STEPS centre

Made by Monsanto: the Corporate Shaping of GM Crops as a Technology for the Poor

This working paper is about the social construction and social shaping of agricultural biotechnology in relation to international development. Genetically modified (GM, transgenic) crops have come to occupy a prominent place in contemporary debates on agricultural development, in relation to a diverse range of issues including productivity and economic growth, food security and nutrition, sustainability and climate change. Yet the types of GM crops and traits currently on the market are widely acknowledged to have been designed to meet the needs of farmers in industrialised countries and to offer little to small-scale farmers in the developing world. Though a range of more relevant crops and traits may be in the pipeline, they appear to be some way off.

This paper examines how it came about that a technology widely recognised to have such marginal relevance to developing-country agriculture nevertheless came to be talked about as if the challenges of development were one of the central justifications for the rapid commercialisation of GM crops in both developed and developing countries. Focusing on the case of the international agribusiness company Monsanto, the paper demonstrates that stories about sustainability and feeding the world played an important role in driving and shaping that company's technological and commercial strategies over a period of twenty years, even though they had little influence over the actual content of the technologies that were being developed in Monsanto's laboratories.

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Made by Monsanto: the Corporate Shaping of GM Crops as a Technology for the Poor

Dominic Glover

GM Crops

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1. INTRODUCTION

> A visitor from another planet eavesdropping on defenders of genetic engineering during the summer of 2000 might have come to the conclusion that it was a technology developed mainly to feed the world's poor and malnourished (Charles 2001:262)

Genetically modified (GM, transgenic) crops have come to be widely invoked as a key technology for improving agriculture in the developing world, enhancing agricultural productivity, alleviating poverty and achieving food security at both household and global levels. For a few years, at least, it seemed that every discussion of agricultural development had to include a statement about the need for careful, responsible, but basically enthusiastic and rapid, development and application of GM crop technology in the developing world (Hisano 2005). Around the turn of the twenty-first century, for instance, a slew of reports, discussion papers and position statements emerged from various prominent bodies, including major international organisations and august scientific institutions, which supported and encouraged the urgent development of various biotechnologies, including GM crops, for various applications in developing-country agriculture – specifically for boosting crop yields and tackling hunger and malnutrition.

For example, weighty reports issued by the Nuffield Council on Bioethics in 1999 and a coalition of seven national and international science academies in 2000 both strongly backed GM technology for use in the developing world (Nuffield Council on Bioethics 1999; Royal Society of London *et al.* 2000). The influential International Food Policy Research Institute (IFPRI), a member-institution of the World Bank's Consultative Group on International Agricultural Research (CGIAR), threw its support behind the use of modern biotechnologies, in combination with other approaches, as a key element of a strategy to revitalise smallholder agriculture and increase food production (e.g. IFPRI 1999; Pinstrup-Andersen et al. 1999; Pinstrup-Andersen and Schioler 2001). The UN Development Programme's Human Development Report 2001 and the UN Food and Agriculture Organisation's (FAO) State of Food and Agriculture report for 2004 both broadly endorsed the potential of the technology to boost global agriculture, with minor caveats about careful risk assessment and appropriate regulation (FAO 2004; UNDP 2001).

Since the late 1990s, biotechnology has frequently been invoked in this way as a crucial tool for agricultural development. The mutually supporting arguments of these formally neutral and influential bodies appeared to reflect an emerging official and scientific consensus that agricultural biotechnology, including GM crops, would be

developed in ways that would be 'pro-poor', benefiting poor farmers and consumers in the developing world. That optimistic consensus was not well-founded. It depended on a number of key, unacknowledged and highly questionable assumptions about the ways in which the technology would be developed and its likely impacts on poverty, hunger and the livelihoods of the poor (Scoones 2002). Among these was an implicit assumption that the adoption of effective new agricultural technologies would inevitably produce beneficial socio-economic change, within an overarching conceptualisation of agricultural development as involving a necessary transition from subsistence farming to a commercial, market-oriented agriculture that was assumed to be inherently more 'productive' and 'efficient' (Levidow 2001). In effect, without troubling to analyse the complex, context-dependent ways in which new agricultural technologies might have an impact on poor people, and the livelihoods of poor farmers in particular, poverty was merely invoked as a 'moral platform' on which a series of assertions about the value of the technology could be made (Jansen and Gupta, no date).

Often, a distinction was acknowledged between the 'first generation' of GM crops actually coming onto the market, which were widely recognised to have been developed for commercial farmers in the global North, and a speculative list of potential crops and traits that might plausibly benefit small-scale, developing-country farmers in the longer term. Too often, however, that important distinction was lost behind the headline messages of enthusiastic support for GM crop technology as a whole, so that the likely different impacts of different types of crops and traits were not explicitly addressed. This conflation allowed the idea to go unchallenged, that the 'first generation' GM crop technologies themselves might, nevertheless, deliver useful benefits for small-scale farmers.

Today, the strength of the consensus position on pro-poor GM crop technology in the developing world has softened considerably. This is partly because – in agriculture as in pharmaceuticals (Hopkins *et al*. 2007; Nightingale and Martin 2004) – the delivery and performance of biotechnology has not lived up to the febrile hype of the 1990s. As understandings of the complexity of the factors governing heritability and gene expression have deepened, the technical challenges involved in genetic modification have proved more difficult than anticipated. Long-predicted innovations like pro-vitamin A-enhanced 'Golden Rice' and 'iron rice' seem as far from commercialisation as ever – and for important technical reasons, not just because of the onerous regulatory hurdles and consumer opposition that are often blamed by their supporters for the delay (Brooks 2008).

More than a decade after the first GM crops were commercialised, global transgenic crop acreages, though large, are still limited to just a handful of major commercial crops (soya, maize, cotton and canola) and two basic traits (herbicide tolerance and insect resistance), and overwhelmingly concentrated in a handful of countries. While a number of other GM crops are reported to be in the pipeline, enhanced with traits such as disease resistance or drought tolerance, they appear to be still some way from commercialisation. In farmers' fields, transgenic crops have

delivered merely incremental and contingent benefits for some farmers rather than the dramatic advantages for the environment and society that were promised by the biotech industry (Benbrook 2004; FOEI 2007, 2008; Raney 2006; Smale *et al.* 2006; Vellema 2004).[1]

In the light of several years of evidence on the cultivation of GM crops in a number of developing countries – including China, India, Indonesia, South Africa, Argentina and Brazil – the technology has been rather soberly assessed, in a major international review, as entailing both opportunities and risks for developing-country agriculture and farmers – outcomes which are themselves contingent on a range of socio-economic, technical, institutional, agronomic and other factors, not merely on the intrinsic properties of the technology itself (IAASTD 2008).

Any student of science and technology in society would have anticipated such a conclusion. New technologies have rarely – if ever – been 'silver bullets'. Where is the modern agricultural technology that has produced only unequivocal social and environmental benefits, free of corresponding costs? In fact, the value and relevance of GM crops for the achievement of developmental goals has been widely contested from the start. Even while the enthusiastic official endorsements of GM technology were being produced, environmental campaigners, development activists and international development analysts and practitioners questioned the simplistic assumptions on which the optimistic 'pro-poor biotechnology' thesis was based (e.g. Altieri and Rosset 1999; Christian Aid 1999; Mayer 2002; Oxfam 1999; Scoones 2002).

Clearly, there is a disconnection between the types of GM crop technology that have actually been produced and the 'pro-poor biotechnology' rhetoric in which they have so often been dressed up. That being so, the question arises: why is it that GM technology came, nevertheless, to occupy such a central place in global policy discussions and public debates about agricultural development? Where did the discourse of a 'pro-poor biotechnology' come from? This paper postulates that one of the key sources of the 'biotechnology for the poor' discourse was the private sector, through both the public-relations efforts of individual companies and through their support for various organisations that work to promote the technology. For instance, it has been noted that one of the key reasons why the large US transnational agribusiness and biotechnology company, Monsanto, has been such a prominent target of anti-GM campaigners is that it has energetically promoted a set of claims about the relevance of GM crops to the alleviation of hunger and poverty (Charles 2001; Schurman 2004).

The role of the private sector, and Monsanto in particular, in promoting GM crops as a pro-poor, developmental technology should therefore be of keen interest to students of agricultural development policy and science and technology studies. It may hold lessons for both policy makers and technology analysts about how

[1] 'Biotech's sparse harvest', New York Times, 14 February 2006.

expectations about new technologies are shaped, and the role played by these expectations in mobilising both support for and opposition to those new technologies. Monsanto is of particular interest because it remains one of the biggest players in agricultural biotechnology, with a remarkably dominant position in the market (ETC Group 2005; Glover 2007d).

This paper will show how and why Monsanto's vigorous promotion of the 'pro-poor GM crop discourse' emerged and developed. In particular, it will show that the discourse was not merely a public relations device, attached to GM crop technology at a late stage of its development in an attempt to smooth its path into the market. It goes without saying that it did, of course, serve that purpose; but, more fundamentally, the discourse emerged alongside Monsanto's GM technologies themselves, through a twenty-year history in which corporate strategy was discussed, rationalised and acted out. The 'pro-poor GM' discourse was part of the rationalisation that was made, both within and outside the company, to justify Monsanto's investments in biotechnology and to attract the necessary support to drive the biotech strategy forward.

The paper will explain how Monsanto's commercial strategy for agricultural biotechnology was shaped during the 1970s and 80s, leading the company towards the development of particular types of technology. A key aspect of that story concerns the types of expectations that were constructed around the potential of the new technology, which included certain visions or narratives about its relevance to and value for developing-country agriculture. The paper will argue that these expectations and narratives were not merely decorative aspects of the story of agricultural biotechnology's commercial development, but closely linked to it. Hence, the simultaneous production of a technology widely recognised as having limited relevance to poverty alleviation alongside a narrative that strongly implied it was intended and designed to achieve that goal can be seen as two aspects or dimensions of the underlying processes through which the technology was produced and shaped.

