodity to be purchased each year. Moreover, this seed does not produce by itself, but needs the input of other purchased commodities (Shiva, 1997).

In countries such as India, the purchase of seed by farmers from transnational companies has been encouraged on the grounds of providing better seeds and more reliable crops. However, it has been argued that the introduction of such seeds has led to an increase in monocultures, indebtedness and, in some cases, increased suicide rates (Shiva, 1999). GM seed trials have also taken place in India, largely without regulation by the appropriate bodies. These trials have led to widespread internal opposition in India, with crops burnt, trials banned and a call for a moratorium on GM seeds. In June 1998, Monsanto announced that it would develop a special microcredit programme with the Grameen Bank of Bangladesh that would have made it financially feasible for cash-starved farmers to take out loans to buy Monsanto's advanced technology products. However, this programme was subsequently abandoned by the Grameen Bank due to intense public pressure within South Asia and around the world.[15]

6. Conclusions

What then does the development of the biosciences industry and GM crops and seeds illustrate in relation to debates over globalization and the role of the state? Certainly transnational corporations have been the major drivers of change through their increased control over biological and genetic resources. In the process, plants and animals are transformed into commodities giving rise to a process which favours the industrialized use of species (McNally and Wheale, 1996). In seeking legitimation for their activities, some of these companies have drawn upon global discourses. For example, arguments by these companies in favour of GM seeds and foods are often predicated on the basis of securing and expanding the global food supply, solving world hunger problems and avoiding social unrest in Southern countries (Lappé and Bailey, 1999). Critics have countered that such arguments avoid issues such as the genetic uniformity and monocultures which gave rise to the need for GM developments in the first place (often promoted by the same companies in the past) and the potential of alternative farming systems to increase yields in Southern countries (Levidow, 1996; Pretty, 1999).

Moreover, given the huge investments in GM technologies and the large risks involved in bioscience corporate strategies, the future development of bioscience companies is closely linked to the development of global market potential through free trade agreements and the imposition of values which override local and national restrictions. The imposition of monopolies and GM products, particularly seeds, is thus being assisted through free trade agreements and the process of globalization. The inclusion of Trade-related Intellectual Property Rights (TRIPS) in the Uruguay round of GATT in 1993 formed the first step towards protecting and promoting GM products. The Cartagena biosafety negotiations involved proposals to ensure that trade in GM foodstuffs would be subject to labelling and to regulation through global agreement. These proposals were initially sabotaged by US interests which opposed the inclusion of commodities such as soyabeans and corn in any

[15] RAFI News Release - 9 March 1999 (http://www.rafi.ca/).

agreement and effectively overturned the proposals on global regulation. In a vote on February 24, the US and five of its allies, the so-called 'Miami Group' (Canada, Australia, Argentina, Uruguay, and Chile) managed to prevent the passage of the internationally binding treaty.[16] A subsequent agreement, the 'Cartagena Protocol' did allow nation states to adopt their own regulations on GM products, but such decisions may still be subject to legal challenge at the WTO. In the light of these international free trade agreements, the potential role of the nation state in regulating GM crops is seen by some politicians as minimal, despite widespread public and media concern. For example, the UK foods minister Jeff Rooker has argued that calls for a UK ban on GM foods is impossible as it would require European-wide action and risk a trade war with the US (Financial Times, 11 August 1998). The development of GM foods and seeds in the first instance, and the future development of the biosciences industry, is therefore closely linked with the processes of globalization as they are made manifest through international trade agreements. The history of genetic engineering, and particularly that of the first wave of GM foods and seeds, therefore directly challenges the views of those who argue that globalization can create the space for counter-hegemonic projects — at best resistance to date has been piecemeal and variable in its success.

