GENETICALLY MODIFIED ORGANISMS, ORGANICS AND THE CONTESTED CONSTRUCTION OF DEMAND IN THE AGRO-FOOD SYSTEM

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INTRODUCTION

Over the last two decades, from different disciplinary standpoints, the category of consumer has increasingly assumed analytical ascendancy over that of producer. For many cultural analysts, consuming rather than producing is now seen as the source of identity construction (Featherstone 1991, Bauman 1998). The politics of privatisation, in turn, has been fuelled by concepts of market democracy and consumer choice/sovereignty (Keat, Abercromby and Whiteley 1994). In economics, the market segmentation and flexible specialisation literature has viewed the mobilisation of rapidly changing demand as the key to economic growth (Piore and Sabel 1984). For its part, the innovation literature, both in economics and sociology, has increasingly focussed on the active role of the end-user (Lundvall 1988, Walsh 1996).

A similar attention to demand and the consumer in agro-food studies initially led to the identification of a shift downstream in the relative share of value added, which favoured the final foods industry *vis-à-vis* interests tied directly to farm inputs, production and processing (Bombal and Chalmin 1980, Audroing 1995). Greater attention was then given to the role of modern large-scale retailing which, it was argued, had assumed a dominant economic position in the food system as a whole (Filser, Garets and Paché 2001). Unlike the other economic actors in the food chain, the retail sector was seen to have no vested interests in specific commodity systems and was analysed as being uniquely oriented to the mobilisation of demand as the condition of its own growth (Fanfani et al. 1990**,** Marsden and Wrigley 1995).[1] The notion of a demand-oriented food system, therefore, captures not only the idea of a shift in economic power to actors directly involved in the promotion of final consumer demand but also the idea of an increasing subordination of the different phases of intermediary demand to those of the final consumer. The farmer must harmonise his interests with the processor who in turn must adapt to the food industry's demand for new ingredients, and all must attend to shifts in final consumer demand.

However, the current efforts to introduce genetically modified (GM) foods would seem to challenge this view of an increasingly demand-oriented agro-food system. Their principal promoters are upstream agrochemicals firms following explicit 'technology push' strategies, or strategies which, at most, are directed to demands at the farm level without taking into account their implications for the final consumer. While Monsanto has been the leading force here, the same strategy has been adopted by the other contenders in this increasingly global and oligopolised upstream sector, including Syngenta, Aventis (now Bayer) and Du Pont (Fulton and Giannakas 2002). In the US, the final foods and retail sectors have tended until now to absorb this new technology, and there was a similar initial response in Europe (Harvey 1999). However, in Europe, later opposition from consumer associations and then from the customer, captured by opinion polls and supermarket surveys (Durant et al. 1998) in a climate clouded by a sequence of confidence-sapping panics, led retail and final foods firms to distance themselves from genetically modified organisms (GMOs).

This contrasting response by differently positioned leading actors would seem to accurately represent their respective distances from the final consumer, with upstream actors being immune to differing final consumer responses while the retail sector and the food industry adjust their strategies to meet perceived consumer preferences. Nevertheless, the tenacity of the drive by the agrochemical company lobby to impose GMOs in countries and regions where opposition has crystallised into regulatory restrictions, suggests that these upstream actors exert greater economic power within the agro-food system than is suggested by the 'downstream shift of value added' thesis referred to earlier. We will argue that the case of GM foods also suggests that these same actors are able to mobilise powerful alliances outside the food system, particularly in sectors of the Government apparatus and the scientific community.

On the other hand, the unprecedented mobilisation against GMOs, most notably in Europe, Brazil and India (but assuming a global profile in the Seattle WTO negotiations), points not so much to a food system "oriented to demand" but

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[1] As the supermarkets make a greater commitment to own brands, however, they also take on board more manufacturing interests, although often this strategy is pursued through outside contracting.

rather to the emergence of new actors representing consumer interests, who are challenging the historical position of producer associations in the definition of policies and the design of a new regulatory framework for agro-food. The renaming of the Germany Agricultural Ministry as the Agriculture and Consumer Protection Ministry is perhaps, the most striking indication of this shift. In their turn, these movements find support in the individual or day-to-day practices of more "reflexive" and questioning customers involved in an unending process of "food learning".