An important theme of this paper is the way that Monsanto's GM technology strategy was influenced by *uncertainty* – a key concept in the work of the STEPS Centre (Leach *et al.* 2007). Drawing on insights from the fields of science and technology studies (STS) and organisation studies, the paper will suggest that the construction of a discourse that depicted GM crops as a pro-poor, developmental technology played a role in helping Monsanto's managers to construct a strategy that appeared coherent and rational. That helped them to mobilise and motivate both the company's employees and the investors it needed to drive the strategy forward, which served to reduce the uncertainty that is intrinsic to radical technological innovation and the associated strategic and organisational change. The point here is not that Monsanto's decision-makers were themselves paralysed by doubt and uncertainty, but that they used strategic tools including storytelling and discourse to help them manage in a context of uncertainty, so as to try and shape a technological and commercial future that would be desirable from the company's point of view.

In other words, the paper will argue that the effort to construct GM crops as a vital technology for achieving sustainable agriculture, food security and rural development was not merely a question of clothing an already existing or naturally evolving technological strategy in slick marketing or public relations talk. More fundamentally than that, by mobilising support for the company's biotechnology research and development programme, it actually contributed internally to driving and shaping Monsanto's emergent technological and commercial strategy. The paper thus aims to help to explain why particular forms of GM crop technology emerged, on one hand, and why they were attached to certain symbolic meanings and purposes, on the other, even though there was no necessary logical connection between the two.

2. THINGS COULD HAVE TURNED OUT DIFFERENTLY

It is instructive to begin by looking back at the ways in which Monsanto personnel framed the developmental promise of GM crops in the past. Shortly before his death in 1990, Howard Schneiderman, Monsanto's senior vice president for research and development (R&D) during the 1980s, completed an article for *Environmental Science and Technology,* together with a Monsanto colleague (Schneiderman and Carpenter 1990). The article explicitly linked genetic engineering of crops to the struggle to feed the world, combat malnourishment and stem the advance of environmental degradation, as well as citing a number of specific opportunities to help developing country farmers and improve subsistence crops.

The article was thoughtful, reflective and judicious. It did not make any inflated claims for GM crops as a silver bullet for developing country agriculture. The authors frankly acknowledged that the kinds of solutions appropriate for intensive, large-scale farming would not work in the insecure situations facing poor farmers in the developing world. The article acknowledged the need for an indigenous, sustainable agriculture that preserves soil fertility. It recognised the complexity of the development challenge, discussing how, on one hand, the insecurity of poverty encourages exploitative land use, while on the other hand there is also the risk that economic development itself may 'generate exploitative terms of production', thus encouraging long-term sustainability to be 'sacrificed for short-term income'.

The article explicitly acknowledged the socially embedded nature of agricultural development, noting that farming on poor soils requires not only skilful farmers but supportive government policy. The authors lamented the fact that 'national agricultural policies favor the spread of capitalized, monocultural cash-cropping and extensive ranching'. They went on to review some of the potential applications of GM crop technology that might be relevant to developing-country agriculture, mentioning the potential to introduce traits like disease resistance and improved

protein content to subsistence crops like cassava, sorghum, millet and taro. They stated that 'The technology of gene transfer must be developed where it will be used, to ensure that it will respond to local conditions and be readily accepted by the people'. They mentioned the need for crops that are suitable for intercropping. They explicitly acknowledged that GM technology cannot be a 'quick technology fix', citing the importance of a slew of other interventions – 'economic and political reform, education, land reform, debt relief, an agricultural infrastructure, a strict deforestation policy, realistic government food subsidies, family planning, and many other things'.

To anyone familiar with Monsanto's typical approach to GM crop marketing and lobbying, such an article seems rather surprising. Contrary to the authors' call for a bottom-up, socially embedded and tailored approach to crop development, focused on farmers' priorities, subsistence crops and mixed cropping systems, Monsanto's current marketing strategy, in the developing as in the developed world, revolves around the promotion of standardised, scientifically defined high-technology packages that centre on a few cash crops, especially transgenic cotton and maize and 'conventional' hybrid maize. Instead of adapting the technology to suit the farmers' requirements, Monsanto expects smallholder farmers to change, using Monsanto's seed and herbicide inputs to make the transition to a more commercially oriented agriculture (Glover 2007d).

How did the (publicly espoused) aspirations of Monsanto managers like Howard Schneiderman come to be transformed into a monochromatic corporate focus on just a handful of crops, two basic traits and the relentless promotion of a standardised package of practices for each crop and trait combination? The remainder of this paper will explore how and why these expectations about the broad applicability and benefits of GM crop technology came to be separated from the specific types of GM crops that were actually developed and commercially released by Monsanto, even while the company continued to use the rhetoric of a pro-poor GM technology.

3. MONSANTO AND THE EMERGENCE OF GM CROP TECHNOLOGY

In 1990, Monsanto was a major chemicals company that had substantial interests in artificial sweeteners and food additives, pharmaceuticals, industrial materials and agricultural chemicals. The company's history lay firmly in the chemicals industry. Having started life in 1901 as a manufacturer of saccharin, by the 1970s Monsanto was involved in businesses as diverse as oil and gas exploration and the production of acetic acid, plastics, synthetic rubber, resins, polystyrene and

polyethylene, insulation and flame retardant materials, acrylic fibres (including a carpet business), silicon wafers for the micro-electronics industry and Astroturf. In 1978, agriculture and food processing together accounted for just 17 per cent of the company's sales (Monsanto 1978).

Today, Monsanto is one of the world's largest seed companies. Although it remains the manufacturer of the world's best-selling herbicide brand, *Roundup* (glyphosate), it has shed its industrial and speciality chemicals division, its sweeteners business and even the pharmaceutical subsidiary which it acquired in 1985. It is now an agri-business and biotechnology giant that focuses on herbicides and seeds and dominates the global market for genetically modified crop traits (ETC Group 2005; Glover 2007d). The major elements of this dramatic transformation in the company's profile occurred in only about a decade, between the early 1990s and the early 2000s.

And yet, when the company had first ventured into the fledgling biotechnology sector in the early 1970s, it had done so very tentatively and speculatively. Monsanto first established a small research programme on cell biology in 1975. Over the course the next twenty years, Monsanto's senior executives steadily increased the company's commitment to biotechnological research and development, but throughout this time they remained highly unsure about where the investment was taking them. Understanding how this initially cautious and tentative exploration ultimately led to the radical transformation of the business requires an examination of the highly specific and contingent sequence of decisions and processes that contributed to it. That examination will help to explain how and why GM crops came to be depicted as a technology for the poor.

Against this background of uncertainty, the Monsanto managers' strategy did not spring into existence fully formed. In this regard, it is important for analysts of corporate strategy to recognise that a causal conception of strategy – as an independent driver of organisational action, like a kind of schematic or blueprint designed in advance – is misleading. More accurately, strategy typically emerges from organisational action and interaction and appears as a pattern of activities or crystallisation of purpose that only becomes apparent in retrospect (Mintzberg 1978). In other words, what we refer to as 'strategy' is not so much about coherent planning-in-advance to achieve particular goals or targets, but is intimately concerned with making sense out of the 'haze of everyday activities' in which a firm and its employees are involved, thus giving them the appearance of meaning, purpose, coherence, continuity and control. In this light, strategy can be understood as a kind of management discourse, designed to convince employees and other stakeholders that someone is in charge and is following a coherent plan (Araujo and Easton 1996:371).

When elaborating such a discourse, managers typically resort to storylines or narratives or invoke vivid metaphors in order to bestow meaning onto what may be a very complex and confusing flow of events and activities, in order to inform,

justify and impose decisions in circumstances where more 'rational' calculation or decision-making is difficult or impossible. Such mechanisms or techniques may thus be used to project a degree of certainty forward into an uncertain future (Dunford and Jones 2000; Grant, D. *et al.* 1998; Hill and Levenhagen 1995; Jamison and Hård 2003). Strategies are therefore 'at least as much devices for understanding and making sense of where one has been in the past as they are instruments for securing the future' (Coombs 1995:339; see also Brown *et al.* 2000).

Seen in this light, Monsanto's entry into the fledgling biotechnology industry will be seen to resemble not so much a confident and sure-footed series of strategic moves as the accretion or accumulation of a sequence of uncertain, contingent steps, which eventually coalesced into a more coherent strategy as a consequence of the accumulation itself. As for the content of the strategy, therefore, one needs to look elsewhere to understand how it emerged.

Monsanto's emergent strategy was informed and shaped by a number of key factors. These included apprehensions and expectations about developments in the chemicals industry; speculations about the business opportunities and threats that would be created by the new technological capabilities emerging from the 'life sciences'; a number of key changes or clarifications in legal institutional arrangements, which were expected to enable companies to reap financial rewards from biotechnological innovations; and judgements about Monsanto's current and future competitive position. I will discuss each of these briefly below.

MATURATION OF THE CHEMICALS INDUSTRY

During the 1970s, Monsanto's top decision-makers, in common with other senior executives and analysts in their industry, were coming to terms with the perception that the chemicals industry was by then a mature, cyclical business, heavily dependent on the fluctuating costs of raw materials. In the future, profitability would increasingly depend on very basic and unglamorous production capabilities – i.e. the ability to drive down costs and make marginal efficiency gains in the production of high volumes of chemicals, meeting specified quality thresholds, to achieve low profit margins. In agriculture, Monsanto's scientists were beginning to realise that the scope for new approaches to crop-management based on chemistry were limited (Resetar *et al.* 1999). Monsanto executives knew that this would increasingly be the kind of sector where products were likely to become increasingly generic, adding value would be difficult and a distinct competitive advantage would be hard to attain and defend (Monsanto 1981:3). Reflecting this concern about the implications of being trapped in a 'sunset industry', Howard Schneiderman told *Business Week* magazine, 'To maintain our markets – and not become another steel industry – we must spend on research and development'.[2]

[2] Quoted in Hoover's company profile, reproduced at http://www.answers.com/topic/monsanto-company?cat=biz-fin (3/6/08).

