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"GMO" as Generative Frame: Targets, Choke Points, Coalitions

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Abstract

Genetic engineering has enabled significant – and widely accepted -- innovations in medicine and pharmaceuticals, and promises advances in other fields of human health and industry. However, political opposition to agricultural biotechnology has limited the development and deployment of new traits, cultivars and applications. A global cognitive divide around the construct and valence of "GMOs" has been the mechanism for limiting the diffusion of innovations, and innovation itself. What distinguished the GMO from the non-GMO was the use of recombinant DNA technology to induce novel traits. Lumping and splitting within the construction of the "GMO" as a classification of certain products of rDNA technologies – but not others -- has furthered transnational coalitions protesting the spread of transgenic crops. This cognitive rift extends beyond the sterile debates of science vs Luddism; protestors against GMOs are by no means opposed to technology, but do have strong interests in some technologies and not others. The "GMO" framing of biotechnology has proved remarkably powerful, but its conjunctural nature and development of undermining forces of interests in the global economy suggest it may well prove ephemeral.

Introduction:

Despite globally organized opposition, few innovations in agriculture have spread so rapidly as transgenic crops. Still, we have seen only the tip of the scientific iceberg; pressing priorities include the expansion of virus-resistant varieties, increased yields, bio-fortification of food for poor consumers, substitution of plant-produced targeted endo-toxins for broad-band pesticides and, perhaps most critically, drought-resistant and salt-resistant cultivars. The imperative to develop more versatile and resilient crops for vulnerable farmers and nations is aggravated by the twin global challenges of climate change and sustainability of agriculture. The precision and speed of genetic engineering in comparison with alternatives constitutes an imperative when time and resources are short, especially for the most precarious agro-ecologies [Herring 2007c; Zilberman, Ameden, Qaim 2007].

Slow progress toward these goals is explained in part by interests of commercial firms: as with medicinal drugs, dealing with poor people in poor places and with multi-tiered regulation may produce thin profits. Likewise, intellectual property claims slow technological change. However, obstacles posed by political mobilization against transgenic crops have been more powerful than either.

As crop biotechnology has spread to more countries and has been taken up by more farmers – now exceeding 10 million, most of them in low-income countries -- political interests in its regulation have grown apace. Conceptually, we are approaching a tipping point on global acceptability of transgenic crops in trade; it is unclear which way the balance will tip. With pharmaceuticals this tipping point came early: in that field, rDNA technology is accepted globally; there are no "FrankenPills" on posters. However, political response to similar technologies in crop plants has proved fundamentally different A critical aspect of the way that transgenic crops have been framed is the positing of a special category of plants: "GMOs", which has subsequently led to the structuring of global trade, and, with the segmentation of markets, divided the interests of farmers and nations; conceptually the world divides into GMO and GMO-free.

Much of the current public discourse on genetic engineering targets Luddism or anti-science beliefs as obstacles to our species taking more advantage of genetic engineering and its products. However, this view fails to appreciate that very real interests are also at work. The narrative of a widely successful opposition emphasizes risks – to human health and ecological integrity – and harm to poor farmers, resulting from corporate duplicity and monopoly. Governmental assurances that bio-safety regulations are in place are undermined by the complicity of governments and corporations in historic catastrophes centered on new technologies. Both challenge and response assume that there is something special about the "GMO."

In this paper, after sketching diffusion of agricultural biotechnology, I explore the bases of opposition to transgenic technology and the implications for future applications of the genomics revolution in biology, particularly in the less-industrialized world. The method is to present a picture of stylized facts – in the sense of incomplete, not un-grounded empirically – and draw from these an interpretation of the connection between authoritative framing of the GMO and social protest.

Diffusion of Agricultural Biotechnology

According to the most recent available data, for 2007, 23 countries have officially-approved transgenic crops growing in fields. More than half of these do not fall into the category of "high-income economies." Ordered by acreage, the following list diverges significantly from public perceptions of North vs South in the politics of GMOs: USA, Argentina, Brazil, Canada, India, China, Paraguay, South Africa, Uruguay, Philippines, Australia, Spain, Mexico, Colombia, Chile, France, Honduras, Czech Republic, Portugal, Germany, Slovakia, Romania and Poland. Of political importance for the future of biotechnology is the presence of eight EU countries in this group, led by Spain in acreage. Nevertheless, European acreages are very small, and remain contentious. For example, in January 2008 France unilaterally banned MON810 transgenic maize. Spain immediately objected to this decision, citing the authority of the European Food Safety Authority (EFSA) to uphold their position [*Besana Portalagrario* 2008].

The global acreage and numbers of nations *officially* allowing cultivation of transgenic crops are presented in Figure 1. One must emphasize the caveat "officially"; in these ISAAA data – as in all international institutional data — unauthorized plantings of transgenics are not represented. The extent of these plantings is unknown, but available evidence suggests that it is quite large. The *Agbios* comprehensive data base on transgenic crops [http://www.agbios.com/main.php] does not list, for example, Thailand, Pakistan or Vietnam, yet transgenic crops are widely grown in these countries [pers communications]**.** As a broad generalization, where transgenic seeds in low-income countries have proved too expensive or too highly regulated for easy acquisition, farmers have acquired illicit "gray market" seeds (also known as "brown bag", Creolized or "stealth" seeds), have saved transgenic seeds for re-planting, or have bred their own [Herring 2007b; Jayaraman 2004; Gupta and Chandak 2005]. This pattern parallels the broader global underground economy that flies under the radar of official institutions [Naim 2005].

Another lesson from agricultural biotechnology is that market-driven steering of research and development may bypass critical needs. Transgenic acreage is still dominated by two traits that cut farmers' costs: insect resistance and herbicide tolerance; dominant crops remain soy, cotton, maize and canola. By far the most rapid growth in terms of traits is herbicide resistance, as Figure 2 demonstrates. If technology is to anticipate a more volatile climate with more poor farmers, social innovation in steering mechanisms to drive new areas of research and development is imperative.

Even with severe limitations of available traits, transgenic crops have been accepted by farmers with alacrity – when affordable and available. Availability is still limited in numerous places, many of them the poorest on earth. Farmers have experimented with transgenics, adopted those that prove useful, and have often acquired the technology even at the risk of prosecution. Opposition has come not from farmers, by and large, but from those with much less direct interests in the technology.

Framing: The Peculiar Case of the "GMO"

Some important limitations to the diffusion of genetic engineering applications to agriculture have been driven by the global mobilization of opposition, typically through social movements and international non-governmental organizations [INGOs] or somewhat more ephemeral transnational action networks. To understand the success – and limitations – of opposition, the ideas and interests of groups that are involved in or affected by this opposition need to be disaggregated, and their inter-relationships clarified.