At the other extreme, the 1990s have seen a major expansion in the demand for organic food, and although this has occurred largely at the margins of the dominant agro-food system, nevertheless the leading players have been forced to respond to this shift. While the radical potential of biotechnology for reorganising the agro-food system was identified almost simultaneously with its birth (Kenny et al. 1982**,** FAST 1984), there were no prospective studies which forecast the growth of organics from a niche into a mainstream activity, which provoked the dominant players into a major revision of their strategies. Since the late 1980s, large-scale farmers, food industry and retail interests have had to reposition themselves to exploit the potential of this unexpectedly dynamic market (Buck et al. 1997). Nevertheless, the definitional frontiers of organics are still in dispute and constantly threaten to spill over into less assimilable meanings: agroecological production systems, non-GMOs, animal welfare, social justice, family farming, sustainable agriculture (Guthman 2001**,** Lockie, Lyons and Lawrence, 2000)

The unexpected responses to GMOs and organics point to the need for a rethinking of the way demand is negotiated within the agro-food system, and this article is intended as a contribution in this direction. We will argue that both GMOs and organics represent a challenge to the view of a continuing shift of value added, and consequently of economic power, downstream in the food chain. In addition, we will show how both these developments draw attention to the increasing importance of events and actors outside the food system itself – expert systems, the scientific community, various government bodies, the medical professions, the media, NGOs – for defining the dynamic of food consumption. Social practices and identities – social and family networks, race, ethnicity, class and gender – are also crucial in defining food consumption options, but we will be primarily concerned in this article with identifying shifts in the relative weight of formally constituted interest groups and organisations.

Our analysis therefore, focuses primarily on: 1) the way demand is constructed within the food system; 2) the new alliances being established between leading agro-food actors; 3) the way in which food consumption practices have become a key focus of interest for strategic actors outside the food system; and 4) the ways in which the supply end of the agro-food chain is able to mobilise powerful new patterns of support both inside and outside the food system.

AGROBIOTECHNOLOGY: PARADIGM LOST?

Research into the application of genetic engineering to agricultural crops coincided with the commodity price crises of the early 1970s which marked the end of the long period of post-war growth. The revolutionary potential of this new technology was immediately recognised and it was seen as offering unique conditions for a renewal of the Fordist growth model through the provision of alternatives to petroleum-based energy and to a protein food regime based on intensive livestock. Biomass, it was thought, could break the OPEC stranglehold and single-cell proteins could similarly short circuit the seemingly impossible equation of a global transition to a protein diet based on animal re-conversion (Byé and Mounier, 1984)

The academic scientists responsible for the breakthroughs in gene transfer technology quickly launched agrobiotechnology start-up firms and reinforced the revolutionary image of biotechnology in their efforts to attract venture capital. The mass media confirmed this vision, which was captured most expressively in a *Time* magazine cover photograph of agricultural workers at a GMO field trial site dressed in the equivalent of space protection uniforms. The leading agrochemical firms which had assumed a dominant position in the agro-food system - both upstream and downstream - gave full support to this new wave of innovations, by financing company start-ups and moving into the seed sector (Kenny 1986).

The 1980s saw a cooling of enthusiasm in government circles as high costs undermined the perspective of alternative biomass energy routes. Venture capital funds also became nervous as longer than expected time-horizons to market led to increased costs and diminished the expectation of returns. By the late 1980s and early 1990s, as the first products came closer to market, scientists and business adopted a more cautious strategy. 'De-dramatisation' was the order of the day with the revolutionary character of genetic engineering being played down in favour of an emphasis on continuities with time-old genetic improvement and fermentation practices (Buttel 1993). Consumer surveys were already identifying warning signals - in Japan, genetic engineering was placed on a par with nuclear technology in terms of risk perception, while in Germany "Down with Genetic Engineering" slogans appeared on *autobahn* bridges. Food industry leaders captured these negative signals, particularly with regard to the use of genetic engineering on animals (Sorj and Wilkinson 1992)

In the late 1990s, NGOs and consumer organisations in Europe positioned themselves against genetic engineering for reasons which varied from the defence of peasant and small farmer interests, to bio-diversity, environment, animal welfare, ethics and consumer health issues. In the face of such opposition, at least one of the world´s leading food firms considered guaranteeing non-use of GMOs, but at that time the appropriate "identity kit" technology to enforce such a claim had not been developed (Sorj and Wilkinson 1992). Field trials of genetically engineered plants were later divulged on the internet and became systematically threatened with protests and sabotage.