ENVIRONMENTAL LIABILITIES

During the 1960s and 1970s, Monsanto's business was increasingly threatened by the emergence of the environmental movement and tougher environmental regulation. Monsanto had acquired a particularly unenviable reputation in this regard, as a major producer of both dioxins and polychlorinated biphenyls (PCBs) – both persistent environmental pollutants posing serious risks to the environment and human health. Law suits and environmental clean-up costs began to cut into Monsanto's bottom line, but more seriously there was a real fear that a serious lapse could potentially bankrupt the company (Hertz *et al.* 2001).[3] In response to these concerns, Monsanto embarked on a number of waste- and emissions-reduction initiatives during the 1980s. In 1983, for example, the company spent US $25m on environmental clean-up costs (Monsanto 1983). Monsanto scored some easy wins in the process, but by the early 1990s this 'end-of-pipe' approach to pollution-prevention and emissions-reduction was running out of steam (Resetar *et al.* 1999; Sastry *et al.* 2002). Senior executives were becoming convinced that Monsanto's long-term viability would have to depend much less heavily on chemicals (Hertz *et al.* 2001).

ROUNDUP[4]

Monsanto launched a new herbicide called *Roundup* (glyphosate) in 1976. The chemical rapidly became a runaway commercial success. Within a few years, it was being marketed in 115 countries. Sales grew by 20 per cent in 1981 and as the company increased production it was soon Monsanto's most profitable product (Monsanto 1981, 1983). Sales volumes continued to grow strongly, years after the chemical was first introduced – for example, 25 to 29 per cent per year in the late 1980s (Monsanto 1988, 1989). It soon became the single most important product of Monsanto's agriculture division, which contributed about 20 per cent of sales and around 45 per cent of operating income to the company's balance sheet each year during the late 1980s and early 1990s. Today, glyphosate remains the world's biggest herbicide by volume of sales.

Such a blockbuster product uncorks a fountain of revenue, but also creates an uncomfortable dependency on the commercial fortunes of a single brand. Monsanto's management knew that the last of the patents protecting *Roundup* in the United States, its biggest market, would expire in the year 2000, opening the field to potential competitors. The company urgently needed a strategy to negotiate this hurdle and prolong the useful life of its 'cash cow' (Hertz *et al.* 2001; McDonald 2001).[5]

[3] In fact, liability for PCB contamination at a former Monsanto plant in the southern US state of Georgia did eventually lead to the bankruptcy of Monsanto's industrial chemicals division, Solutia, in December 2003 – several years after Monsanto divested the company to shareholders and 26 years after Monsanto had ceased production of PCBs (Hoover's company profile reproduced at http://www.answers.com/topic/monsanto-company?cat=biz-fin, 3/6/08).

[4] *Roundup* is a registered brand name of the Monsanto Company.

[5] 'A Weed Killer is a Block to Build on', New York Times 02/08/01.

DEVELOPMENTS IN BIOTECHNOLOGY

The prospect of using genetic engineering to improve plants, animals and even humans had been anticipated long in advance of the 1973 breakthrough by Stanley Cohen and Herbert Boyer, who first successfully transferred a section of DNA[6] from one bacterium to another. Both scientists and industrialists quickly began to explore commercial applications of the new technology. For example, Herbert Boyer founded the company Genentech in 1976 to develop a process for producing human insulin from genetically modified *E coli* bacteria. The company announced its breakthrough in 1978 and their insulin went onto the market in 1982 (Bud 1993; Wright 1994). At that point, it was still unclear whether a commercially viable agricultural biotechnology industry could be created from this new science, but Monsanto was just one of many agribusiness companies monitoring developments in the field, and preparing to take advantage of any breakthroughs that might emerge (Charles 2001; Wright 1994).

REGULATORY FRAMEWORKS FOR INTELLECTUAL PROPERTY

Two key changes in the regulation of intellectual property rights in the United States helped to create a much more favourable environment for the commercial exploitation of biotechnology, while steering the emerging industry strongly towards genetic modification. The most important of these changes came in the form of new rulings from the US Supreme Court in two key judgements handed down in 1980 and 1988, in which the Court allowed transgenic life-forms to be patented. The earlier decision, in the famous case of *Diamond v. Chakrabarty* (1980), unleashed a frenzy of investment interest and speculation in the commercial potential of the new technology (Bud 1993, 1995; Charles 2001; Wright 1994).

The second key change came in the form of the Bayh—Dole Act of 1980, a piece of legislation that enabled universities to own intellectual property that had been created through research projects that had been funded by American taxpayers' money in the form of grants from the US federal government. This opened up new opportunities for universities to license their intellectual property to the private sector for commercial exploitation, and created greater incentives for universities and companies to enter into new research collaborations (Bradford 2005).

Each of those factors played a key role in shaping Monsanto's technical and commercial strategy for biotechnology. The impacts can be illustrated using a number of key examples. For instance, just two years after Cohen and Boyer's breakthrough in creating a transgenic organism, Monsanto established its cell biology research programme. The head of the programme, Ernie Jaworski, made himself 'a fixture at scientific conferences' (Charles 2001:9) and kept a close eye on scientific developments, cultivating relationships with leading microbiologists

[6] Deoxyribonucleic acid.

in order to learn about the latest laboratory developments at as early a stage as possible. In those days, university scientists were perhaps less keenly aware than they are today about the implications of such information-sharing relationships, and Monsanto personnel became frequent visitors to the biotechnology labs at their local higher education institution, Washington University in St Louis (WUSTL) (Charles 2001; see also Wright 1994).

Some of the consequences of the Bayh—Dole Act and the Supreme Court ruling in *Diamond v. Chakrabarty* can be seen in the scaling up of Monsanto's biotech research in the early 1980s. In 1979, Monsanto enticed Howard Schneiderman from the University of California, Irvine to lead the company's biotech research efforts with the prospect of a US $275m research budget. Within a few months, Schneiderman and Jaworski had recruited a team of scientists to drive Monsanto's R&D programme on genetic modification, including three men who were to play critically important roles in enabling Monsanto to be among the first to successfully transform a plant, in 1982:[7] Steve Rogers, Robert (Robb) Fraley and Robert (Rob) Horsch. Monsanto opened a state-of-the-art, multi-million dollar molecular biology research facility in St Louis in October 1981 (Monsanto 1981). Schneiderman also negotiated a major collaborative research agreement with researchers at WUSTL, which was first signed in 1982 and renewed in 1987 and 1990. Over the years, this collaboration played a critically important role in helping Monsanto build a competitive lead in GM crop technology (Charles 2001; Culliton 1990; Hertz *et al.* 2001).[8]

The revenues generated by *Roundup* were vital in enabling Monsanto to boost its R&D investments substantially from the mid-1980s onwards. In his first year in charge, chief executive Richard (Dick) Mahoney (1984—1995) increased agricultural R&D spending to about 8 per cent of sales, and biotechnology was a major research priority (Monsanto 1984). This level of spending, which was sustained in subsequent years, actually corresponded to an even higher proportion of the agriculture division's sales, since R&D in the chemicals sector remained relatively flat, at about three per cent of sales for that division. That rate of spending demanded a significant effort by the chief executive to justify it to investors and shareholders (Hertz et al. 2001; Resetar *et al.* 1999).

The disparity between R&D spending on chemicals and biotechnology reflected the maturity of the chemicals sector as well as the management's steadily increasing conviction that the shift away from chemistry to biotechnology in agriculture would be vital for the company's future. For instance, Dick Mahoney has been quoted as saying 'Because of parathion [a particularly hazardous insecticide], I don't ever want to be in chemicals again. And that's why we're in biotechnology' (quoted in Charles 2001:25, parenthesis in original). The chemicals division was eventually sold off altogether in September 1997. The spin-off indicated a major departure for Monsanto, since the chemicals division could be regarded as the historical core

[7] The breakthrough was announced in January 1983.
[8] 'Betting the Farm on Biotech', New York Times 10 June 1990.

of the company, contributing almost US $3.7bn out of nearly US $9bn in annual sales in 1995 (Monsanto 1995). But the swelling importance of agriculture was clear: despite contributing a significantly smaller (though rapidly growing) share of sales, the agriculture division had significantly outperformed the chemicals division in terms of operating income every year since 1990, and the gap was increasing.

However, Monsanto's transformation into a 'life science' company, with an agriculture strategy increasingly centred around biotechnology, was by no means smooth or seamless. Disagreements within the company, between the formerly unchallenged chemicals camp and the supporters of the emerging biotechnology, were a source of significant tension and conflict over a number of years (Charles 2001; Resetar *et al.* 1999; Sastry *et al.* 2002:286, n.3). Right through the 1980s, no-one knew how to turn the new technology into a successful business, but company scientists and executives still persuaded themselves that something useful might emerge. Reflecting this uncertainty, Mahoney said, 'R&D wasn't part of the strategy; R&D was the strategy…. The science was so intriguing, it was my feeling we ought to just keep going' (quoted in Hertz *et al.* 2001:11).

The biotechnology advocates came to include most of the key senior executives in the company, which helps to explain why their arguments eventually prevailed. But how did they themselves become sufficiently convinced of the arguments that they could definitively nail Monsanto's colours to the mast of biotechnology and contemplate jettisoning the company's chemicals arm altogether? The next sections examine this question. To understand how and why Monsanto's leaders convinced themselves and their colleagues and investors to follow the biotech path, it is necessary to examine the kinds of rationalisations that they put forward to justify the shift to the 'life science' model. Exploring these justifications helps to show how, as an intrinsic part of its production, biotechnology came to be depicted, by many actors within the company as well as by the company as a whole to actors outside it, as a technology that had something to do with attaining agricultural sustainability and feeding the world.

4. CONTINUITY COMPETES WITH REVOLUTIONARY CHANGE

In the early days of its big biotech adventure, Monsanto stressed the basic continuity of its biotechnology research programme with its existing competence in chemistry, as in this extract from the 1981 annual report:

> The Company has also increased its efforts in biotechnology which has emerged as a valuable complement to Monsanto's chemical technology. Biotechnology offers novel ways for Monsanto to manipulate molecules. And, manipulating molecules has been and continues to be the basis of Monsanto's chemical businesses (Monsanto 1981:6).