Some interests are straightforward: profits for commercial firms, incomes for farmers, jobs and resources for movement leaders. But many interests must be processed through a cognitive screen that makes sense of the structure around us. Social movement theorists call this cognitive screen a "collective action frame" [Soule 2007; Snow 2004; Snow and Benford 1988; Benford and Snow 2000; Tarrow 1992;.] Frames typically contain elements that are *diagnostic* [identifying problems and causation], *prognostic* [allocating blame], and *motivational* [providing reasons for action]. Mobilization of global coalitions requires both shared collective action frames and a mode of diffusion (Smith and Johnston 2002: ch 1; della Porta and Kriesi 1999; Tarrow 2005). Social scientists attribute considerable explanatory power to such framing when analyzing the success or failure of collective political action.

Science continually presents new challenges to the way interests are framed by citizens, officials and politicians [Herring 2007e]. The discovery and redefinitions of interests in ozone holes and climate change were driven by increasingly authoritative atmospheric science. Interests in biotechnology likewise must pass through a cognitive screen; the science is difficult to grasp, uncertainties remain, and understanding is unevenly distributed within and across social movements. The most general frames have posited either novel threats or technological promise arising from rDNA technology.

One can see the consequences of framing in the behavior of global actors. For example, the Pesticide Action Network [http://www.panna.org/] pursues sustainability through reductions in pesticide use. PAN has two over-riding interests: environmental sustainability and funding itself. Insecticides are not only lethal, but produce treadmills that entrap farmers in poverty [Pray et al. 200] The second-most prominent biotechnology globally is insect-resistance in agricultural crops: maize, cotton, rice, canola, eggplant, soy. Specifically, Bt technology was introduced to reduce pesticide applications in agriculture, which have especially deadly effects on landless laborers in poor countries and fragile agro-ecologies generally [Shelton 2007; WHO 2004]. Bt technology theoretically reduces pesticide applications by enabling plants to manufacture protoxins in their tissues targeted on specific pests. Before there was systematic evidence on actual results in cropping systems, Bt crops were opposed in coalitions of which PAN is a part. Even tests to determine environmental effects were opposed, and sometimes destroyed [Shiva, Emani, Jafri 1999]. Because introduction of the insect-resistant trait into plants involved genetic engineering, the plants were labeled as "GMOs." The utility of the trait – insect resistance – was of no importance; what mattered was how the trait was introduced into the plant. Mobilization against biotechnology began with this decisive framing: one technique for modifying plants was normatively framed as unacceptable, whatever its utility to the farmer or environment.

The master frame of opposition has stressed threats of biosafety and bioproperty introduced by genetic engineering. The *diagnostic* element of this frame identified special dangers from novel organisms: the biosafety problem. In terms of the *prognostic* framing, threats to human health and environmental integrity could not be authoritatively evaluated because of the financial interests and dominance of multinational corporations: this is the *bioproperty* issue. The power of multinationals meant that government science and regulation were as suspect as the self-interested firms. Since safety testing was done under corporate auspices, and MNCs had strong proprietary interests in the technology and its products, the science could not be authoritative. Furthermore, positing of a realm of bioproperty introduced downstream framing of social justice and development. Having claimed their bioproperty, multinational firms would dominate and exploit farmers by using patents and, most alarmingly, "terminator technology" -- gene use restriction technology that in theory renders transgenic plants sterile [Herring 2007a]. The *motivational* frame follows logically: caring for the safety of our families, for powerless victims of exploitation in the third world, and ecological integrity -- all necessitate opposition, perhaps militancy, targeting "GMOs."

None of the framing above differs in any substantial way from the use of transgenic technology in pharmaceuticals with one exception. Huge firms with deep pockets are likely to dominate, they have enormous political clout, they have an interest in scientific testing that they themselves organize, and their intellectual property provides a basis for control. The exception is the so-called "terminator technology": GURT. Terminators proved a dramaturgical success but failed to show up in any commercial crop anywhere in the world. Moreover, GURT is a plausible solution to the most serious ecological risk, if there is one: gene flow to wild relatives of cultivars.

Framing genetic engineering in agriculture as unnatural and anti-developmental proved powerful, but was fundamentally dependent on a prior framing: the invention of a special category of "GMOs." Regardless of trait, event or species, all products of rDNA technology were lumped together into one ominous category. This framing made possible the targeting – and torching -- of "GMO" test plots; campaigns against "GM-food;" or the celebration of and promotion of "GMO-free zones." The framing proved durable and consequential. Regulatory strictures that apply exclusively to transgenic crops have delayed research and development in the private sector [Pray et al. 2007; Paarlberg 2001]. The global biosafety provisions of the Cartagena Protocol – the rules set out under the Convention on Biological Diversity -- set norms for dealing with "living modified organisms" such as transgenic seeds [Convention on Biological Diversity, 2006]. The radical cognitive move is to separate out products of one form of genetic modification – rDNA technology – as belonging to a unique and novel category fundamentally different from those framed by default as natural. Without this cognitive move, there could have been no Frankenfoods and all that followed. The question typically elided is: What is a GMO?

Article 2(2) of EU Directive 2001/18/EC5 [The European Parliament and The Council. *Off. J. Eur. Commun.* **L106**, 1–38 (2001)]
provides the operative definition: "'GMO' means an organism, with the exception of human beings, in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination." The bright line is constituted by the phrase "does not occur naturally by mating… "

The implied natural alternative conjures an image of Gregor Mendel puttering with peas in a tranquil garden; Mendel demonstrated that intraspecific hybridization within a plant species could yield results more to human purpose than random "natural recombination." But the selection intervention is gentle and intra-specific, or at least inter-generic. In the mid-twentieth century, techniques far less akin to "mating" or "natural recombination" evolved in agriculture. Both radiation and chemical mutagens are used to create variants with traits valued by plant breeders. Genetic diversity can also be increased by somaclonal variation; induced polyploidy is sometimes useful. Tissue culture enabled production of progeny from otherwise sterile matings of plants. So-called "wide crosses" of plants that do not normally sexually reproduce were managed: triticale, a hybrid of rye and wheat, is one example. Colchicine has been used to double the chromosome number and thus permit a fertile line to be produced. Embryo rescue has been used to obtain new drought-resistant rice lines across species barriers. Protoplast fusion carried out in an electric field may yield viable recombinants that can be grown up in culture [Winston 2002; Herring 2007a; Fujii, Andoh and Ishihara 2004]. Batista et al 2008 have produced an innovative study that concludes**:** "improvement of a plant variety through the acquisition of a new desired trait, using either mutagenesis or transgenesis, may cause stress and thus lead to an altered expression of untargeted genes. In all of the cases studied, the observed alteration was more extensive in mutagenized than in transgenic plants."[1]All plant breeding yields uncertainties.

