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Illicit Seeds: Epistemic Brokers and the Politics of Property in Genetic Engineering[1]

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Abstract

The global political rift around agricultural biotechnology ["GMOs" in political use] hinges on two inter-related dimensions: *bio-property* and *bio-safety*. Genetic engineering in agriculture has enabled new claims of intellectual property in seeds, leading to conflicts over what can be owned, by whom, under what conditions. Firms seek strong intellectual property, relying on claims of novelty and utility parallel to patent claims. Claims of novelty, however, reinforce a second dimension of contention: if novel, might products of genetic engineering raise special risks in comparison to other cultivars? Political framing of "GMOs" as risky products created global soft law for special regulation, in response to transnational advocacy politics. Both property claims and bio-safety regulation increase incentives for emergence of underground seed markets, where evasion of both regimes is possible. Contraband, "gray-market," "brown-bag," or "creolized" transgenic seeds diffuse widely beneath the radar of both firms and states in a global pattern about which little systematic is known. Stealth transgenics build on rural grass-roots challenges to formal intellectual property claims, and simultaneously constitute continuous challenges to states' bio-safety claims of special regulatory authority and capacity. Illicit seeds render problematic conventional wisdom on the extent of diffusion of transgenic technologies, income-distribution effects of intellectual property claims and the effectiveness of bio-safety regimes. Successful demands for stronger regulation of transgenics on grounds of bio-safety ironically strengthen property-like rights of multi-national firms that find it difficult to enforce their property claims in any other way. Bio-safety regulation is a functional substitute for bio-property; the contradiction in oppositional politics is un-noted. This essay relies mostly on field work in India.

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[1] Paper presented at the American Political Science Association Annual Meetings, Toronto, August 26, 2009. Slight change in title from that in the program is meant to avoid confusion with a publication now in press, Herring and Kandlikar 2009. This paper does not reflect Kandlikar's participation, though it does benefit from collaboration on the related paper with a similar title.

Miracle Seeds and Suicide Seeds: Contentious Knowledge Claims

"I blame GM crops for farmers' suicides." His Royal Highness Charles, Prince of Wales October 5, 2008

Why would Prince Charles famously declare that farmers commit suicide because of "GM crops?" The declaration seems at first blush counter-intuitive: famers have adopted transgenic crops rapidly and widely over the last twelve years where affordable and available [Herring 2008a]. In much of the world, farmers have purchased new seeds at premium prices, mobilized politically for access to biotechnology, and frequently have planted illegal "stealth" seeds even at risk of prosecution [James 2008; Jayaraman 2001; Joshi 2003; Herring 2007b; Herring 2009a]. Few if any innovations in agriculture have spread so rapidly. Why would people whose livelihoods depend on planting the right seeds select ones that are driving their neighbors to suicide? Why would rural people, who are typically disadvantaged in formal-legal institutions, take risks entailed in illicit seeds without expectation of significant reward? We think of diffusion of illicit drugs as an understandable risk for reward calculation. Moises Naim [2005] subtitles his book *Illicit:* with a strong claim: *How Smugglers, Traffickers and Copycats are Hijacking the Global Economy.* Illicit seeds fit into a pattern of resistance to global property regimes – and in the case of transgenics, soft-law bio-safety regimes as well -- but the question then becomes doubly puzzling: why would farmers participate in illicit activities that eventually end in suicidal catastrophe? Does global diffusion of illicit agricultural biotechnology indicate false consciousness on the part of farmers? Are they duped? innumerate? Incapable of learning?