When the first genetically engineered seeds came to market in the mid-1990s. the Fordist era had given way to the "economics of quality", and food marketing in Europe became heavily identified with appeals to nature, health and tradition (AgBioForum 1998). Significantly, it was at this time that large supermarket chains committed themselves more intensely to the promotion of organic foods. By way of contrast, marketing of the first biotechnology seeds in the US was carried out by agrochemical multinationals, based on agronomic virtues and directed to farmers of commodity crops. Nothing could be further from the new profile of food demand in Europe, the US's major export market. That the seeds were rapidly adopted by US farmers derives from the pattern of economic co-ordination prevailing in commodity markets, where traders and futures markets shield the agricultural producer from direct contact with the food industry and the consumer.

With no compelling virtues, genetically modified foods presented risks which were difficult to justify in Europe at a time when confidence in the industrialised food system and its scientific expert systems had been repeatedly shaken by listeria, salmonella and "mad cow" scares (Guivant 2001). This widespread consumer mistrust in Europe combined with vigorous NGO activism at first met little resistance in political circles, which saw that there were even some advantages to be gained from opposition to GM foods; domestically, such opposition meant that there was less pressure on the production of surpluses, while internationally, domestic opposition could be use as a bargaining weapon in trade negotiations. In addition, many farmers, for their part, were now increasingly identifying their interests with the development of quality markets rather than simply increasing output.

There is a growing literature on the different responses to GMOs, especially in the case of Europe and the US, but a similar analysis could be extended to India, Brazil, Argentina, China, Australia and Japan (AgBioForum 1998). The apparent lack of opposition to GMOs in the US has been attributed both to cultural factors, such as different views of agriculture and nature, and/or institutional factors, such as the authority of the Food and Drug Administration (FDA) and the weakness of NGOs. Evident differences of interest could also be adduced, such as the fact that US export farmers competing on world markets have traditionally welcomed technology which promised increased productivity and/or lower costs.

In Europe, many observers see current opposition to GMOs as a 'teething problem', or as an early phase of a new technology which can be overcome by a repositioning of GMOs in the direction of quality enhancing criteria, for example, through the integration of GMOs into the broader category of nutraceuticals (Joly and Lemarie 1998). In the US, on the other hand, increased opposition to GMOs is predicted to emerge, as agronomic claims are called into question and as the authority of the FDA comes under increasing scrutiny, for example, as a consequence of its "revolving door" policy (involving a continuous movement of personnel between government and industry), or its widely rejected proposals on organic food regulations.

While GMOs are popularly identified with Monsanto and are currently associated with only a few (mainly animal feed) crops, the agrochemicals/seed industry as a whole (both private and public), is committed to the application of genetic engineering, which is now being extended to food crops, including wheat, rice, fish and meat products. FDA data have identified the marketing of forty genetically engineered or 'novel' food crops, which include potatoes, tomatoes, chicory, papaya, melon, squash and linseed. In addition, it must be remembered that the soybean is the principal genetically engineered crop and soy-based products, as protein or functional ingredients, are to be found in an extremely wide range of industrialised foods. Second and third generation biotechnology products in the forms of speciality and therapeutic crops are being actively researched and tested in leading laboratories across the globe from Scotland, to Australia, China and the US. Both national and international public agricultural research systems (associated with the Consultative Group on International Agricultural Research, or CGIAR) are actively committed to exploring the application of genetic engineering and genomics to an increasingly wide range of crops.

Cultural and institutional factors must clearly be taken into account when analysing responses to GMOs, but it is not clear that a direct causal relation can be established between these variables and opposition or support for GMO's. The US gave rise to a strong movement against using the genetically engineered bovine somatotrophin hormone (also a Monsanto product) in milk herds, and at the Asilomar Conference in 1975, its academic community established a moratorium (albeit short-lived) on genetic engineering research (Kenny 1986). On an institutional level, respect for the FDA in the US did not extend to acquiescence when this body tried to include GMO's as permitted ingredients of organic food. In Europe, on the other hand, the many factors adduced to support the rise of an anti-GMO movement have not deterred the European Commission from adopting an increasingly determined stance in favour of ending restrictions on GMOs (see below).