To separate out rDNA techniques as the only meaningful form of genetic modification is a political, not scientific move. Transgenic seeds and foods carry the stigmata of this original frame.

Secondly, what could occur by "natural recombination" requires enormous hubris and a constricted time frame. From the point of view of a Silurian era trilobite, the notion of dinosaurs, chimpanzees, whales and kangaroos would have seemed inconceivable as a result of "natural recombination." And yet here we are. That maize might over [enough] time acquire Cry genes from some form of Bacillus thuringiensis by natural means seems impossible only to creationists or those with truncated time horizons; transfer of genes from prokaryotic to eukaryotic species is by no means unheard of in nature [Andersson, J. O. 2005].[2] What "conventional" plant breeding techniques have in common is genetic modification without, and historically prior to, rDNA technology. To mark genetic engineering as the only meaningful form of genetic modification is a political, not biological, move.

Framing molecular breeding as the only meaningful form of genetic modification had political consequences. There was nothing inevitable or conspiratorial about this outcome. The regulatory regime in Europe reflected interactions among firms, industries, public perceptions of risk and institutions of governance in a specific historical conjuncture [Tait 2001; Chataway, Tait, and Wield 2006; Bonny 2003]. Nevertheless, the authoritative cementing of the "GMO" in Europe created opportunities for collective action, and, through the Cartagena Protocol and transnational activist networks, nodes for mobilization across national boundaries.

Disaggregating Opposition: Food and Genetic Engineering

European framings of "GM-food" in particular have contributed to slowing down the global commercialization of transgenics [Fukuka-Parr 2007 26-31;

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[1] See especially Table 1 "Significantly induced and repressed genes (fold change > 2 or < _2) for each experiment" p 3642.

[2] The political rather than biological nature of the distinction seems clear, even to some EU officials in charge of enforcing it [note, Harry Kuyper interview here].

Pinstrup-Anderson and Schioler 2000 Ch 6; Winston 2002 194-213]. However, Europeans themselves exhibit the same dominance of interests over ideology that one sees among farmers growing ‘stealth seeds’. Europeans – especially young Europeans – are no more suspicious of biotechnology generally than are Americans and Canadians [see Tables 1, 2], but “GM-food” remains suspect. Objections to biotechnology in Europe are not to genetic engineering, but to “GM food,” which has no perceived benefits and, perhaps, some as yet unidentified risk. The so-called “white” [industrial] biotechnologies, like the “red” [medical] biotech applications, are widely supported. There is broad support for industrial applications in degradable bio-plastics, bio-fuels, and bio-pharming. More than 70 per cent of respondents in the Eurobarometer 2005 study support incentives to develop bio-fuels and plastics. Even the very controversial “pharming,” whereby pharmaceutical inputs are produced by genetically engineered plants, receive support from more than those opposing it, except in Austria. Consumers even expressed willingness to pay more for bio-plastics and biofuels [EB64.3 24-26; Figures 8,9].

By contrast, few Europeans find reasons to buy GM food. But of the possible benefits recognized in sample surveys, three reasons for spending money on the products of agricultural biotechnology are all plausibly related to interests: less pesticide residue, nutritional benefits, and general environmental protection [EB 64.3 69-71; Figure 32]. The disproportionate European contribution to blocking technology where it is needed the most emanates from successful bundling of all biotechnologies together as “GMOs” for purposes of political mobilization.

Political movements respond to and reinforce frames. Opposition activists found a special niche in “GM-foods, whereas they understood that it was not in their interest to mobilize themselves around banning drugs that involve rDNA technology — Global trade has not been segmented around “GM drugs,” although the use of recombinant DNA technology is common in pharmaceuticals, and indeed much supported by public opinion in Europe [EB 65.3 15-22]. Physicians are for reasons of cognitive consonance treated as authoritative; you have to believe your doctor to submit to treatment. By contrast, authoritative knowledge concerning food is contested. The Food and Drug Administration of the United States has ruled that foods from transgenic crops are “substantially equivalent” to any other food. This view may be incorrect, but it is an authoritative interpretation of the absence of difference [by gross measurement] between transgenic cultivars and their isogenic equivalents. Are foods from transgenic crops "substantially equivalent" to other sources, or sufficiently different to warrant extra caution, labels and a separate regulatory schema? The official European framing on this question has introduced caution into the calculation of interests by consumers, food-exporting farmers and nation-states.

The transition came first in Europe, where enthusiasm for genetic engineering was initially high. Once introduced into trade, "GMOs" quickly became the target of pre-existing coalitions opposing corporate control and irresponsibility, drawing together American and European activists [Schurman 2004; Schurman and Munro 2006]. Europe was profoundly affected; in a few short years in the late 1990s broad support for biotechnology turned into quite effective opposition, despite a limited numerical base [EB 64.3].[3] Both state and farmers in France, for example, originally framed biotechnology as essential for maintaining economic competitiveness; erosion set in with reframing of transgenics in terms of ecological risks, corporate power and threats to culturally validated norms for food [Sato 2007: 47-78; Bonny 2003; EB64.3 51, passim]. Activists drew parallels with discharges of dangerous things that moved mass publics: Chernobyl, Three Mile Island, Love Canal, Bhopal; the idea of genes escaping into the environment resonated deeply with a discourse of corporate irresponsibility and environmental risks. Language is important: transgenic plants are "released;" other seeds are simply planted. The "mad cow" and dioxin scares reinforced the notion that neither government nor their authoritative science could be relied upon to protect mass publics, especially when profits were at stake.

European discourses came to dominate the framing of metropolitan elites in low-income countries through international networks opposing globalization [Madsen 2001; Assayag 2005; Reddy and G. Bhaskar 2005]. INGOs needed authentic voices and faces of the "third world" for their mobilization and funding, local activists needed resources. INGOs then became dependent on their local brokers for information, putting a premium on reports of extreme events that attract media attention and spread through internet connections.

[3] Eurobarometer surveys show that optimism concerning biotechnology fell from 50 per cent in 1991 to 41 per cent in 1999; pessimism increased over the same period from 11 per cent to 23 per cent. From a low point in 1999, the percentage of optimists increased by 2005 to 52 per cent, a figure somewhat higher than 1991; pessimists declined to 13 per cent, just two points more than in 1991.