Prince Charles did not concoct his conclusion from whole cloth, nor is he alone in his outrage over the continuing holocaust of poor farmers at the hands of GMOs. Wide-spread anxiety and outrage drive a politics that has divided the world into "GMO-free" and "GMO-friendly" nations, counties, departments and farms. The great puzzle is the divide between farmers' action in pursuit of illicit seeds and the political construction of that pursuit as irrational. More puzzling still, the catastrophe construction has great political power driven by very small numbers with no material interests in agriculture, in contrast to the millions of stealth farmers with direct material interests in agriculture. This essay argues that the successful politics of opposition to biotechnology on a global scale derives from

multiple authoritative knowledge claims diffused within transnational advocacy networks. Both elements are critical: diffusion could not happen without the networks, and the content of the political attack on transgenics could not have power without authoritative knowledge claims about agricultural biotechnology. The suicide narrative is specifically linked to intellectual property; its common features include monopoly pricing, dependency, debt and agrarian crisis: in short, "bio-serfdom" and "bio-feudalism" – the subjugation of the peasant to IPR regimes. This *bio-property* narrative is functionally related to a critique invoking *bio-safety*: if rDNA seeds are novel enough for patent protection, are rDNA seeds not novel enough to be especially risky? These two strands – bio-property and bio-safety -- are linked in global resistance to the "GMO" [Herring 2008a]. The single most politically efficacious culmination of this merger is Terminator Technology, or "Monsanto's Terminator gene" that renders second generation seeds sterile.

Networks opposing biotechnology have succeeded in much of the world through diffusion of powerful knowledge claims around bio-safety and bio-property. Unlike control of international air traffic or infectious diseases, no authoritative knowledge provides consensual norms for products of genetic engineering [Jasanoff 2005], nor is there any consistent property regime. Some nations have approved or promoted biotech crops; many others prohibit them. "GMO-free zones" continue to expand; moratoria on the technology are contested from India to California, Poland to Japan. Contention around the GMO diffuses through international institutions: the World Trade Organization, the *Codex Alimentarius*, the Cartagena Protocol, the United Nations Development Program, the European Commission and the Food Safety Authority. Though much of the political discourse poses a North-South architecture of contention resonant with a property-centered critique of global development, the axis exhibits neither income nor areal clustering. The top five nations utilizing transgenic crops after the United States are Argentina, Brazil, India, Canada and China [James 2008]. The three most recent countries to legalize transgenics are Slovakia**,** Burkina Faso and Egypt. In both promotional and oppositional networks, epistemic brokers are central actors. Who could support diffusion of transgenic technology if it in fact kills farmers by the tens of thousands?

Threats from Plants: Epistemic Brokers

The threat construction of the GMO in transnational advocacy networks [TANs] connected two strands of bio-property and bio-safety: 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" [horizontal gene flow]; threats to human health, in the form of undiscovered allergens.[2] Resonance of anxieties around both bio-safety and bio-property was conditioned by fears of neo-colonialism. Intellectuals in the ex-colonial world made critical contributions to theorizing genetic engineering as especially catastrophic for development [Shiva 1997]. These networks were led by international non-governmental organizations [INGOs] such as Greenpeace International and Friends of the Earth International. INGOs carry considerable authority; their imprimatur ratifies authoritative knowledge about a topic of considerable cognitive obscurity to brokers in the periphery. For example, Mae-Wan Ho's book *Genetic Engineering* [2000] posited "serious hazards inherent in the technology." The author is identified as a British scientist and Fellow of the US National Genetics Foundation. Her book's sub-title query -- "Dream or Nightmare?" – was answered decisively on the nightmare side. The sub-subtitle is: *Turning the Tide on the Brave New World of Bad Science and Big Business.* The Appendix contains two calls to action: *Global Moratorium on GE Biotechnology* and *No to Patents on Life*. As a cover endorsement, the publication *Earth Matters* from Friends of the Earth states:

> "The battle to stop genetic engineering is nothing less than a struggle for human freedom itself. Mae-Wan Ho's book provides excellent ammunition for us all."

The "ammunition" in Ho's book claims the authority of science. The appendix contains the text of a *World Scientists' Statement* "signed by more than 100 scientists from twenty-four countries [p299]." Included in this statement is reference to transgenic potatoes that reportedly had deleterious biological effects on rats that ate them. No one who believes this account would support rDNA work

[2] On global framing, Tarrow 2007: 59-76; 203; on intellectual work in theorizing the GMO, Schurman and Munro 2006. For examples of this narrative, Friends of the Earth International 2006 Greenpeace International 2007; Madsen 2001; Assayag 2005; Herring 2005; Reddy and Bhaskar 2005; Heins 2005; Shiva, Jafri, Emani and Pande 2000; Scoones 2008.