ORGANICS: FROM PROTRACTED BIRTH TO EXPLOSIVE GROWTH

In earlier analyses, we have argued that, historically, the modernisation of agriculture took the form of the appropriation of different phases of the rural production process and their transformation into industrial inputs and machinery (Goodman, Sorj and Wilkinson 1987). On-farm sourced organic nutrients were replaced by synthetic fertilisers, and techniques of biological control gave way to insecticides, fungicides and herbicides. Organic agriculture therefore, represented the antithesis of the upstream inputs industry and also posed a fundamental challenge to the food industry. The organic movement was heavily identified with non-processed products whereas the food industry relied increasingly on the use of

synthetic additives to facilitate large-scale processing, restore taste and appearance, and preserve the final product. Organics, therefore, when not specifically identified with agricultural products, were associated with artesan food products.

The industrialised agro-food system, however, never fully replaced agriculture as a natural production system, permitting the latter to be both a potential competitor and a normative reference for quality (Wilkinson 1993). Organic agriculture persisted and took on an increasingly organised form on the basis of life-style groups in which production and consumption form an integrated circuit. Organic producers, together with committed "representative groups" (largely NGOs), consolidated farming practices on a decentralised basis, which were transformed into collective learning with the establishment of national and international networks. For example, the International Federation of Organic Agricultural Movements (IFOAM) was created in the early 1970s when certification also began to be systematised (Raynolds 2000).

In the 1980s there also emerged an affinity between organics and a diverse range of concerns around issues of health, environment, food processing, food safety, market segmentation and so on. As a consequence, this sector came to provide an alternative focus for the diffuse and pervasive anxieties created by the industrialised agro-food system (Fonte 1999). In Europe, between 1985 and 1995, the area cultivated to organics increased from 100,000 hectares to almost 3 million hectares, and similar developments are evident on a global basis, in the US, Japan, Poland, Australia, Uganda, Mexico, Argentina, Brazil **(**Lampkin 1999**,** Marsden 2000**,** Geier 1999). This widespread adoption of a productive system which emerged and developed on the margin of the industrialised agro-food system is the obverse of the equally massive rejection in Europe of a powerful transnational productive base in the case of GMOs.

There is no doubt that this shift of organics from niche to mainstream has depended on the entry of key actors (large-scale farmers, supermarkets, government agricultural policymakers) as has the shift from acceptance to contestation in the case of GMOs. This convergence of different actors, however, was only effective in transforming the scope of demand because of the long term, incremental accumulation of collective learning practices on the margin and in opposition to the industrial agro-food system. The force of this movement can be gauged in the (selective) adoption of organic strategies by the leading final food industries, such as Nestlé, Danone and MacDonalds. The tensions created by organics can best be illustrated by the decision of one of the world's leading transgenic seed producers to exclude GMO corn from its baby food products. In response to pressure from Greenpeace, Novartis, the owner of Gerber Products Company which specialises in baby foods, declared that it would no longer use genetically modified ingredients in its food products not only in Europe but throughout the world, and particularly in the US where its sales of baby food reach US$700 million annually. According to the Wall Street Journal article which reported this issue:

> "Gerber, going even further than what Greenpeace demands, plans to use corn flour and soy flour that are "organic" – that is, the crops not only aren´t genetically altered, but they are also grown without the use of any insecticides or herbicides. Then, if the technicalities can be worked out, it plans to change ingredient labels on certain baby-food boxes and jars to include the word "organic". 'I want our mothers to be comfortable', says Al Perigallini, president and chief executive officer of Novartis´s U.S. consumer health operation, which oversees Gerber.' (Wall Street Journal, 30 July 1999).

After the fusion of its seed activities with AstraZeneca to form Syngenta, Novartis is now the world´s leading seed firm and second only to Monsanto in its promotion of GMOs. (ETC Group Communique 2001)

THE DUAL CHALLENGE OF GMOS AND ORGANICS

GMOs and organics therefore represent polar opposites in the study of demand in the agro-food system. The former was adopted at birth by hegemonic players and integrated into the dominant paradigm of the agro-food system, only to be opposed by the increasing political and organisational capacity of new actors emerging around the demand end of the system. Organics arose outside the organised agro-food system and was sustained over decades at the margin by committed farmers, NGOs and consumers. Coinciding with new sensibilities concerning food and health, it expanded rapidly in the 1980s on the basis of direct farmer/consumer sales circuits. Demand took off and organics moved from niche to mainstream status with its adoption by key downstream actors, aided by post-productivist public policies for agriculture and rural development. Both examples provide a radical challenge to uncritical notions of the move to a demand-oriented food system.