Vandana Shiva claimed that Bt cotton seeds were "genocidal", and had led to the suicides of tens of thousands of Indian farmers [Shiva 2006; Herring 2006; Shantaram 2005]. Bt cotton leaves were reported to be causing the deaths of sheep, then cattle, in villages of Andhra Pradesh. Such reports motivate activist opposition around the world, independently of their verifiability. The first claim was orthogonal to evidence on the economic utility of Bt cotton to farmers in India; the latter misunderstood the mechanism for the Cry1Ac protoxin's lethal effect on lepidopterans – a mechanism that cannot function in mammalian guts [Narayanamoorthy and Kalamkar 2006; Herring 2007d; Rao 2007]. The validity of claims "from below" is hard to authenticate, and the interests of activists are not served by looking too hard.

Framing and Developmental Interests

The framing of "GMOs" as an authoritatively designated exclusive category of commodities created dilemmas for low-income nations in which the state seeks robust development [Herring 2007d]. With adverse regulation in Europe in the late 1990s, "GM Food" became a distinct category for global trade and market segmentation.[4] Before this emergent market segregation had solidified, developmental enthusiasm for genetic engineering was both proactive and defensive. For example, announcements of projects such as Malaysia's "biovalley" and Indonesia's "bioisland" indicated strong interests of Asian states in biotechnology as a growth sector. Government officials involved in these projects explicitly worried about falling behind a "new breed of super crops" and about "biotech colonization" by China [Barboza 2003 A3].

Development of genetic enginering as a state project slowed with global mobilization against GMOs and increased regulation in Europe. India, Brazil and China have the capacity and size to pursue biotechnology autonomously [eg India 2001], but smaller and more dependent states became cautious. The structural power of European markets, European aid programs, and the dependency effects of colonial ties — reinvigorated by INGOs — proved powerful retardants. This is especially true in Africa, where farmers are in

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[4] Consider the effective use of the label by the leader of India's Gene Campaign in urging Thailand to avoid transgenic rice: "GM tag for Thai jasmine rice 'is unwise'" SUMAN SAHAI Bangkok Post, March 8 2008
http://www.bangkokpost.com/News/08Mar2008_news18.php

most desperate need of improved technology [Paarlberg 2008 Ch 4]. Through these mechanisms, interests became structured by the opposition's success in framing as threatening some products of rDNA technology but not others, some forms of moving DNA around plants but not others. To protect export markets from the GM stigma, nations are slow to acknowledge that their farmers are growing unauthorized transgenic crops – consider Brazil before 2002 or Thailand after 2004 [Herring 2007b; Davidson forthcoming].

Although the international coalition against "GMOs" had much in common with their local partners in opposition to corporate globalization, the ideology was too general to fit local conditions. A framing of biotechnology as a creature of multinational corporations with hegemonic intentions -- "biopiracy" and "monopoly" -- resonated in countries with deep memories of colonial control and acute realization of inferior position in the hierarchical global economy [Shiva 1997]. But the power of this narrative proved uneven on the ground. Mobilization against Bt cotton in India via "Operation Cremate Monsanto," for example, completely failed. No amount of alarm about the evils of Monsanto, nor "suicidal" or "genocidal" seeds, could counter the interests and field experience of Indian farmers [Naik, Qaim, Subramanian and Zilberman 2005; Shiva et al. 2000; Herring 2006; Roy et al 2007; Jayaraman 2004; Stone 2007]. On the ground, there was reverse biopiracy, intense competition among seed sellers and rapid adoption by farmers of all size classes: ie, the absolute antithesis of monopoly and concentration. The fate of this campaign reflected the deep disjuncture between the ideas and interests of global activists and farmers they claimed to represent.

One would think that sticking with extreme claims that proved untrue on the ground would be irrational for social movement organizations. How can you represent farmers when your narrative of agriculture is completely inconsistent with farmer understandings and experience? The answer is that audience and life-lines are is not local but distal. "Sheep death," for example, is reported in a distal district by mobile shepherds mediated through local NGOs, publicized by state-level NGOs who fund them; the phenomenon eventually enters the political and policy stream via INGOs that fund national and state-level organizations [Shantaram forthcoming; Rao 2007]. This outcome is biologically impossible, as recognized by regulatory institutions in India, does make a splash in the network's media.

Reports from Europe that rely on “local knowledge” then reverberate back as authentic knowledge ratified by London or Berlin.[5]

Positing a tyranny of monopoly and patent-control proved inconsistent with farmer ingenuity and institutional capacity in countries with large agricultural populations. Intellectual property in seeds, for example, has proved difficult to claim or enforce. We have seen in the fields opportunistic appropriation of useful technology, akin to that of intellectual property rights [IPR] on films, pharmaceuticals, music, and software [Herring 2007b]. Simultaneously, the monopoly and patent critique did not appreciate new institutional arrangements that have arisen in response to biotechnology. Humanitarian use transfers loosen the property nexus for low-income farmers and countries [Lybbert 2003]. Globally the sphere of open-source technology has grown; in some countries, public sector research and firms have been active in biotechnology [Cohen 2005]. Universities have produced important breakthroughs – eg the transgenic virus-resistant papaya of Cornell University and the University of Hawaii [Gonsalves, Lee, and Gonsalves 2007; Davidson 2008]. Moreover, we must remember that even though such traits as Bt insect resistance were created with profit in mind, seed technology is almost perfectly divisible; even the smallest farmer – or especially the smallest farmer – benefits from cheaper and more effective pest control.

In the global movement, “terminator technology” framed transgenics as hideously unnatural – seeds that could not reproduce, a biocultural abomination [Gold 2003; Ramanjaneyula and Ravindra l999, ETC 2007]. Gene-use restriction technology (GURT) provided opponents with perhaps their most powerful dramaturgical tool; the technology itself was not commercialized, in part because of political opposition. This framing, however, outran the technology; to date, there is no parallel in seeds to copyright protection built into DVDs, music, and software. It is still possible that the Terminator — so important historically to mobilization against genetic engineering — will someday make an appearance in farmers’ fields. Ironically, GURT offers a biological solution to the as-yet uncertain environmental risks from gene flow [Thies and Devare 2007], whereas social institutions have proved leaky [Jayaraman 2001]. Nevertheless,

[5] We found that both in the matter of sheep death and the Eenabavi “GMO-free” Zone, we often had more “information” than people in the district itself. This outcome is a function of our embeddedness in international media and the internet.

successful framing of GMOs as more dangerous than other plants has had structural effects helpful to diffusion of movement tactics. Though often ineffective and costly, bio-safety institutions have constituted nodes for mobilization, even veto points, for opponents of genetic engineering. Here the frame selects for a mode of tactical diffusion that has been expecially effective. Moreover, difficulties in creating these institutions – whether for lack of capacity or political opposition -- slow adoption of biotechnology and direct interests of firms toward other sectors and places [Pray and Naseem 2007; Paarlberg 2001].