in food, much less eat the potatoes. That is, the epistemic brokerage is critical for inducing doubt: "where there's smoke, there's fire" is folk wisdom in at least fifty-five languages [Heath and Heath 2007: 11-12]. This aphorism recognizes the salience of smoke over other forms of evidence – such as a thermometer. After all, dry ice [solid carbon dioxide] produces the smoke we see in films and Las Vegas shows. The poisonous potatoes exemplify a class of political acts: accounts of extreme events diffused through consonant networks that attempt to unsettle an emergent scientific consensus with difficult-to-assess evidence from "the field" or "the laboratory."

These particular potatoes were included in Alan McHughen's chronicle of "scary myths" about transgenic crops [2000: 114-121; 258]. The experiment that produced the scare was not scientifically credible, but has become a mainstay of oppositional knowledge. Much of the world read about these poisonous potatoes, along with fish genes in tomatoes and the grave threats of FrankenFoods – and "Monsanto's Terminator Gene." There are many examples of comparable horror stories.[3] These stories enter politics and have political effects first because of their resonance with a master narrative of risk: "GMOs" are different from other plant-breeding products. Secondly, the cognitive precautionary principle is rational and widely deployed: because few of us read peer-reviewed journals of plant science, it seems best to code smoke as an indicator of fire, not dry ice. The threat construction often came to ex-colonies from sources in former colonial powers, and carried thereby a kind of ironic authority in the ex-colonial world, particularly in Africa [Paarlberg 2008: Ch 4]. Refutations of junk science, or counter-narratives, were missing from networks opposing GMOs. Networks in which Fox News is central in the United States are in a similar fashion more receptive to messages that President Obama has no birth certificate or is planning "death panels" for sick Americans.

Refutations of the extreme claims carried a special burden because of the connection between bio-safety and bio-property. Assurances that "GMOs are tested and safe" were widely dismissed as self-serving corporate propaganda. The property connection was critical. Because transgenics were produced and owned by MNCs, effective regulation – or even objective assessment – was widely discounted in TANs organized to stop genetic engineering in agriculture [Friends of the Earth 2006]. MNC science was held to be suspect; MNC political power rendered government science untrustworthy as well. In the ex-colonial world, permissive regulation in the US – the source and political supporter of GMOs –

[3] See Dan Agin, *Junk Science* [St Martin's, New York: 2006], especially pp 59-72.

was seen as a predictable reflection of corporate power under neo-liberalism. However much of the actual transgenic diffusion derived from public sector seeds, or farmer-bred stealth seeds, or seeds controlled by a Humanitarian Board, the GMO was wedded politically to the United States, to strong property regimes, and to multinational corporations.

The Bio-Property Frame: From Choice to Inequality to Genocide

Bio-property became political in three modes: *market, developmental* and *catastrophic*. The straight-forward *market mode* constructed the plants as technological progress that comes with a cost, but a cost that is fundamentally open to free choice. Farmers can and will pay more if they believe the added marginal revenue exceeds the marginal cost. The analogy is Microsoft Word: you can choose alternatives, from pencil and paper to open-source processors -- but Word will cost you money if you choose it. For many years, enforcement of software IP in the US was lax, and in much of the world remains extremely lax. [My only legal version of MS Word entered my computer fairly recently, enforced by Cornell University's IT staff.] Farmers can buy or reject more expensive seeds; their experience will lead to subsequent dis-adoption or re-purchase. Firms believe that enhanced productivity will convince farmers to pay extra for transgenic seeds just as they paid more for hybrid seeds: the financial bottom line will determine utility to the farmer. Empirically, the market model receives confirmation: benefits are in fact shared out across firms and farmers [Pray and Naseem 2007]. Were this not the case, it would be very hard to explain the diffusion of transgenic plantings in countries with strong property rights such as the US and Canada. The role of the state in this mode is simply to enforce contracts freely chosen among economic agents.