The implication that biotechnology represented a natural evolution of Monsanto's chemicals business no doubt helped soothe the anxieties of chemists within the firm. Nevertheless, in the same annual report, the company also stressed the first inklings of much more revolutionary possibilities. The document anticipated the prospect of inserting valuable new traits into crops, 'such as insect and disease resistance', and discussed using this technology to 'feed a hungry world'. Even at such an early date, Monsanto was 'committed to becoming a world leader in this field' (Monsanto 1981:7).

Still, many people inside the company questioned the merits of the biotechnology research programme. Tangible results were slow to emerge, and those involved with the programme came under increasing pressure to justify their work. They often tried to do so by emphasising the long-term strategic potential of GM technology, even though the exact dimensions of this potential were uncertain. Robb Fraley, for instance, as head of the plant molecular biology research team, is said to have hyped the potential of GM crops as a once-in-a-generation opportunity for Monsanto to dominate a whole new industry, invoking Microsoft and the market for personal computers and software as a powerful analogy (Charles 2001). But the nebulousness of such grandiose prospects did not have sufficient traction on its own.

The more down-to-earth argument that really convinced most colleagues was that genetic engineering offered the best prospect of preserving the commercial life of Monsanto's most important product, *Roundup*. One former Monsanto researcher and manager told a revealing story which illustrates this point, showing at the same time how people within the company were telling one another stories designed to make strategic sense out of their activities in the context of an uncertain future. The Monsanto manager recounted how the company's former CEO, Dick Mahoney, once dropped into his laboratory during the 1980s. As the two men discussed the ongoing research taking place in the lab, Mahoney asked 'Why are we doing this?' Looking back, my informant recalled how he had cast around for plausible and convincing justifications for the company's continued investment in his work (and, of course, his own continued employment). His first line of argument related to the challenges Monsanto would face once the patent expired on *Roundup.*

Roundup helped shape Monsanto's technology strategy in the following way. Glyphosate began life as a non-selective weedkiller. It had a number of attractive properties. While it killed more or less any growing plant, it was considered non-toxic to humans or animals and broke down easily in soil through the effects of rain and sunshine. This meant farmers could apply *Roundup* to their fields before planting, and sow their crop soon afterwards, often without having to plough the ground first (a practice known as 'conservation tillage', sometimes 'minimum tillage', 'con-till' or 'no-till') (Charles 2001).

[9] Interview, Monsanto research scientist, 24/06/05.

In the early 1980s, Monsanto scientists had noticed that certain bacteria inhabiting the waste outflows from the company's glyphosate manufacturing plants were impervious to the chemical. Ernie Jaworski and some of his colleagues reasoned that they could dramatically enhance *Roundup's* commercial value if they could introduce the genes responsible for this resistance to glyphosate into crop plants. Farmers would then be able to spray *Roundup* onto their fields even during the growing season, killing unwanted weeds without harming the crop. This would significantly expand the market for *Roundup* and, more importantly, help Monsanto to negotiate the expiry of its glyphosate patents, on which such a large slice of the company's income depended. With glyphosate-tolerant GM crops, Monsanto would be able to preserve its dominant share of the glyphosate market through a marketing strategy that would couple proprietary '*Roundup Ready*' seeds, priced at a level high enough to recoup the company's substantial investment in R&D, with continued sales of *Roundup*, priced low enough to undercut potential competition from manufacturers of generic glyphosate (Charles 2001; McDonald 2001).[10]

Monsanto's heritage of agricultural chemicals thus had a profound impact on the first generation of products that emerged from its biotechnology research programme. This must have been an uncomfortable truth for many of the so-called 'gene jockeys' in the firm, who regarded GM as a clean, green technology that would fundamentally transcend the grubby and harmful chemical paradigm in agriculture. For instance, Robb Fraley is said to have exclaimed, '"If all we can do [with biotechnology] is sell more damned herbicide, we shouldn't be in this business"' (Charles 2001:60, parenthesis in original). And yet it was Fraley's own team – under pressure from senior management to deliver a commercial product at long last – which set to work on the development of the first generation of *Roundup Ready*[11] crops (Charles 2001). According to one member of Fraley's team, they eventually zeroed in on the *Roundup Ready* trait because 'this was the one project that the administration of the company understood' as a commercial proposition (quoted in Charles 2001:67).

Monsanto's particular institutional features also helped to ensure that insect resistance would be the other type of GM crop appearing in the first generation. Apart from the fact that the introduction of the Bacillus thuringiensis (Bt) gene proved to be technically straightforward, with the prospect of delivering a significant commercial product using a single gene, the fact that Monsanto's strength lay primarily in herbicides rather than insecticides meant that GM insect-resistance technology opened up a new market segment without conflicting with or undermining any significant 'pesticide interest' within the company.

As the above account illustrates, Monsanto's biotechnology strategy was clearly shaped by some basic, down-to-earth features of the company's particular institutional history and contemporary circumstances. These included its existing

[10] Monsanto, 'The Road to *Roundup Ready*® Crops' (http://www.monsanto.com/features/road_to_roundup.asp, 2/6/08).

[11] *Roundup Ready* is a registered brand name of Monsanto Company.

technologies and technological capabilities, its competitive position, the developing trends in the chemicals sector, and the financial pressure to commercialise some new products as quickly as possible. Accordingly, the biotechnology strategy evolved around the company's existing customer base – that is to say, primarily large-scale, commercial farmers in the industrialised world – and crop–trait combinations that were both technically feasible and commercially viable.

Monsanto's emerging commercial strategy for biotechnology was therefore firmly grounded in the company's history in the chemicals sector and its existing markets among large-scale farmers located mainly in the global North. The *Roundup Ready* commercial model served as a bridge between the company's chemicals heritage and its potential biotech future. One can therefore identify elements of commercial and technical continuity as well as discontinuity in what was often seen and portrayed as a radical shift from the chemicals paradigm to a biotech paradigm. However, the tension between these two alternatives was still not definitively resolved. In the early 1990s, Monsanto was still essentially a chemicals company (by volume of sales), and GM crops would not arrive on the market until 1995. At that point in the story, therefore, basic uncertainty still clouded the company's future.

That context of uncertainty helps to explain why Monsanto's managers increasingly downplayed the continuity of their approach to biotechnology and energetically promoted the company's thrust into GM technology as a radical break with its past. They portrayed GM crop technology as a clean, green and environmentally friendly alternative to, rather than continuation of, the chemical-dependent paradigm in farming. This amounted to a discursive framing of GM crop technology, but its importance was not merely rhetorical, because it helped to shape the commercial-technical strategy itself. An important side-effect of this discursive framing would be to foster a new attention towards, and a sharper focus on, the potential market for GM crops among poor farmers in developing countries. The next section examines these points in more detail.

5. MANAGING UNCERTAINTY

The future is fundamentally uncertain, of course. Corporate managers can use a variety of tools to help them anticipate events and predict outcomes, but the costs and benefits of a particular course of action are always more or less unknowable in advance. In the absence of reliable prediction, managers' perceptions about the situation in which they find themselves, and what to do, are best regarded as matters of judgement rather than calculation. The degree of uncertainty is particularly acute in relation to the potential impacts of radical innovation and major technological change (Nelson and Winter 1977; Rosenberg 1976). Radical innovation can be distinguished from incremental technological development precisely because

it involves much greater potential for change and, consequently, high levels of uncertainty (MacKenzie 1992, 1996). The types of technologies in question are those which have the potential to spark a round of 'creative destruction' that will precipitate a 'technological revolution', launch a new 'technological trajectory' or overturn an existing 'technological paradigm' (Dosi 1982; Dosi *et al.* 1990; Nelson and Winter 1977, 1982; Schumpeter 1987 [1943]). At the outset of such a dramatic re-ordering of conventional patterns, corporate managers are confronted with acute uncertainty, in the face of which they still need to make decisions.

Where radical innovation is concerned, it is important for the innovation analyst to avoid falling into the trap of thinking that the properties of the future technology are self-evident in advance, as if natural, intrinsic or endogenous. This error can result from applying some economic approaches to the study of innovation, such as Nelson and Winter's (1982) evolutionary theory of technological change or Herbert Simon's (1976; Simon *et al.* 1992) notions of 'bounded rationality' and 'satisficing' behaviour. These approaches represent an advance on classical and neo-classical economic approaches, which assume the existence of perfect information, and they can also help to address the implications of uncertainty to some degree, by shedding light on the routines and rules-of-thumb by which real managers actually make decisions in the face of incomplete information (Coombs et al. 1992).

Nevertheless, to varying degrees, they still treat technology as a more or less independent variable – that is to say, a defined set of attributes, known and unknown, around which corporate managers try to shape their decisions. Unfortunately, one cannot depend on the characteristics of an emerging technology or its technological system themselves, for guidance on how one should make decisions in relation to them. That is because these features are still unknown, precisely because they are still emerging and because they will not unfold through some self-contained inherent logic but through processes of social shaping. In the 1970s, Monsanto executives had no way of knowing what their own company's commercial GM products would look like in twenty years' time.

In such circumstances, the decisions made and actions instigated by organisational managers do not carry their own intrinsic or objective validity. Instead, they acquire validation through social processes, through which novel norms of validity and common-sense are constructed (Fligstein 2001; Gioia and Chittipeddi 1991; Weick 1995; Weick *et al.* 2005). This may be termed 'sensemaking', a social and communicative process which typically involves the related process of 'sensegiving'. Sensegiving describes the efforts made by some actors, having made sense of an issue or situation to themselves, to project a particular construction of the meaning of events in an effort to persuade and enrol a wider group. Sensegiving can therefore be seen as particularly characteristic of organisational leaders, when they attempt to articulate an organisational strategy and especially when they want to instigate major strategic change (Dunford and Jones 2000; Gioia and Chittipeddi 1991; Weick 1995). Sensemaking may take the form of a 'strategy discourse' (see above; Araujo and Easton 1996) or varieties of persuasive narratives or story-telling, which

create expectations about the future that encourage people to fall into line with a particular strategic direction (Deuten and Rip 2000; Michael 2000; Rosenberg 1976; Sanz-Menéndez and Cabello 2000; Selin 2007; van Lente 2000).