Framing and Social Protest -- Preliminary Discussion:

The preceding argument is that the GMO frame is political rather than biological; nevertheless, this authoritative framing has consequences for diffusion of the technology and for income distribution across and within nations. The frame proved powerfully generative, but also, it can be argued, conjunctural. The frame generated targets, sub-narratives and data: without the GMO, there could be no "GM-food," nor "GMO-free zones," nor global and national biosafety institutions. There would be no "living modified organisms" to generate transaction costs and targets from the Cartagena Protocol. There would be no jobs with "GM Watch" nor any necessity of "Bija Nigrani Samithi" [local seed surveillance committees]. The presumed special safety concerns of "GMO crops" favors large firms with deep pockets and testing expertise -- multinational life science corporations – as well as a global tactic of burning test crops in the field. These constructions provide not only focal points for collective protest, but also in the case of biosafety institutions choke and veto points.

We can flesh out these effects by looking to Sarah Soule's [2007] overview of theories of social movements, while not prejudging the empirical question of claims to social movement status. We find empirically that much of the claims to social movement status, or "civil society organizations" etc. is more aspirational or propagandistic than real. Many SMOs turn out to be several people with a server and social connections. Moreover, some of the most powerful social-protest actors – Greenpeace, e.g. – are coalitional transnational activist networks which must theoretically have somewhat different characteristics than do social movements [Tarrow 2007].

Strain Theories:

Globalization was seen as a threat in the mobilization around GMOs, or at least a producer of systemic uncertainty. It is clear in the literature produced by NGOs in India that a Polanyi-esque anxiety was centered on dislocations from extensions of neoliberal institutions and market expansion – by scope and scale [Madsen 2001]. The framing of globalization as first and foremost a matter of enhanced corporate power and consolidation enabled the connection of the Bioproperty and Biosafety sub-narratives of the GMO. The mechanism for the former – a means to enforce property claims – created a powerful dramaturgical fiction – Terminator Technology.

Opposition was constructed explicitly in terms of *threats*: threats to national independence, in the form of dominance of agriculture by multinational corporations; threats to farmers, in the form of bondage to monopoly seed corporations ["bio-serfs," "neo-feudalism"]; threats to nature, in the form of "biological pollution" [gene flow]; threats to human health, in the form of undiscovered allergens. The threat was global because the vector – MNCs – were global. The globalization framing allowed for significant lumping rather than splitting: all GMOs do the same things, are owned by the same people, carry the same threats. As discussed above, this closure prevented coding say Bt cultivars as contributions to sustainability and pesticide reduction: a GMO is a GMO.

Collective Action Frames:

Responses to the GMO as a component of anxieties in globalization are usefully separated by diagnostic, prognostic and motivational elements, as Soule and the literature suggest.

Diagnostic: Technology, beginning in 1973, had created a new entity and it was a problem. "GMOs" had special characteristics; they are different from organisms that we have previously dealt with. Uncertainty derives from the unnatural origins of these organisms. Moreover, since 1980, property in these biological inventions has been possible, raising possibilities of monopoly under hegemony of the United States, the global promulgator of strong property rights.[6] The clear presumption and implication of the global Cartagena Biosafety Protocol[7] is that there is something dangerous,

[6] On food, note that the GMO frame is directly obverse to the substantial-equivalence frame of the US FDA, which regulated "GM foods" separately from insect-resistant crops. The more disaggregative US frame did not carry the authority of Europe – after 1999 -- and transnational networks.

[7] Passed in 2000, came into force 9-11-03.

something different from “food” that presents a problem to all countries in the world.[8]

Prognostic: Because of both patents and terminator technology, GMOs are controlled by MNCs, which are driving corporate globalization. Moreover, because GMOs are created by and owned by MNCs, effective regulation – or even objective assessment -- is impossible. MNC science is self-serving and not to be trusted; MNC political power renders Government science untrustworthy as well. The regulatory frame of the United States will come to dominate globally unless contested. Loose regulation in the US is a reflection of corporate power; assurances of regulation are self-serving. This linkage ties GMOs to threats of neo-colonialism and exploitation.

Motivational: Extreme threats to our values necessitate action: Ban the GMO outright, stop the field trials, demand rollbacks. Motivation requires recovery in terms of universal valents: biodiversity over biological reductionism; self-reliance in place of subordination to foreign market power; safety over uncertainty and risk; the natural over the unnatural.

In combination, these elements produced a coherent and powerful narrative of great threat. Addition of the terminator theme both highlighted the claim of un-natural acts of creation – which played better in England than in China or India – and a mechanism for bondage: bio-serfs [farmers] were part of the narrative. Monsanto provided a target that diffused rapidly, eg through Citizen Tribunals in which the corporation was tried *in absentia* and convicted with extensive press coverage. Monsanto was a convenient condensation symbol and was held to control Bioproperty in the Terminator – both claims false but effective.[9]

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[8] Even though the Protocol is premised on the environmental threats of transgenics, it explicitly mentions questions of “food safety” as well. Article 10.6 and 11.8, explain the privileging of risk over science: "Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of an LMO on biodiversity, taking into account risks to human health, shall not prevent a Party of import from taking a decision, as appropriate, with regard to the import of the LMO in question, in order to avoid or minimize such potential adverse effects."

[9] I have taken to asking audiences when I lecture on these topics how many people think Monsanto invented and deployed the Terminator Technology. Even in educated audiences, the belief the “GMO” seeds cannot be saved and bred by farmers is widespread.

Resource Mobilization:

As Schurman [2004] and Schurman and Munro [2006] document, the GMO entered world history at a stage when transnational social networks opposed to corporate power and environmental irresponsibility were connected and strong. Such networks offered at least some level of skills, personnel, finances and legitimacy. Major players such as Greenpeace needed local brokers to legitimate their global claims, and local brokers needed the resources of Greenpeace. Moreover, Greenpeace international was able to deploy authoritative knowledge – ironically from former colonial powers [Paarlberg 2008 Ch 4]. In return, the TAN enhanced its claims to authority and legitimacy through dissemination of knowledge "from below."[10] Increasingly, NGOs seem to be tapping into large sums of money from international development agencies and bi-lateral donors, as well as traditional INGO sources. For India, I would argue that the opposition to GMOs would collapse without these external props.