The *developmental mode* adopted by international development institutions qualifies the market version [Herring 2007a]. Transgenic seeds in poor countries pose a threat because of unequal access. Poor farmers and nations might lack access, or need special institutional support, to participate in the "gene revolution." Technology fees and their enforceability matter greatly. In the worst-case scenario, poor farmers might be disadvantaged by aggregate market forces generated by new technology, but have no voice in the matter. Poor farmers would lose if technology fees are prohibitive—and enforceable—and yields improved on farms of those who can afford fees. 'Farmers' as a class could still benefit, but poor farmers would be caught in a backwash of lower output prices because of increased yields on adopter-farms, but with no reduction in input costs or increased yields on their

own farms[Lipton 2007]. Enforcement of intellectual property claims would in this scenario accelerate concentration of land and the ruin of small farmers. In the developmentalist version, intellectual property that raises costs or restricts access may redound to the disadvantage of the poor, whatever the success of the technology in the aggregate. The assumption behind both market and developmentalist arguments is that biotechnology is agro-economically favorable for farmers.

The *catastrophic mode* escalates the threat posited by developmentalists from inequality to catastrophe. Here, the rDNA seeds are not valuable for agriculturalists of any size class, but rather a path toward a new form of subjugation: bio-serfdom, bio-feudalism. India as an empirical case came to be internationally powerful as a confirmation of the catastrophic mode: the "failure of Bt cotton" on agronomic and economic grounds was widely accepted as established fact and decisive case in networks opposing globalization [eg Greenpeace International 2007; Herring 2009b]. The primary epistemic broker in this development was Vandana Shiva, whose account illustrates the oppositional property argument in pure – and widely influential -- form:

> "Pushed into deepening debt and penury by Monsanto-Mahyco and other genetic-engineering multinationals, the introduction of Bt cotton heralds the death of thousands of farmers. High costs of cultivation and low returns have trapped Indian peasants in a debt trap from which they have no other escape but to take their lives. More than 40,000 farmers have committed suicide over the past decade in India—although the more accurate term would be homicide, or genocide."
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> "These seeds kill biodiversity, farmers, and people's freedom—for example, Monsanto's Bt cotton, which has already pushed thousands of Indian farmers into debt, despair, and death. Bt cotton is based on what has been dubbed 'Terminator Technology,' which makes genetically engineered plants produce sterile seeds." [*Shiva* 2006: 86]

In this narrative, there are no choices, only compulsion and traps. Vandana Shiva's *Biopiracy: The Plunder of Nature and Knowledge* was published in l997, before there was any legal transgenic in India; its themes provided the main frames for the connection between globalization and transgenics in India. Chapter One sets the stage: *Piracy Through Patents*. Chapter Two throws down the rhetorical gauntlet: *Can Life Be Made? Can Life Be Owned*? Dr. Shiva's over-riding concern with biotechnology is that techniques are being made available for "the control of

agriculture by multinational corporations (1997:91)." In the resulting movement in India, concern with intellectual property rights and corporate power was married to cultural and nationalist themes of self-reliance, nonviolence, local knowledge and biodiversity [Herring 2006]. It is clear why this narrative had power within a section of the Indian middle classes and intelligentsia; the resonance is powerful. But what makes Shiva's accounts important to the argument of this essay is their empirical claims, which became authoritatively established in global networks opposing biotechnology.

The mechanisms are important. If large-scale circulation of illicit seeds is a global phenomenon, the bio-property catastrophe story – debt-driven pandemic suicides, for example –depends on several strong claims. First, the technology does not work ["high costs and low returns"]. Second, dependency [loss of freedom] is produced by enforcement of property rights biologically via the "Terminator Technology." This is important because patents in plants are by no means universal; in the Indian case Shiva analyzes, there are no patents on any plants, including Bt cotton. As importantly, in the early years of Bt cotton diffusion in India, many of the most successful varieties were illegal derivatives of Monsanto's Cry1Ac implementation of insect resistance in cotton. The rapid diffusion of Bt cotton in India began with stealth seeds that neither the government nor Monsanto – nor the suicide seed coalition that Dr. Shiva led -- discovered until a massive bollworm incursion in 2001 wiped out the non-transgenic cotton in Gujarat, laying bare the "Robin-Hood" character of the illicit seeds [Herring 2005]. The discovery of stealth seeds was made not by Leviathan, nor civil society in surveillance mode [*bija nigrani samithi*], but by Mahyco-Monsanto [MMLB] trying to defend their investment in cotton seeds. No property rights adhered to these seeds, but Robin Hood could be quashed for violation of the bio-safety regime. The only transgenic cotton under-going bio-safety testing to become legal belonged to MMBL. The quashing of Robin Hood was successful, but as in insurrections generally, dozens rose up to take his place; a cottage industry was born [Gupta and Chandak 2005; Jayaraman 2001; 2004].