In the following sections the focus is on three areas which can contribute to a clearer understanding of demand formation in agro-food. The first of these concerns the way in which important changes in the organisation of the agro-food chain, particularly the reversal of trends to vertical integration, have facilitated a recognition of the differing interests at work among the leading economic actors. The second draws attention to the evolution of public regulatory and normative practices regarding food, and particularly to the way in which state dietary recommendations have increasingly distanced themselves from the interests of the industrialised food system. And, finally, we show how the economic power of upstream actors has been strengthened by new alliances inside and outside the agro-food system, in spite of the dominance of demand-focussed actors within the food chain, particularly large-scale retail outlets, and the increasing political weight of civic actors defending consumer and citizen rights.

INNOVATION AND DEMAND STUDIES IN AGRO-FOOD

The adoption of advanced biotechnology strategies by leading agro-food players led to the incorporation of neo-Schumpeterian innovation theory into agro-food studies which focussed on the emergence of a new supply-based

technology paradigm (Ducos and Joly 1986). At the same time, however, a transition in food consumption patterns in the industrialised countries from the 1970s promoted new lines of research on food industry strategies (product differentiation and market segmentation), and particularly on the emergence of new actors articulating demand (large-scale retailing). These two research programmes - the former highlighting technological innovation in the upstream industries and the latter organisational innovation downstream - reflected tensions emerging within the organisation of the agro-food system (Fanfani et al. 1990).

The classical agro-food chain analyses had argued that the increasing sophistication of the food system, or the successive addition of value in post-farming activities, had resulted in leading actors adopting strategies of vertical integration, moving along the food chain from supply to demand. Cargill was a classic example of this tendency, starting as an upstream supplier and trader and advancing along the meat and grains chains to the point of producing prepared frozen foods (Bombal and Chalmin 1980). No producer firms, however, showed themselves capable of moving into large-scale retailing, and the emergence of this latter sector to a hegemonic position (combined with the increasing liberalisation, deregulation and globalisation of agro-food markets) led to a strategy of re-focussing around "core competencies", identified with the major "stages" in the agro-food chain. This was then accompanied by horizontal rather than vertical integration, involving an increasingly wide range of products traversing individual commodity chains, but involving similar economic activities and competences. International oligopolies have now emerged around seeds, trading and primary processing, final foods, and retailing. Unable now to migrate along the food chain appropriating the evolution of value-added, leading firms anchored around its major stages try to impose their competitive advantage on the overall system – through GMOs (in the case of agrochemicals companies); through a recycling of the commodity system (by primary processors); through highly industrialised brand products (for final foods producers); and through own-products and demand-articulated supply systems (in the case of the retailing sector).

Whereas vertical integration tends towards the diffusion of homogeneous values, the current retrenching of oligopolies at different strategic axes of the food chain creates a proliferation of often conflicting value systems, exposing the varied "worlds of production" of convention theory which compose the agro-food system (Salais and Storper 1993). Industrial, market, domestic and scientific appeals to legitimation compete for consumer loyalty, revealing the sectoral economic interests behind what were previously considered to be common values. While the earlier vertically-integrated industrial agro-food system tended to spawn only minority opposition groups, the current conflicting and competing values of the leading agro-food players are propitious to the development of a more generalised dissatisfaction.[2]

This latent discredit has been activated both internally by the strategies of new retailing interests (e.g. the development of own products and the sourcing of niche, artesan and organic products from outside the mainstream suppliers), and externally as a result of the spate of food scares. The originality of retail strategy has been its ability to base itself on the promotion of a reflexive consumer participation. The sunk-costs of other agro-food sectors prohibit such a flexible interaction with consumer demand, whereas retailing has been able to introduce the just-in-time and tailor-made producer-consumer model within the food system precisely because it lacks specific assets (either material or knowledge based) in productive activities. As a result, the consumer has emerged as the major new actor in the food system, and inducement of consumer behaviour is increasingly combined with, and subordinated to, knowledge of consumer behaviour as the key to competitive advantage.