Political Opportunity Structure:

The GMO frame has not only found an opening in the international mobilization against environmental degradation and for sustainability, but has created its own mechanism for opening niches in political systems in nation-states around the world. The Cartagena Protocol on Biosafety, as a supplement to the Rio Treaty [Convention on Biological Diversity] was a victory for global opposition to transgenic agricultural crops. The Protocol slightly modified the Genetically Modified Organism into the "Living Modified Organism," but followed the same lumping strategy of Europe, as opposed to the splitting logic of the United States. It provides focal points and veto points for mobilization. It links environmentalists with GMO opponents, though there is no necessary connection there, and mentions ominously in passing concerns for "human health." As legislation is extremely difficult to legislate for conflicts of interest[11], setting up the institutions mandated in the soft law of Cartagena blocks resolution of the status of "LMOs" – ie GMOs. Moreover, every step of establishing these institutions can be challenged in court. The absence of laws and institutions

[10] An example of the phenomenon is [Assayag 2006?].

[11] E.g. between the Agriculture Ministry and the Environmental Ministry; on Brazil, see Herring 2007b]

has meant delays in official authorization of GMOs, though farmers are not always so legalistic.[12]

***Diffusion and Network Theory*:**

It is no surprise that the internet is the backbone of the diffusion of tactics, knowledge and motivational appeals of social protest against the GMO. Highly resonant reports from the field increase the legitimacy of the narrative. Nodes of authoritative knowledge become easily accessible locally. Websites also become products to convince funders and donors that good works are being done. Press releases permit cross-fertilization of media in different sites, multiplying incidents [eg dead sheep] as they go; media reports from local press then feed international coverage, lending an air of authenticity to the knowledge thus displayed. A fundamental difference from the social movement historically is that huge impact can result from very few actual activists; some "civil society organizations" are essentially single individuals in search of a job. Websites can aggregate far-flung experts to appear as one organization, producing counter-knowledge: eg the Independent Science Panel in London. To play in the international game of persuasion, mobilization of scientists and studies becomes more prevalent, even if many of the studies are not only not peer-reviewed but difficult to find, beyond their web-citation.

Lumping, Splitting, and Limits to Framing:

The GMO frame has been phenomenally successful. It succeeds in bundling all the novelty and uncertainty involved in rDNA technology minus the widely recognized benefits. The encompassing frame facilitated diffusion and solidarity of knowledge claims across the globe; its embeddedness in new institutions produced powerful effects in structuring interests globally. But the framing itself may well prove conjunctural and ephemeral, as the configuration of interests is changing rapidly.

To argue that the frame's power was conjunctural, we have to make predictions about the tipping point alluded to earlier. As the political terrain has shifted, outright opposition to biotechnology is looking more and more futile.

[12] Herring, investigation in Vietnam, July 2007 found wide-spread use of Chinese Bt cotton smuggled across the border when the state proved incapable of providing biosafety institutions, primarily because of opposition of the environment ministry.

Opposition to genetic engineering globally has been selective and interest-driven. Only some products of recombinant DNA technologies have been targeted by transnational activist networks: crops, or “green” biotechnology. The so-called “white” and “red” biotechnologies [industrial and medical respectively] have been normalized, just as the United States Food and Drug Administration has normalized “GMO” foods as “substantially equivalent” to their non-GMO counterparts. The rational/scientific basis for special treatment of “GMOs” is very thin and limited in scope to certain traits and events; all contemporary agricultural plants have undergone genetic modification and all create potential consequences for human health and environmental integrity. Mutagenesis, for example, as a tool of “conventional” plant breeding seems capable of producing more genetic alteration of the plant than transgenesis [Batista et al 2008]. It is increasingly clear that the collective action and regulatory frame of “GMO” is a political, not biological, construction. One then has to ask: what is its political base? Where is political opposition emerging?

First, the consequences of category lumping where splitting makes more sense are developmentally significant. Consider as an alternative a focus on traits, where the main interest is utility. The Agbios data base [http://www.agbios.com/main.php] lists as already commercialized globally 14 traits; 45 different transgenes representing 117 unique genetic events have been inserted into 22 crops. The permutations of these variables are huge. Commercialized traits reach far beyond the insect resistance and herbicide resistance that are most common in transgenic crops. Nutrition -- fatty acid composition, e.g. – and disease -- virus resistance, for example are traits more immediately recognized as valuable than herbicide-resistant grass for golf courses.

Though political discourse has been about lumping together all these permutations as “GMOs,” there is an alternative construction based on disaggregation for assessing transgenic crops. One could – and biologically should -- disaggregate by traits, events, or crops in terms of benefits, risks, regulation. The covering term “GMO” lumps these relevant differences under one rubric – based on the criterion of means of inserting the trait – which may well not be the most important question. For example, it is reasonable to ask whether herbicide-resistant crops reduce field labor demand and thus wages of very poor people, or encourage more herbicide application, or threaten field biodiversity; but the same questions are not relevant for virus-resistant transgenic plants. The only thing these two cultivar types have in common is how the trait got into the plant. Yet it is the trait itself that has phenotypic consequences and is relevant for assessment. The risks of herbicide-resistant cultivars, and the agro-ecological consequences, are the same whether the trait is introduced by "conventional" breeding or rDNA techniques.

The GMO-lumping through a widely successful frame then serves political ends but not policy ends. The frame itself is a construction and distinction consistent with utility – and interests – of a global cosmopolitan middle class that needs neither higher yields in their fields, nor cheap food nor biofortification, but may well need pharmaceuticals, where genetic engineering has been universally accepted. There is strong cognitive consonance at work here, deriving from the authoritative knowledge of the medical profession and the manifest interests of patients.

Supposing this rationalist account is accurate, what difference does it make? To take a counter-example, regulation of "minerals" distinguishes radioactive from non-radioactive minerals; the former pose significant risks and are heavily regulated. There is science behind this distinction and a reason for the distinction, as well as non-controversial tests to tell the difference. The same could be said of "poison" – which indeed was the characterization of "GMOs" by some nations in Africa during the famines of 2002 [Herring 2007a; Paarlberg 2008]. Regulatory costs and externalities of regulation can be justified and are inter-subjectively shared in mass publics with regard to "radioactive materials" and "poisons." If the USDA is right about "substantial equivalence," the "GMO" frame is a distinction without a difference, and the downstream consequences will eventually come up against compelling normative interests in food and agriculture, as they already have in genetic engineering in medicine. Moreover, the frame itself creates a niche for brokers and salaried employees in the global regulation, education, mobilization activities around "GMOs" – i.e. there are material consequences of the framing, but beneficiaries are sharply divided by class from losers. As a result, TANs and SMOs moved to do two things. First, they came to stress a new frame that is positive rather than negative: promotion of what was framed as an alternative to "GMOs:" i.e. "organic agriculture." The dichotomy is important, because again it is again not at all obvious that the distinction makes sense behaviorally.[13] Second, opponents moved to provide projects focused on "education," which was often a thin cover for opposition, but more resonant with European notions of transparency, democracy, and knowledge-based citizen activism.