Monsanto's venture into agricultural biotechnology is a case in point. From the standpoint of the 1970s and 80s, the technological and commercial implications of biotechnology were open-ended. In the words of Dick Mahoney, '[w]e didn't have a good business plan on how to make money out of this stuff' (quoted in Hertz et al. 2001:11); 'the discussion of how we were going to make money in agricultural biotechnology went on into the 1990s' (quoted in Charles 2001:109). In the context of this fundamental uncertainty, as described in the previous section, managers and employees within the company were involved in ongoing discussions and story-telling in an effort to make sense of what the company was doing and where it was going. Through this process, Monsanto's GM crop technologies actually emerged under the influence of a number of key factors and pressures acting on the company during the 1970s and 80s, rather than being driven by intrinsic characteristics of the technology itself or foreknowledge of what its potential future markets might look like. But these factors, being inherently uncertain, were not unequivocal facts whose implications spoke for themselves. In order to produce their effects on Monsanto's emergent strategy, they had to be interpreted and translated by decision-makers and other influential people in the firm.

Monsanto's senior executives and managers made sense of the range of technical, financial, institutional and competitive features of the landscape through protracted processes of discussion and debate. As they became more convinced in their own minds, and more confident that they knew which way to lead their company, they engaged in sensegiving activities, designed to enrol and persuade their colleagues. An important way of convincing staff within the company was to engage in debates with key actors outside the firm, making interventions in public debates and particular forums where it was hoped to influence the opinions of key stakeholders, such as industry observers and journalists, stock analysts and investors. This was therefore a dual process, in which the gradually strengthening consensus of people within the firm helped to convince important stakeholders outside the firm, and vice versa. The next section explores this process in more detail.

6. BUILDING A SOCIO-TECHNICAL NETWORK FOR GM CROPS

In order to understand what was going on in this innovation story, it is helpful to turn to the insights of sociologists of science and technology into technological innovation as a social process (Bijker *et al.* 1987; Bijker and Law 1992; Callon *et*

al. 1986; Latour 1987; MacKenzie and Wajcman 1999). As these scholars have argued persuasively, a scientist's success in constructing a new scientific fact or an entrepreneur's success in bringing into being a new technology depends on their success in working at a number of different levels to create and stabilise networks of support that will underpin their breakthroughs and promote their adoption and commercialisation. In order to build these networks, innovators need to enrol various people and assemble disparate assets, including people or 'relevant social groups', know-how, money and other resources – for example, patents, laboratories, tools and equipment, regulations, potential end-users and consumers of technologies, and so on (Bijker *et al*. 1987; Callon 1987, 1991, 1992; Law and Callon 1992). By successfully working on these different fronts, the innovator can help to make his or her enterprise less risky, by increasing the certainty that it will be successful.

The 'scientist–entrepreneur' (Latour 1987) should thus be envisaged as a 'heterogeneous engineer', 'extended concurrent engineer' or 'system builder' rather than the stereotypical boffin, toiling in isolation in the laboratory or workshop, and producing technologies which are only 'diffused' in society as part of a separate, subsequent process (Deuten *et al.* 1997; Hughes 1987; Law 1987, 1991). This process has been documented in both medical and food biotechnology, where companies have been shown to have worked intensively with 'lead users', as well as lobbying trade organisations, regulatory bodies, legislators and journalists, in order to create and shape a favourable market environment for their new products (Green 1991, 1992; Miller 1997; Walsh 2002). This work of building support for an innovation process entails an effort to attract the attention and investment of a heterogeneous group of actors, typically by depicting the particular technology or project in question as the path towards a solution to a given problem or a necessary step on the way to a desired goal (Callon 1987, 1992; Law and Callon 1992).

How was this task approached in the case of Monsanto's GM technology? Although the company's technological strategy had been shaped by basic technical and commercial considerations, Monsanto's managers actually embarked on a concerted campaign to depict GM crops – and Monsanto as their chief provider – as an essential tool for addressing critically important future challenges in hunger, environmental sustainability and international development. It is important to note that these altruistic goals were not Monsanto's own. Instead, they served as vital human goals, challenges that humanity would necessarily have to address in order to survive. Monsanto's leaders' target was to ensure that their company, and its technologies, would be perceived as indispensable stepping stones on the path towards meeting those challenges. In this way, they aimed to convince both employees and investors that the company would be a vital player in future markets for agricultural technology, and so mobilise their support for the emerging corporate strategy. In the paragraphs that follow, I will attempt to explain how this came about.

TELLING STORIES ABOUT GM TECHNOLOGY

It was noted above that Monsanto managers sometimes depicted biotechnology as a natural continuation, using more modern tools, of the company's long history in 'manipulating molecules'. In a similar way, it has been widely remarked-upon that the supporters of GM crop technology have often sought to depict it as a natural descendent of ancient techniques in which mankind has used living organisms in processes to make useful products, such as yeast in bread-making, or merely a more precise and controllable enhancement to conventional methods of selective plant- or animal-breeding. These kinds of language were intended to reassure people within the company and outside it, by downplaying the novelty and emphasising the basic familiarity of genetic engineering.

However, a company does not win new customers and investors by claiming to be doing the same old things. In order to justify its heavy spending on R&D, Monsanto's managers needed to stress the remarkable, revolutionary possibilities opened up by genetic engineering, emphasising the decline of the old chemicals paradigm and sketching the potential advantages of founding a new industrial sector. This helps to explain the rhetorical ploys of key managers like Robb Fraley, as he depicted genetic engineering as both an opportunity to define the shape of an entire new industry and as a clean, green technology that would ensure food security while opening the door to a new, more sustainable type of agriculture worldwide (Charles 2001).

Alongside other senior executives and managers, Fraley conjured up the revolutionary potential of biotechnology using dramatic, inspirational rhetoric. In their accounts, genetic engineering was not merely a rather humdrum-sounding new technique for 'manipulating molecules' or a more precise kind of plant-breeding. It became the key to a much grander vision, which evoked human values and principles of profound importance, such as sustainability, environmental stewardship and even civilisation itself. For example, Monsanto's 1984 annual report talked about commercialising biotech products 'for the benefit of mankind' (Monsanto 1984:4). This kind of language was undoubtedly influenced by Howard Schneiderman. By all accounts, Schneiderman was a charismatic and persuasive advocate for biotechnology. He wanted people to understand that the technology was much more than an ingenious new tool. During a speech in 1985, he identified biotechnology and genetic engineering as possibly 'the most significant scientific and technological discovery ever made', one that would in all likelihood outlast steam power, electric power generation, nuclear power, fusion power and the microprocessor. Through biotechnology, said Schneiderman, 'Humanity, using nature's own methods, will have learned to persuade her to be a full partner in humanity's major enterprise – civilization' (Davidson 1985:1282).

Schneiderman typically linked this awe-inspiring vision of biotechnology to the needs of developing countries (Gilbert 1994). As discussed above, Schneiderman's co-authored 1990 article for Environmental Science and Technology explicitly linked transgenic crop technology to the challenge of feeding the world, tackling

hunger and malnutrition and achieving environmental sustainability, and mentioned several specific ways in which biotechnology might be used to improve subsistence crops and help small-scale farmers (Schneiderman and Carpenter 1990).

Schneiderman's lieutenants, Rob Horsch and Robb Fraley – both of whom attained very senior management roles during the 1990s – also ventured into public discussions about genetic modification. Such articles typically invoked the potential benefits of GM technology for agriculture in developing countries, often in substantial sections of their own. For instance, in a 1993 article, Horsch described in some detail Monsanto's collaboration with the US Agency for International Development (USAID) and the Kenya Agricultural Research Institute (KARI) in a project to enable Kenyan scientists, led by Dr. Florence Wambugu, to introduce a virus-resistance gene into sweet potato (Horsch 1993). In a later article, which focused largely on technical descriptions of different types of GM crop transformations then in development, Horsch illustrated his discussion of work on virus resistance – not a major trait of interest to the biotech multinationals – with examples from Mexico and Costa Rica on potatoes and squashes, respectively (Horsch 1995).

Fraley's 1992 article 'Sustaining the Food Supply' touted genetic modification as a sustainable technology for increasing agricultural productivity and providing developing countries with a 'readily accessible, economically viable means of addressing primary food production needs' in order to feed a growing global population (Fraley 1992:40). Fraley – echoing Schneiderman and Carpenter (1990) – also conceded that GM technology could not be a 'quick fix' for global hunger, '[n]either is it a substitute for measures such as conventional agricultural development, economic and political reform, education, solutions to rural landlessness, international debt relief, and population control. But it can help ensure a sustainable and adequate food supply' (Fraley 1992:42).

Fraley also indicated a role for the private sector in projects to transfer technology to the developing world, citing another paper in the same journal issue, which assessed a number of such projects and actually cast doubt on whether 'tinkering' with technologies developed in and for the developed world could really make a difference in the developing world (Hodgson 1992). The fact that Fraley had apparently read and acknowledged these kinds of points is another fascinating indication of the kind of cognitive dissonance that was opening up, between the kinds of technologies Monsanto was actually developing and the company's claims about their relevance to the needs of farmers in the developing world.

Another charismatic spokesperson for biotechnology, in an even more influential position, was Robert (Bob) Shapiro, who took over from Dick Mahoney as Monsanto's CEO in 1995. Shapiro is often described as a 'visionary' leader, who motivated his colleagues with inspiring, emotional speeches at company retreats and staff meetings (Charles 2001; Chataway and Tait 2000).[12] He is credited with

[12] Interview, Monsanto executive, 15/08/05.

overturning Monsanto's formerly cautious approach to public dialogue on crop and food biotechnology in favour of a much more energetic policy of promoting the technology (Vellema 2004). Like Schneiderman, Shapiro saw the potential of biotechnology in emotional, almost religious terms. Soon after stepping down as Monsanto's CEO in 1999, he told one interviewer,

> 'The thing I would never have guessed about this job is that it gives you a chance to make a difference in the world. When you go home at night and you talk to your family about what you're working on, it isn't like "Gee, I designed a really cool paper clip today". It's about the earth, it's about the environment, it's about food. It's about health and nutrition. These are deep, ancient things for civilization, and they are for people'. At that point, Shapiro stopped talking, because he was fighting back tears… (Specter 2000:64).