PUBLIC REGULATION, NORMATIVE PRACTICES AND CIVIC REPRESENTATION

Large-scale retailing may have been responsible for the "endogenisation" of the consumer as an actor in the agro-food system, but in the language of convention theory, along with the consumer, it is the civic world of justification of economic action which is introduced into agro-food and begins to have a decisive impact on strategies and policies (Boltanski and Thévenot 1991). Government and increasingly influential civic associations compete with the supermarkets for the representation of the consumer-citizen. Civic associations play a key role both in focussing the enemy (chemical inputs and ingredients, animal cruelty, transgenics and environmental damage), identifying alternatives (organics, socially and ecologically correct products) and pressurising both Government and leading agro-food actors.

In all countries, the Government for its part has been a decisive actor in the construction and maintenance of the industrialised agro-food system, from R&D and extension services through to financing and regulation. More than this, it has legislated the definition of different food products, thereby creating the conditions for outlawing and punishing adulteration. This legislation was complemented by hygiene and sanitation measures appropriate to the increasing separation in space and time between production and consumption of perishable goods. All these measures can be seen as reinforcing the industrialisation of the food system and even more as consolidating its oligopolisation, since only medium

[2] In agro-food studies, the commodity chain (Goldberg 1968**,** Friedland et al. 1981**)** and *filière* (Malassis 1979) analyses increasingly gave way to actor-network approaches (Long and Long 1992, Murdoch 1995) which were better able to capture the articulation of heterogeneous actors in the journey from farm to table. Convention theory, for its part, while it incorporates much of the actor-network approach, provides a more structured typology of the location of different interests and values (Wilkinson 1997, Murdoch et al. 2000). In the economic literature "cluster" and "local systems" and "industrial district" approaches have all tried to compensate the limitations of *filière* style analyses.

and large-scale operations could adapt to the costs of hygiene and sanitation requirements. This "hygienic regulation", to use Marsden's expression (Marsden 2001) has been reactivated in England in the wake of the foot and mouth outbreak.

Governments, however, also relate to the food system from a public health perspective. In the early years of this century in the industrialised countries, and still so in underdeveloped countries, the key problems identified were those of adequate access to food, which may be interpreted as being compatible with the profile of the modernised food system. However, a change emerges from the 1960s and 1970s, when public health concerns came to question the nutritional basis of modern diets. Nutritional science emerged in symbiosis with the modern food system, but its application to issues of public health brought it into increasing conflict with the dominant post-war trends in industrial food production (Mennell, Murcott and van Otterloo 1992). From the 1970s, dietary guidelines were established in most industrialised countries, supported by international bodies such as WHO and the FAO. These focussed on the diseases of affluence, such as overeating, and campaigned for a reduction in the consumption of sugars, fats and salt. Initially directed at individuals, these guidelines became transformed into national objectives in the 1990s. In addition to identifying as "killers" the fats and sugars which have been central to the industrial food system since its birth, the guidelines consistently favour less processed foods and extol the virtues of fruits and vegetables (Tansey and Worsley 1995). Since the 1980s, therefore, a public consensus has emerged, which views the industrialised food system as questionable in health terms. In this context, food panics can rapidly transform such latent dissatisfaction into alternative consumer demand patterns.

AGROCHEMICALS AND NEW ALLIANCES INSIDE AND OUTSIDE THE FOOD SYSTEM

If the anti-GMO movement finds strong support from tendencies both inside and outside the food system, this is no less true of the agrochemicals and genetic inputs sector. We have adduced four factors which help to explain the twin phenomena of opposition to GMOs and support for organics: 1) the normative role of "naturalness" for industrial food quality; 2) the economic strength of food sectors whose strategies are based (not unambiguously) on the negotiation of consumer demand; 3) the public sector, and the academic, nutritional and medical communities' prescriptions on food and health; and 4) the emergence of new actors representing consumer/citizen interests (Guivant forthcoming).