Europe has been the linchpin of the global opposition to transgenic crops, particularly from a resource mobilization perspective. Attitudes in Europe are changing, among both farmers and mass publics. As a materialist perspective would predict, the reasons have to do with interests and their perceptions. The younger Europeans are, the less their negativity even about "GM food." To the question of under what conditions they would buy foods from transgenic plants, the under-25 set gave 61% positive responses "if more environmentally friendly"; 61% if food "contained less pesticide residues;" and 67% "if healthier." All these outcomes are feasible, some already demonstrable. Moreover, those involved in research and development of biotechnology (scientists and industry) "attract growing public trust, some of their critics in environmental groups appear to be losing the confidence of the public" [EB 64.3 47; Table 9]. In a sense, the strong path dependency that resulted from the European U-turn on molecular plant breeding in 1999 was a conjunctural lucky hit for mobilization against the "GMO." Bhopal and Chernobyl resonated with the metaphor of "release," coupled with mad cow, dioxin, and other instances that eroded trust in government and science. That the lumping of loss of trust and material interests skipped over bio-pharmaceuticals even in this period reflects the power of interests and authoritative knowledge in limiting framing.

If this material-interest based assessment of the limits to framing[14] is accurate, the future may well look different from the past. Global mobilization against genetic engineering in agriculture has slowed

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[13] See Devparna Roy's work [To Bt or Not to Bt] on organic farmers' acceptance of transgenic cotton in Gujarat by coding it organic – since it remained free of external chemical inputs but was more effective in defeating bollworms, because of the pro-toxin of Bt. Roy 2008? Publication pending.

[14] EB64.3 p 27-8 concludes that their European data show a calculation in which utility is dominant but discounted by considerations of risk and morality. "Europeans support the development of nanotechnology, pharmacogenetics and gene therapy. All three technologies are perceived as useful to society and morally acceptable. Neither nanotechnology nor pharmacogenetics are [sic] perceived to be risky. While gene therapy is seen as a risk for society, Europeans are prepared to discount this risk as they perceive the technology to be both useful and morally acceptable."

innovation and diffusion of technologies, but for reasons that do not predict future constraints. First, it is primarily the ideational construction of “GM food” that has been effective politically. Biomedical applications are manifestly in the interest of consumers; there are no campaigns against FrankenInjections, nor for Pharmaceutical-free zones. Second, successful opposition has been in formal-legal institutions, not in the fields of farmers, where direct interests have outweighed ideology. More and more farmers, in countries rich and poor, have material interests in biotechnology [Figure 1]; they have proved ready to lobby for transgenic crops or grow them without authorization [Herring 2005]. Third, rising international powers such as China, India and Brazil see biotechnology as a growth sector. Because there are competitive advantages to biotechnology in agriculture, national interests are likely to push against formal-legal restrictions implemented by a sub-set of the wealthier nations. Furthermore, we may anticipate that urgent crises will over time create or make more manifest distinct interests in such fields as bioremediation, biodegradable plastics, drought-resistant plants, and biofortification of food for those who cannot afford dietary discretion [Bouis 2007]. Framing has great power, and the GMO frame has proved generative: productive of political coalitions, collective action, government policy, market segregation and institutional change. But the bifurcation of transnational mobilization empirically has shown that it is not recombinant DNA technologies that are opposed, but rather soft targets of a limited niche: food among some well-fed consumers.

Normative Conclusions:

It is unclear how the global balance of forces contesting biotechnology will tip; the previous analysis suggests a shift away from Europe, even in Europe. But either way, there is serious risk to some already vulnerable groups globally. Agriculture will almost certainly be stressed by climate change beyond anything we have seen historically. The poorest farmers have the least capacity to adjust. For them, the worst case scenario would be a transgenics divide similar to the digital divide: technology lowers the cost of production for those with access, but leaves those without access at an even worse competitive disadvantage [Lipton 2007]. Some governments are denying this technology, some are trying to deny technology but ineffectually, and some governments are promoting rDNA research. As biofuels take up more and more crop land, and prices of grains rise, poor consumers will lose unless there are countervailing dynamics to raise productivity and address biotic and abiotic stress of field plants. The

Nuffield Council rightly stressed the ethical obligation to use technology to alleviate human suffering wherever possible [Nuffield 1999]. This obligation falls particularly on those privileged by accident of birth, who have been the main proponents of blocking diffusion of recombinant DNA technology.

The ethical problem for opponents to transgenics is Rawlsian. That is, opposition is not a politics of Luddism – all participants gladly accept advances in digital technologies, for example, indeed depend on them. Nor is it a politics of risk. Suppose we frame computers, software and cell phones as electron manipulation technology, or EMT. There are enormous risks in this technology, though one would recognize variation: cells phones are presumably less risky than digitization of national accounts, stock ownership, medical records, air traffic control patterns, terrorist watch lists and personal data of all kinds. What if new viruses destroy both internet and data storage facilities? And yet the whole apparatus of EMTs raises remarkably few fears [except among software professionals], certainly no global movements. There is no comparable threat even conceivable from "GMOs," which have spawned both fears and movements. One must then ask about the interests and ethics of mobilization against GMOs but not EMTs. The former has proved of interest to poor farmers, but not of high-income consumers. The latter is vital to the cosmopolitan middle class, but only marginally important to poor farmers. The case for pharmaceuticals is even more striking. It would be impossible to argue from an original position behind Rawls' veil of ignorance that the preferences of the well-fed and comfortable should dominate those of the more numerous and vulnerable.

For conscientious citizens of the "first world," the first obligation is recognition that our political preferences have powerful influences on decisions in parts of the world where the options are fewer and less attractive. If European aid programs and global civil-society organizations are to press their preferences in low-income countries, they have an obligation to get the empirics right. This obligation is most apparent when information about places remote from their experience is so misleading, filtered through frames that rely on brokers with strong ideological screening. Would the Pesticide Action Network be so opposed to "GMOs" if the evidence were widely available on pesticide reduction through Bt technology, for example? Given that farmers have adopted transgenic technologies in droves, how plausible are reports that they continue to replant seeds that failed them and are destroying their health and environments? Would they feed their sheep poisonous leaves? Who is going to find out?

To know these things is demanding. Certainly the relevant natural science and social science are frequently unavailable to mass publics, and difficult to vet even for the conscientious observer. Those of us in the relatively privileged world need to shed the cultural blinders that come with distance. Had mobilizers against agricultural biotechnology had more respect for the rationality and agency of farmers in poor places, they might well have avoided egregiously erroneous constructions of their interests. What we learn from this history of activism is the political power but cognitive numbing of the GMO framing. Disaggregation is critical – more splitting, less lumping: what traits, what cultivars, where, under what conditions? Only with this knowledge can the species devise steering mechanisms more effective than the blunt force of profit.