It is important to remember that this kind of rhetoric, though it may appear in a public forum, is addressed to internal as well as external audiences. As Shapiro's predecessor Dick Mahoney had recognised, Monsanto's younger generation of employees 'share the background and values of many members of environmental groups; some may well be members themselves' (quoted in Vorley and Keeney 1998:211). One Monsanto employee, who joined the company in 1998, related that she had been struck by the way that the values of environmentalism and sustainability appeared to her to resonate naturally with her new colleagues because they were life scientists.[13]

Under Shapiro's leadership, Monsanto adopted the now-infamous tagline that reflected his grandiose claims: *Food* ◆ *Health* ◆ *Hope*.[14] By selling the company's chemicals division and concentrating on agriculture, pharmaceuticals and nutrition businesses, Shapiro planned to transform Monsanto into a 'life sciences' company working for 'sustainability'. He said that its goals would be 'to help people around the world lead longer, healthier lives, at costs they can afford, and without continued environmental degradation' (Monsanto 1997:2).

Shapiro's narration of the sustainability challenge had a millenarian tone. He argued that 'the early 21st century is going to see a struggle between information technology and biotechnology on one hand and environmental degradation on the other' (Shapiro 1998:4). Unless humanity could meet the sustainability challenge, he foresaw dire scenarios unfolding, '…a world of mass migrations and environmental degradation on an unimaginable scale. At best, it means the preservation of a few islands of privilege and prosperity in a sea of misery and violence' (Shapiro in Magretta 1997:80).

This depiction of the sustainability challenge clearly espoused the need to address the needs of the have-nots in the world, as well as the already-haves. Through such stark, dramatic depictions, Shapiro sought to place Monsanto symbolically in the

[13] Interview, Monsanto executive, 20/06/05.
[14] Interview, Monsanto executive, 15/08/05.

vanguard of mankind's struggle towards sustainability and the fight to address the global challenges surrounding population growth, hunger, poverty and inequality. It was in this aspect of his argument that Shapiro began to symbolically associate his company and biotechnology with the challenges of poverty alleviation, international development and the needs and hopes of people in developing countries.

The vision of a life science company working for sustainability was undoubtedly an inspiring one, but its business implications were hardly clear, as Shapiro candidly admitted (Magretta 1997). In an effort to grapple with these implications, in 1996 Monsanto established seven strategic teams to explore sustainability issues from various angles and assess their implications for the company's future business. Two of these teams considered the implications of global water and hunger issues, with a view to identifying whether and how Monsanto might develop businesses to help address the needs in those areas. Other teams grappled with the practical challenge of incorporating concepts such as eco-efficiency, life-cycle analysis and full-cost accounting into the company's operations. By 1998, Monsanto planned to develop sustainable development criteria for all of its products and develop the necessary tools and plans to incorporate these criteria into its decision-making processes (Magretta 1997; Resetar *et al.* 1999).

In 1997, the work of most of the sustainability teams was folded into a new Sustainable Development Business Sector, established to operationalise the sustainability strategy (Resetar *et al.* 1999; Simanis and Hart 2000). The Sustainability Sector included a Smallholder Team which was 'charged with developing products, services and partnerships to meet the needs of rural, small-scale farmers in developing countries' (Simanis and Hart 2000:A7). Agricultural genetic modification was identified from the start as a major plank in this effort (Resetar *et al.* 1999).

It is important to observe here that this corporate focus on emerging markets in developing countries was not only stimulated by Shapiro's ideas about sustainability, insofar as they entailed certain logical implications with regard to poverty, hunger and development. Monsanto's engagement with the problems of developing-country agriculture also emerged organically from the conjunction of its efforts to promote *Roundup* in the developing world, which typically involved the promotion of the chemical as part of a conservation tillage technology package, and the desires of a number of individual company employees to use their technical knowledge and Monsanto's resources for the benefit of resource-poor farmers.

It is often not appreciated that Monsanto has been one of the most energetic promoters of conservation tillage, in a particular form that binds the concept tightly to *Roundup.* According to Resetar *et al.* (1999), it was only some time after farmers had started using *Roundup* in 1976 that Monsanto realised the chemical could be used advantageously in con-till or no-till farming systems. Since then, Monsanto scientists and technicians have been among the leading researchers on the concept and the company has energetically promoted the concept to farmers and agronomists, in farmers' fields and agricultural conferences, beginning in the USA

and Canada in the early 1980s (Hall 1998; Howe and Graham 1982; Soteres 1982) but rapidly spreading their message to Brazil (Landers 2000, 2001; Resende 1985) and sub-Saharan African countries including South Africa, Ethiopia and Kenya (Chedzey 1986; Collins 1986; Kemboi 1986; Meyer 1986). The company continued to promote the concept at conferences in countries such as Spain, the Philippines and India during the 1990s (Baria 1996; Schumacher 1997; Vilamajó 1995).

Although some of these examples examined the potential of no-till systems in rainfed agriculture, the company's promotion of the concept in the 1980s was addressed primarily towards the larger-scale farmers who could afford the necessary inputs. However, beginning in the early 1990s, Monsanto began to provide financial and technical backing to projects run by the NGOs Sasakawa Global 2000 (SG2000) and Winrock International to promote no-till methods to resource poor, small-scale farmers in Brazil and several sub-Saharan African countries (Ekboir 2003; Ekboir et al. 2002; Findlay and Hutchinson 1999; Fowler and Rockstrom 2001; Ito *et al.* 2007).[15] Monsanto's support for these kinds of initiative had been prompted partly by voluntary efforts on the part of a number of its own employees, located mainly in the company's African businesses or with professional experience in developing countries, who wanted to use their technical expertise and Monsanto's resources in non-commercial philanthropic projects to help poor farmers.[16]

One senior executive referred to the promotion of con-till to small farmers, using special small packages of *Roundup* herbicide, as the first practical translation of a corporate target known as the 'developing country (or countries) goal'.[17] This goal, to 'transform agriculture' in developing countries, was adopted by Monsanto's agriculture division in the early 1990s, when Robert Shapiro was its managing director.[18] That goal was partly a commercial objective, but it also contained within it a notion of 'making a contribution to transferring modern farming technology to under-privileged small-scale farmers' (Findlay and Hutchinson 1999:52). This formulation is a classic example of the way that Monsanto has consistently elided the distinction between raw commercial self-interest and philanthropic do-gooding (Glover 2007b).

This brief digression serves to illustrate that the flurry of activity around the issue of sustainability, launched by Shapiro when he became Monsanto's CEO in April 1995, grew from a longer history in which the company had begun to pay closer attention to developing countries and to experiment with ways of serving smallholder markets. Nevertheless, even while all this work was going on, Shapiro candidly admitted that he didn't know how helping people to break out of poverty could be made to work as a business venture:

[15] Much earlier, the British agri-chemicals firm ICI (later Zeneca, AstraZeneca and Syngenta) had helped to launch the Brazilian no-till project, which began in the late 1970s (Ekboir 2003).
[16] Interview, former Monsanto executive, by telephone, 11/07/08.
[17] Interview, Monsanto executive, St Louis, 20/06/05.
[18] Interview, Monsanto executive, St Louis, 20/06/05. My source could not recall the exact terms of the developing country goal, including the number of countries targeted for agricultural 'transformation'.

> 'It's difficult, in the short term, figuring out how I am going to make money dealing with people who don't have money,' he said at one point. 'But in practice, the development of agriculture at a village level is something that could make an enormous amount of business sense over time' (Charles 2001:271).

Confessing to this degree of uncertainty is striking in view of Monsanto's status as a publicly listed company. The strenuous efforts by Shapiro and his colleagues to sell the life science and sustainability vision indicate the challenge, as well as the importance, of persuading investors and shareholders to back such an uncertain venture. Transforming the company from a diversified chemicals business into a life science company involved a new configuration of material assets and technical capabilities, which in turn required a determined effort to assemble a new network of support, both externally (especially among investors) as well as internally. Accordingly, Monsanto vigorously promoted the new vision through its in-house magazine[19] and annual reports (especially the 1997 report), as well as various public channels. For instance, a number of articles were published under Shapiro's name, in addition to magazine interviews and profiles of the CEO (Magretta 1997; Scott 1996; Shapiro 1998, 1999). Reporters from business newspapers and magazines began to discuss the changes under way at Monsanto, with varying degrees of admiration (Grant, L. 1997; Jaffe 1998; Lenzner and Upbin 1997; Melcher 1998; The Economist 1997; Walmac 1997).

WHAT CHANGED?

What difference did all of this activity and rhetoric make to Monsanto's activities? It is worth reiterating at this point that, as suggested by innovation analysts, Monsanto's managers' purpose in invoking the broad goal of global sustainability was not a question of establishing that goal as a target for the company itself. Their aim was to find ways of making viable businesses out of the opportunities that they expected to arise from the sustainability challenge. Therefore, sustainability was invoked as a way to convince the company's key stakeholders that Monsanto was on top of developments that were about to unfold, and that the products and services it was gearing up to produce would make the company an indispensable player in the years to come – a safe bet for both financial investors and employees.

As discussed earlier, Monsanto's basic technology strategy was already firmly entrenched, having been shaped by various technical and institutional changes as well as the company's existing technologies and market strengths. Although many people within the company came to see Monsanto as a pioneering life science business whose products contributed to sustainable development, food security and poverty alleviation, all that had really changed was essentially a difference

[19] An article entitled 'Fields of Promise: Monsanto and the Development of Agricultural Biotechnology', written by independent consultant Karen Keeler Rogers, was published in Monsanto Magazine in two parts at the end of 1996 and beginning of 1997.

of perspective – a new way of looking at the same basic products rather than a transformation in the nature of the products themselves (Sastry *et al*. 2002; van Gelder 1999; Vellema 2004).[20] As one of the company's critics put it:

> 'As far as I can see, there has been little or no change. Whatever plans and products they had in their pipelines came right on through. I don't know of any new products that came about because of any environmental commitment, and the old underlying divisional culture of ramming products into the marketplace without consulting a broader stakeholder community about effects, values, science, and other potential concerns – with the arrogance that entails – remains intact. What exists now is a company without clear leadership, with … a product line that is truly unnerving' (Paul Hawken in van Gelder 1999).