Faced with this articulation of interests, the upstream and, until now, farmer-oriented strategies of agrochemical companies would seem to be weakly positioned. We pointed out earlier, however, how both GMOs and organics tentatively represented a reversal of the downward shift in value-added away from primary activities. Recent studies have identified the emergence of new strategic alliances spanning both agrochemicals and primary processing (and even the retail sector) for the production of speciality raw materials, based on patented genetic material, for which the final foods sector would have to pay premium prices and, increasingly, royalties (Heffernan 2001). Agreements between Monsanto and Cargill, between Novartis and ADM, the growth of United Agri-Products within the ConAgra complex, and Dupont's Protein Technologies International (PTI) association with General Mills, all point in this direction. More significantly, Marks and Spencer, the British food retailer, has launched a line of products using PTI ingredients. These alliances are situated within the broader strategy of developing functional foods, for which advanced biotechnologies are seen to be a decisive tool (Wilkinson forthcoming).

Strategic sectors of the scientific community are also firmly behind the push to consolidate genetic engineering, and include the greater part of public national and international agricultural research systems, the molecular biology laboratories of the leading universities, and the burgeoning "expert system" of bioethics, largely created around and increasingly integrated into the life sciences industry[3] (Elliot 2001). The privatisation and subsequent multinationalisation of germplasm banks and seed production has led to a greater inter-dependence and collaboration between the national agricultural research systems and the leading agrochemical/seed firms, and is responsible for an increasing share of contract funding. Many of the leading molecular biology laboratories are not only heavily funded by these global companies but a large part of their research programme is jointly elaborated with them. In its turn, the new bioethics community, which is responsible for monitoring life-science research and advising on relevant policy issues, is increasingly funded by the same global actors (Elliott 2001).

More important even than the support of these sectors of the scientific community is the adoption by governments of science and technology as the key to competitive strength in what the OECD refers to as "the knowledge-based economy" (OECD 2000). In this equation of science, technology and innovation with economic development, biotechnology comes a close second to, and in genomics is increasingly merged into, informatics. Given the relative concentration of informatics in the US, biotechnology is increasingly seen both in industrialised country competitor blocs (the European Union) and developing countries (Brazil and the Mercosul) as central to competitiveness in global markets (Wilkinson 2000). There is intense pressure in these blocs, therefore, on the part of key sectors of the state bureaucracy, to move towards a liberalisation of the marketing of GMOs:

> 'In a strategy paper revealed yesterday, the Commission acknowledged that public concern over biotechnology was holding back its evolution in the EU. The paper sets out a 30-page action plan designed to overcome the problem by 2010. Europe's biotech sector is currently worth just Eur7-8bn (US$6.17.0bn), approximately a third of the US biotech industry. Concerns over the high-profile end of the sector, such as genetically modified food, have delayed consumer acceptance. The Commission clearly sees a business case for moving forward.

[3] For a scathing account of US bioethics, see Elliott 2001

> "Uncertainty about societal acceptance had stifled our competitive position, weakened our research capability and could limit our policy options in the longer term," the commission said in its strategy paper' (Just-Food.com, 24 January 2002)[4].

Brazil's Green Paper "Science, Technology, Innovation" (Ministry of Science and Technology, 2001) reiterates a similar message and receives strong endorsement from the scientific community stimulated by recent indications of its international competitiveness in the cutting edge field of genomics (FAPESP 2001).

If we consider the bioethics community as a counterpart to the NGOs supporting the anti-GMOs alliance, we can see how the agrochemicals strategy is also firmly rooted in four key sectors, including also new alliances within the agro-food chain, important sectors of the scientific community and an increasingly influential sector of the state bureaucracy, particularly in those countries and blocs which have become strategic in their rejection of GMOs.

CONCLUSION

The monolithic character of the agro-food system has imploded in the 1990s, exposing heterogeneous interests organised variously around industrial, scientific, marketing, domestic and civic forms of justifying production and consumption practices. Its future profile now depends on the new alliances being formed both inside and outside the agro-food system. While the anti-GMO, pro-organic alliance would appear to be firmly based on the major tendencies detected in food markets (quality, naturalness, health), agrochemical interests are contesting these spaces through the development of "functional" alternatives and have fundamental support in the state bureaucracies identified with economic growth and competitiveness, now also couched in the language of ecology and sustainability. Given the strength of each coalition, polarised opposition will probably give way to a negotiated co-existence, with priorities shifting to the development of traceability and identity preservation production systems, a tendency already in evidence in private initiatives in the United States and at community level in the European Union.

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[4] The CEC Document referred to in this quote is Commission of the European Communities (2002).

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