The example of the biosciences sector illustrates the complexity involved in processes of globalization and the interaction between spatial scales of action. The example of GM foods and seeds provides evidence of contested notions of 'progress', 'nature' and 'safety'. Much of the power lies with large transnational bioscience companies, enacted through trade agreements, while the evidence is that local and national resistance have only limited impact. Indeed, there is evidence to suggest that Sklair's notions of 'globalizing politicians and bureaucrats', supporting transnational enterprise and forming a transnational capitalist class has much validity here (see also Ho, 1998). Certainly, in the US deregulation of the industry and the granting of patents were associated with bioscience company lobbying of government and Congressional fears over loss of competitiveness. Deregulation was seen as a boost to competitiveness and, together with tax credits for R&D and reduced capital gains tax, led to a substantial increase in US biotechnology investment in the early 1980s (Guthman, 2000). In the UK, the globalizing discourse of the (New) Labour Party, with its emphasis on world competitiveness, goes some way to explaining the support given to the industry by senior politicians and the fears of bodies such as EuropaBio and BBSRC that any restrictions will lead to a loss of European and UK competitiveness. In these senses then, the nation state has not vanished, but the powers of the state are being reconfigured and reoriented.

While it is possible to thus conclude (for the moment at least) that the globalizing activities of the bioscience companies, allied with trade legislation, have either paralysed or co-opted nation state governments, this does not mean that the proponents of globalization do not face resistance. The nation state is not monolithic, but may contain, for want of a better word, 'anti-globalizers' as well as globalizing elites. As Yeung (1998, p. 292) comments *"though it invades local contexts of action, globalization does not destroy them; instead, new forms of local resistance and local expression emerge, reinforcing the interconnectedness of the local and the global, and the multiplicity and hybridization of social life at every spatial scale"*. To date, such resistance to GM has come in two main forms.[17] In the developed world, the response has been one of general acceptance in the US and resistance in Europe. In the latter case, resistance has taken two main forms related to environmental issues. First, a concern over the implications of widespread planting of such crops upon biodiversity and related long-term environmental risks. Second, and more immediately, there has been widespread concern over the inclusion of GM crops in foodstuffs and the potential health risks that this may entail. Pressure groups, such as GenetiX Snowball in the UK, have taken direct action including digging up GM crops in fields and removing GM crops from supermarkets on the grounds that they constitute 'dangerous substances' and as such should be handed over to local environmental health departments. Similar protests involving uprooting crops, mass trespass and squatting have taken place in Ireland, France and Germany (Blackledge, 1998). Whether GM foods gain acceptance remains to be seen, although many food processing firms in Europe such as Unilever, Danone and Nestle have shifted away from GM foods in certain sensitive markets. The advent of 'functional foods' or 'nutraceuticals' may change the terms of the debate as the effects of modifying foods to improve human health may be more acceptable to consumers.[18] Conversely, in Southern countries, the concern has been much more fundamental. There have been widespread protests over the increasing compulsion to use GM seeds in India and opposition to the issue of patenting human, animal and plant genes. Community

[16] http://www.inmotionmagazine.com/geff.html

[17] This is not to imply, of course, that all the consequences of GM are necessarily deleterious. As Rifkin (1998) points out GM can provide substantial benefits.

[18] These are foods that are said to provide health benefits, by adding vitamins or treating human illness. Given the public outcry over GM foods that improve shelf life or appearance, bioscience companies have been attempting to shift the terms of the debate through emphasizing these products. One example is the promotion of a new strain of rice fortified with vitamin A to combat developing county health deficiencies.

seed banks have been established to protect indigenous seed diversity and opposition to 'bioprospecting' developed (Shiva, 1997), while more direct action has involved burning crops and a 'Quit India Monsanto' campaign. To date, resistance in Northern countries has been relatively more successful, and certainly more prominent, than that in Southern countries — perhaps an indication of the importance bioscience companies place on the respective consumer bases. Finally, it is important to note that this paper has only covered the initial stages of debate over the consequences of genetic engineering through looking at one early example, that of GM foods and seeds. In the future, these debates are set to expand, not least as a consequence of research to map the human genome and the potential this is likely to provide for the commodification of human life.

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