As Vorley and Keeney (1998:208) have argued, drawing on the case of Monsanto among others, 'the top-down visions foisted on employees by born-again CEO environmentalists' typically fail to stimulate the fundamental redesign that is needed in order to transform a company into a sustainable business.

Nevertheless, at first, nothing happened to disabuse Monsanto staff from the belief that they were on the right track. Investors also seemed to buy into the life science model, and GM crop technology enjoyed a successful commercial launch in the USA in 1995 and 1996.[21] The enthusiasm of both farmers and Wall Street appeared to endorse Shapiro's strategy, reinforcing employees' confidence in their company's identity as a successful, sustainable business. However, during 1998 and 1999 this self-assurance was to be seriously challenged by a backlash against biotechnology. The backlash precipitated a serious crisis for Monsanto, and became the catalytic moment that sparked major public debates about agricultural biotechnology in development, helping to establish it as one of the key axes of public disquiet about the socio-political and ethical implications of biotechnology.

7. THE ANTI-GM BACKLASH: DEVELOPING COUNTRIES BECOME MORE IMPORTANT

Europe was expected to be the focus of Monsanto's next major market-expansion thrust. There, however, Monsanto's plans ran into serious problems in the autumn of 1998. Various structural and contingent features of the European landscape made it a particularly ripe location for a blacklash against GM crops that had been

[21] Interview, Monsanto executive, 20/06/05.

[22] 'Seed Money: Huge Biotech Harvest is a Boon for Farmers – and for Monsanto', Wall Street Journal, 24/10/1996.

brewing for twenty years or more (Schurman 2004; Schurman and Munro 2006). Anti-GM activists there had been campaigning against the technology since the first attempt to import GM grain into European ports in 1996, and momentum had been building through 1997. In the autumn of 1998, an ill-conceived Monsanto advertising campaign helped to trigger a widespread backlash by European consumers. The campaign explicitly asserted that 'worrying about starving future generations won't feed the world. Food biotechnology will' (quoted in Charles 2001:222). Within days, European food retailers were pulling foods containing GM ingredients from their shelves. Within months, the European Union had imposed a *de facto* moratorium on further approvals of GM crops. Surveying the scene, in the summer of 1999, analysts at Deutsche Bank issued a market analysis that declared 'GMOs are Dead' (Charles 2001; Schurman 2004; Schurman and Munro 2006; Simanis and Hart 2000).[22]

From a financial point of view, the crisis had a disastrous impact on perceptions of Monsanto's ability to realise profits from its large investments in biotechnological research and development, as well as service the huge debt the company had taken on (Vellema 2004). In other words, the emergency threatened to seriously undermine the socio-technical network Monsanto's managers had been trying to assemble behind its life sciences strategy. Moreover, the crisis also revealed the inadequate scope of the network, which left out important stakeholder groups that had the power to disrupt the company's plans. The crisis suddenly revealed the opposition of stakeholders whose interests Monsanto's leadership had fatally misconstrued, misjudged or failed to anticipate. As they built the network of support that would help them to manage and reduce the uncertainty surrounding the future of biotechnology, Monsanto's senior executives had relied on a set of mistaken assumptions about the interests and values of consumers and almost entirely overlooked or seriously underestimated the potential objections of other important groups, such as environmental activists and development practitioners and campaigners. In other words, the company's leaders had proceeded as if innovation were a unilinear process in which technologies would flow unproblematically from the company's labs to a compliant public.

Part of Monsanto's problem was that the 'first generation' GM crop technologies were designed to help farmers manage their operations and did not offer a direct benefit to end-consumers (Tait and Chataway 2005). That helps to explain why Monsanto's public relations managers resorted to an alternative set of claims, in which they invoked the potential benefits of (future) GM crops for poor farmers and consumers in the developing world – a potentially powerful moral claim that has consistently been used to evoke a supposed ethical responsibility, on the part of wealthy consumers in regions such as Europe, not to impede the urgent development and commercialisation of GM crops in the global South.

[22] The report may be found as an appendix to the same analysts' subsequent report on DuPont (Deutsche Banc Alex. Brown 1999)

Struggles over the interests of developing country farmers were at the very centre of the crisis facing Monsanto. Provoked by the company's claims about the role of its technologies in feeding the world, opponents of GM crops latched onto Monsanto's announcement, in May 1998, that it planned to acquire the Delta & Pine Land Company. Shortly before the announcement, Delta & Pine, together with the US Department of Agriculture, had been awarded a US patent on a sterile-seed 'genetic use restriction technology' (GURT), that would render genetically modified plants infertile. Anti-GM activists from the Rural Advancement Foundation International (RAFI)[23] dubbed the technology 'the terminator', raising the alarm over the possibility that it could be used to prevent farmers from saving seeds and thus make them dependent on biotechnology and seed companies (Charles 2001; Schurman and Munro 2006; Simanis and Hart 2000; Whipple 1999).

Finding themselves depicted as a big, evil corporation intent on controlling and impoverishing farmers was a profoundly unsettling experience for Monsanto staff, who had become used to thinking of their company as being engaged in the sustainability business. It is important to note the degree to which many people within Monsanto had evidently internalised the corporate narrative about biotechnology and sustainability. Indeed, unless one takes this factor into account, it is hard to understand why Monsanto's leadership – ignoring the well-informed advice of both their European staff and competitors (Schurman 2004; Tait and Chataway 2005) – stumbled so blindly into the firestorm of controversy that engulfed the company when it sought to introduce GM crops to the European market. The reactions of company officials displayed genuine shock and surprise (Glover 2007d; Tait and Chataway 2005). Weick (1995) identifies this kind of shock, which destabilises an established way of seeing the world, as an 'occasion for sensemaking' – a time when it becomes necessary to bring contrary signals or perceptions back into line with one another. But this was about more than merely soothing Monsanto people's self-image; Monsanto urgently needed to repair its commercialisation strategy for biotechnology.

In particular, with markets in Europe closed indefinitely, Monsanto needed to turn urgently to other markets in order to begin realising a bigger return on the huge investments that had been ploughed into biotechnology over more than two decades. Developing countries were one of the obvious places to turn. Between 1995 and 1999, Robert Shapiro had led Monsanto on a US $8–9bn spending spree to buy, or acquire interests in, biotechnology and seed companies around the world. Shapiro and his colleagues had recognised that gaining control of seed companies would be crucial in order to deliver Monsanto's GM traits to farmers. The acquisitions included a number that had transformed Monsanto, almost overnight, into a major player in seed markets in the global South – notably the purchase of Cargill's international seeds business, the Brazilian seed firm Sementes Agroceres and a stake in the Maharashtra Hybrid Seed Company (Mahyco), in India. Monsanto's

[23] RAFI's name was changed to the ETC [Erosion, Technology and Concentration] Group in 2001. See www.etcgroup.org (01/08/08).

plans for commercialising GM crops in certain key developing countries, such as China, India and South Africa, were already in train, but these planned expansions became all the more important in the light of the difficulties the company was facing in Europe. As an illustration of this point, it is worth noting that Shapiro's successor as CEO, on taking the helm in February 2000, laid down as an urgent priority GM crop commercialisation in three international markets, two of which were in the developing world (Brazil and India – the third was the European Union) (Monsanto 2000a).

Monsanto's activities in the global South were a key trigger of many anti-GM campaigners' anxiety. They alleged that, by establishing a market for its GM crops in major producer countries in the global South, Monsanto hoped to make the technology a *fait accompli*, thus rendering impotent the opposition of consumers to transgenic crops in Europe and elsewhere. For their part, however, Monsanto's senior executives and their allies remained convinced that they had a positive story to tell about the benefits of GM crop technology for poor farmers and consumers in the developing world. One of the consequences of Monsanto's setback, therefore, was to stimulate a redoubling of the company's efforts to promote these positive stories at every opportunity. This would be vital if the company were to reinvigorate the network of supporters it needed to drive its biotechnology strategy. Investors were key; their confidence in Monsanto had been shaken by consumers' and activists' unwillingness to approve the company's products. Hence, in order to bring the investors back on board, it was important to try and persuade consumers and development activists – and mediators of public opinion and debate such as journalists – to drop their opposition.

Monsanto's leadership took a number of key steps. Following an intervention by the then-president of the Rockefeller Foundation, Sir Gordon Conway, Monsanto publicly renounced the terminator technology.[24] (In any case, Monsanto's plans to acquire Delta & Pine foundered in the face of an anti-trust investigation by US regulators.[25] By then, however, the damage to Monsanto's image was already done; even today, many people believe that Monsanto's GM seeds contain the terminator gene.) Then, in November 2000, the company publicly announced the adoption of a new corporate code of conduct, the New Monsanto Pledge, together with the creation of the Technology Cooperation and Smallholder Programmes (Monsanto 2000d).

The New Monsanto Pledge was a revamped version of an existing set of environmental commitments that Monsanto had adopted in the early 1980s (Monsanto 2000d; Sastry *et al*. 2002). It committed the company to a 'new way of doing business'. One of the key commitments was 'to bring the knowledge and advantages of all forms of agriculture to resource poor farmers in the developing world to help improve food security and protect the environment' (Monsanto 2000d).

[24] 'Monsanto issues pledge on sterile seeds', Financial Times, 5/10/99.
[25] Monsanto went on to acquire Delta & Pine in 2006.

The Technology Cooperation Programme was an initiative to licence select pieces of Monsanto's intellectual property to external researchers for non-commercial applications, particularly public-good research and applications relevant to the developing world. It built on the company's previous experience with the virus-resistant sweet potato project in Kenya (see above). Examples of the programme's activities include Monsanto's deal, concluded in April 2000, to share its working draft of the rice genome with public-sector researchers from the International Rice Genome Sequencing Project; and its decisions to share proprietary technology with scientists working on the development of beta carotene-enhanced 'Golden Rice' and 'Golden Mustard' a few months later (Monsanto 2000b, c, e).