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Figure 1: Global Diffusion of Transgenic Crops, ***by Area***: 1996-2007

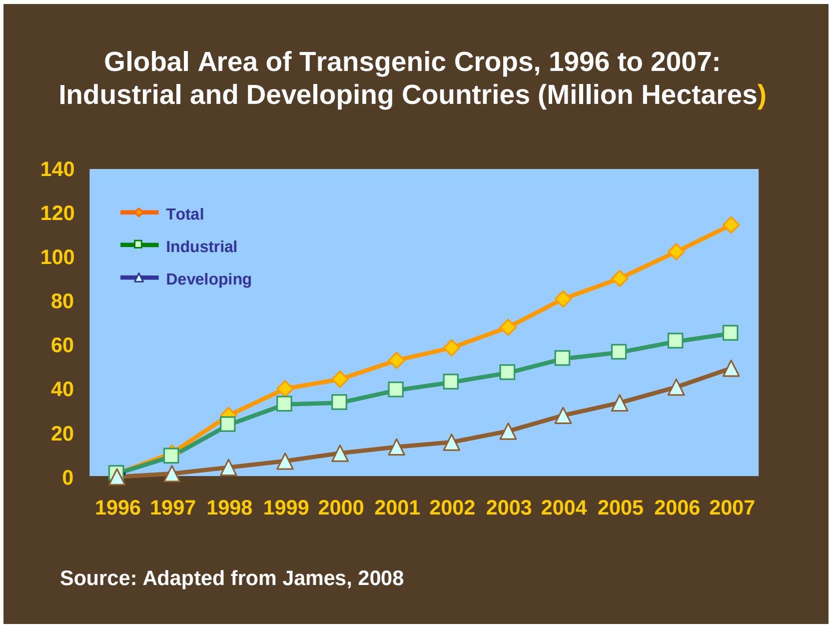

Figure 2: Global Area of Transgenic Crops ***by Trait***, 1996-2007

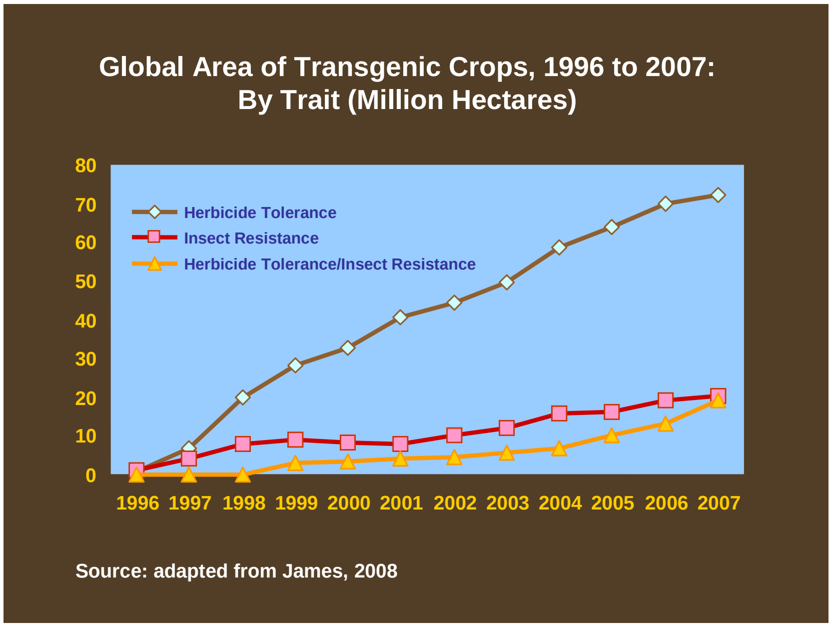

Figure 3: Transgenic Divide Globally:* *Adoption Across Richer and Poorer Countries, Transgenic Crops in Mln Hectares 1996-2007

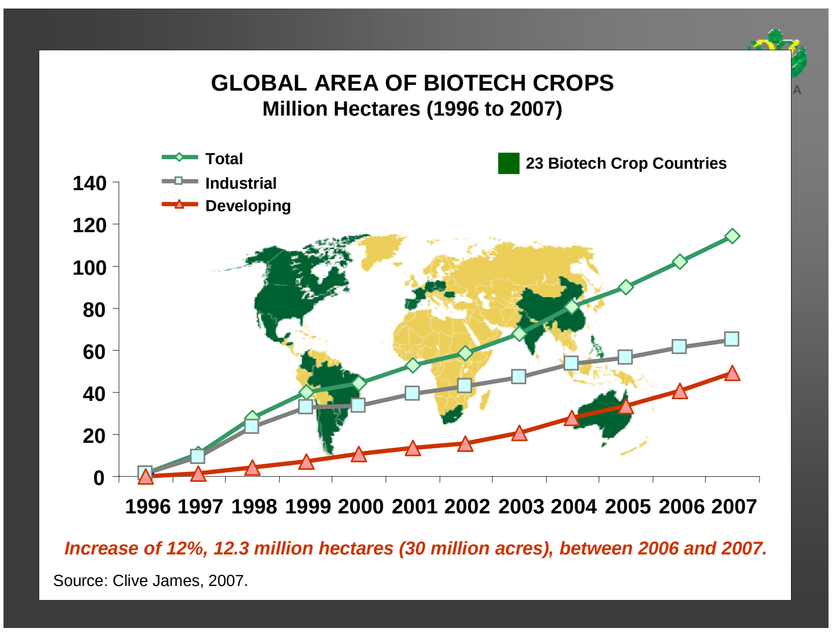

Table 1: Optimism Concerning New Technologies

Do you think each of the following technologies will improve our way of life in the next 20 years?

	% Europe	% US	% Canada
Computers and IT	82	86	83
Biotechnology	75	78	75
Nanotechnology	70	71	68
Nuclear Energy	37	59	46

Adapted from Table 14, p 83, EB64.3 2005

Table 2: Approval of "GM food" and Nanotechnology*

	Europe %	US %	Canada %
GM food	45	61	53
Nanotechnology	76	81	81

Adapted from Table 16: EB 64.3 p 84; *Percentage Expressing unqualified and qualified approval

Source in full: George Gaskell*, Sally Stares, Agnes Allansdottir, Nick Allum, Cristina Corchero, Claude Fischler, Jürgen Hampel, Jonathan Jackson, Nicole Kronberger, Niels Mejlgaard, Gemma Revuelta, Camilla Schreiner, Helge Torgersen and Wolfgang Wagner, July 2006. "Europeans and Biotechnology in 2005: Patterns and Trends," A report to the European Commission's Directorate-General for Research. Final report on Eurobarometer 64.3. EU Commission. Brussels.