The Smallholder Programme brought together, into a coherent corporate programme, a number of individual projects that had been initiated on a piecemeal and *ad hoc* basis, often on a voluntary footing, by different Monsanto business units in various parts of the world, as well as the company's support for the con-till projects implemented by SG2000 and Winrock International that were described above. The programme was supposedly designed to provide a package of agricultural extension support and advice to resource-poor farmers in a selection of developing countries. It was used by Monsanto to help develop new markets among smallholders, promote particular Monsanto technology packages and products, encourage farmers to make the transition from subsistence farming to commercial agriculture, and generate evidence to show that GM technology was suitable and appropriate for small-scale farmers in the developing world (Glover 2007a,c).

On top of these initiatives, in 2000 Monsanto also earmarked US $6m to fund research into the economic, agronomic and environmental impacts of GM crops. The supported researchers were encouraged to 'make the research findings available to the public through peer-reviewed scientific publications and presentations at conferences and public meetings' (Monsanto 2001:13). According to Monsanto, the initiative generated 82 presentations and 44 publications in 2001 alone and would fund more than 90 different projects in Asia, Europe and the Americas by the end of 2002 (Monsanto 2001). One example cited by the company was a paper presented by researchers from Reading University (UK) at a prominent conference in Johannesburg, South Africa in September 2001 (Ismael *et al.* 2001).[26] Monsanto's funding programme was expected to continue 'through 2002 and beyond' (Monsanto 2001:13).[27]

[26] The cited paper reported yield increases and economic advantages for small-scale Bt cotton-adopters in South Africa on the basis of research carried out during two growing seasons. Subsequently, the same team of authors has extended its research to India and to Bt maize. Their findings are generally presented as favouring the argument that Bt crops are beneficial for poor farmers. See http://www.reading.ac.uk/apd/staff/r-m-bennett.asp (10/10/08) for an extensive selection of their papers.
[26] Monsanto funded research undertaken by Prof. Richard Bennett of Reading University's School of Agriculture, Policy and Development on the livelihood impacts of Bt cotton and maize in South Africa during 2005/06 (http://www.reading.ac.uk/apd/staff/r-m-bennett.asp, 10/10/08).

A question not directly addressed by this paper is what may have been the connection between Monsanto's long-standing claims about the relevance of GM crop technology to the needs and problems of developing-country agriculture, on one hand, and the ways in which these claims were echoed in the 'pro-poor biotechnology' position that was put forward by international organizations and scientific bodies on the other. What is clear is that Monsanto, both independently and in concert with other actors, engaged in a well-funded effort to publicise its developing-world activities and to promote GM crops as a safe, environmentally friendly technology that was relevant to international development, food security and smallholder farming. In numerous glossy publications, slick websites and public statements, the company sought to create positive associations between GM crops and agriculture in the developing world (Glover 2007b, c).

Monsanto also joined other major agribusiness companies in supporting third-party organisations, such as the Biotechnology Industry Organisation (BIO), the International Food Information Council (IFIC), the Agricultural Biotechnology Council (ABC), the International Service for the Acquisition of Agri-biotech Applications (ISAAA) and others, which have vigorously promoted GM crops as a safe, environmentally sustainable and appropriate technology for development. Some of these organisations have resorted to Machiavellian tactics to influence media reporting and manipulate public opinion, even going so far as to fabricate artificial demonstrations of support for GM crop technologies by poor (and not-so-poor) farmers in India and South Africa (de Grassi 2003; Hisano 2005; Matthews 2003).[28] It is at least plausible that these kinds of activities have had a strong influence on journalists, policy-makers and opinion-formers.

For a sustained period in the late 1990s and early 2000s, Monsanto's efforts to frame GM crops as a technology that was centrally concerned with development appeared, arguably, to be paying off. The supposed moral imperative to facilitate and encourage the commercialisation of GM crops in developing countries has been invoked relentlessly in the biotech industry's efforts to browbeat European consumers and decision-makers into accepting the technology. While consumers' and environmentalists' attitudes remained hostile and even seemed to harden against GM crops, the biotech lobby's message had much more traction with influential politicians, policy-makers, scientific bodies and official development organisations.

The prominence of the issues of poverty, hunger and development in debates about genetic modification technology probably also owes something to the fact that these claims by the biotech industry provoked such ire among development activists and environmentalists. Thus, through a clash between public relations hype by biotechnology's supporters and angry denouncement by its opponents, the images of smallholder farmers and poor consumers in developing countries

[28] 'Monsanto's "shock and awe"', AgBioIndia Bulletin, 17 April 2003, reproduced in GENET News, 17 April 2003 (http://www.gene.ch/genet/2003/Apr/msg00057.html, 5 June 2008).

– as victims of hunger, as technological entrepreneurs and so on – assumed a weighty symbolic importance in global disputes about the merits and risks of GM crops (Bernauer and Aerni 2007).

8. CONCLUSIONS

Many people assume that Monsanto's energetic promotion of GM crops as a technology to benefit the poor and boost food production is no more than a set of public relations claims that stem from the company's efforts to fight back against the anti-GM backlash that erupted in the late 1990s. Such an assumption is sociologically implausible, if it is taken to imply that the rhetoric of a pro-poor GM technology sprang spontaneously into existence in the late 1990s, more or less fully formed, from a vacuum.

This paper has argued that the rhetoric of a pro-poor GM technology actually has at least some of its roots in the process by which Monsanto effected its eventual transformation from a chemicals and pharmaceuticals conglomerate into an agricultural biotechnology business. In other words, the rhetoric has a much longer history than is sometimes appreciated, and it emerged alongside the development of Monsanto's GM technology itself. This paper has argued that the rhetoric that presented GM technology as a sustainable, environmentally friendly and pro-poor technology emerged from the same set of underlying corporate processes that produced the GM technologies themselves.

Furthermore, the paper has argued that the formulation of the pro-poor GM rhetoric actually played a role in the process of shaping Monsanto's commercial and technological strategy. This was partly because it clothed a situation of technology development that was fundamentally uncertain in the appearance of greater certainty, by creating a storyline which gave a sense of purpose and direction towards a particular goal which, it was argued, would prove to be technically and commercially viable. The rhetoric thus conjured up a set of expectations about the technology, which assisted the coalescence of an emerging corporate strategy by encouraging both Monsanto employees and external actors, especially financial investors, to fall in line with it. It thus helped Monsanto's senior managers to negotiate their way from a starting point of profound uncertainty to a place where they could feel more confident in their directions and goals and, indeed, make those outcomes more likely to come about.

This paper has shown that Monsanto's attention to developing country agriculture, and its rhetoric about the relevance of modern farming technologies – including biotechnology – to the needs of developing countries, pre-dates the late-1990s backlash against biotechnology by many years (as indeed the backlash itself

was rooted in a much longer history of developing opposition to the technology (Schurman and Munro 2006)). The company's representation of GM technology as a sustainable, environmentally friendly and pro-poor technology that would feed the world first appeared in company documents at least as long ago as the early 1980s. Over the next twenty years, these kinds of ideas were further elaborated and promoted within the firm and outside, especially by key individuals like Howard Schneiderman and Robb Fraley. Over the same period of time, Monsanto also became engaged in the promotion of conservation tillage in the developing world, which extended, by about 1990, on a quasi-philanthropic footing, to include a focus on resource-poor farmers in the developing world.

During the same period, Monsanto was also engaged in a long drawn-out process of exploring the implications of biotechnology for its business model. Profoundly influenced by the company's early experiences with con-till, by the mid-1980s the *Roundup Ready* commercial and technical model became cemented into company strategy, but the model did not become a commercial reality until a decade later. Meanwhile, the 'developing countries goal' had been adopted, which began to focus the company's attention more squarely on the commercial opportunities opening up in the developing world. Thus, the commercial-technical strategy and the focus on developing-country agriculture were developing in tandem.

However, the 'pro-poor GM' rhetoric and the commercial biotechnology strategy were evolving somewhat independently of one another. The GM crop technology strategy was shaped during the 1970s, 80s and 90s by various technical, financial, competitive and industrial trends. Among the most important considerations was the need to sustain the profitable life of *Roundup*. These factors had little to do with the needs and priorities of smallholders. Instead, the first generation of GM crop technologies were being shaped around the needs of Monsanto's core markets among large-scale farmers, primarily in the industrialised world.

Nevertheless, the elaboration of a storyline about global agricultural development, sustainability and the challenge of global food security was important in the development of the company's technical and commercial strategies, because it helped Monsanto's senior management to mobilise the resources they needed to drive their technology strategy. It performed this role by helping them to articulate a storyline or narrative that linked the company's history in chemicals, via a present in which careful investments were being made in biotechnology, to a cleaner, greener future in which Monsanto's products would be vital, in-demand tools for delivering sustainable, productive agriculture.

The content of the narrative helped to place developing country agriculture and the needs of smallholder farmers near the centre of Monsanto's business strategy, so that they became key symbolic stakeholders in the development of modern biotechnology and GM crops. This occurred in two ways. First, the vision of a life science company harnessing revolutionary science for the attainment of important human goals, articulated most clearly by Robert Shapiro, implicitly involved poor

farmers and consumers of the developing world as key stakeholders in agricultural biotechnology. Second, the GM crop moratorium in the European Union meant that developing country markets became more important from a commercial point of view, but in addition the anti-biotech backlash also challenged Monsanto to justify its claims about the relevance and value of GM crops in the developing world. The latter imperative gave rise to a strenuous effort to generate and promote good news stories around GM crops in developing countries, as this paper has shown.

In summary, this paper has shown that, although there was and remains a logical disconnection between the types of GM crops that have actually been commercialised by Monsanto, on one hand, and the company's rhetoric surrounding GM crops as a technology for the poor, on the other, the production of both the technology and the rhetoric can be seen to have been produced in tandem, driven and shaped by the mixture of commercial, institutional and technical considerations that were influencing the development of the company's strategy over many years.

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