Monsanto's "Terminator Gene" as Archetype

India's explosion of underground Bt cotton hybrids could not have happened had the terminator claim been true. "Monsanto's terminator gene" provides an archetypal example of the political deployment of powerful intellectual-property claims by epistemic brokers in networks. It is important that they are brokers with epistemic standing and that their claims have a mechanism for distribution and authentication. That India has no patents on plants would be largely unknown in

networks where the patent story about Bt cotton is promulgated as authoritative knowledge, nor even in urban India.[4] The claim was that Monsanto's terminator gene was patented and incorporated into Bt cotton brought into India through collusion of the Indian state with a global neo-liberal regime and with Monsanto specifically, through bribes. The terminator summarized in one construct the multiple threats of biotechnology. The bio-cultural abomination of seeds that could not reproduce resonated with a narrative of corporate greed and acts against nature [Gold 2003].

The *bio-property* and *bio-safety* sub-narratives of the GMO were connected globally through dissemination of reports of actually existing "terminator technology" -- so named by a Canadian NGO [Rural Foundation International, now ETC] through web communications [ETC 2007]. "Monsanto's terminator gene" came to India through epistemic brokers located in international networks, such as Vandana Shiva and *Navdanya* [Herring 2006]. The terminator would in theory permit engineering of plants that could not produce viable seeds, forcing farmers to return each season to buy new seeds -- generating a biological dependence of farmers on firms unmatched by customary arrangements. More important symbolically, the venerable cycle of "self-organizing" agriculture would be replaced by dependency and cash nexus. This construction – linking multinational capital, globalization and a cultural abomination of suicide seeds -- created a capacious symbolic opening. Though demonstrably untrue on the ground

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[4] The patent is held by Delta and Pine Land Company, in collaboration with the United States Department of Agriculture's Agricultural Research Service -- U.S. Patent 5,723,765 entitled "Control of Plant Gene Expression," granted March 3, 1998 on a concept referred to as the Technology Protection System (TPS). Monsanto's attempt to purchase Delta and Pine Land failed, but "Monsanto's terminator" became inextricably linked to Bt cotton in India, and through India, globally [see below]. Despite its political prominence, terminator technology was not commercialized, due in large part to vigorous international protests and intervention of the President of the Rockefeller Foundation, Gordon Conway [personal communication]. See also, Scott Kilman. "Monsanto Won't Commercialize Terminator Gene," Wall Street Journal, October 5, 1999. There have to my knowledge been no applications for field testing of this technology and it has not deployed it in any crop anywhere in the world.

– if for no other reason, the stealth seeds were spreading very rapidly -- the threat narrative diffused widely.

Monsanto as creator and owner of terminator technology then provided a condensation symbol for the narrative: multinational, American, owner of an un-natural and exploitative technology. Clubbed together with Dow Chemicals, which together "brought us Bhopal and Vietnam," Monsanto was accused of planning to "unleash genetic catastrophes."[5] Real attributes of the firm's record were combined with a false attribution to Monsanto of property rights for engineering sterile seeds.[6]

Monsanto's representative in India rebutted charges of suicide seeds: "Since the so-called terminator gene does not exist today in any plant in any country in the world, the question of its involvement in the field trials currently on in India does not arise". MAHYCO-Monsanto Seeds chairman BR Barwale emphasized that the seeds being tested had been approved by the Government of India's Department of Biotechnology for trials and have "nothing to do with the so-called terminator genes". [7] Nevertheless, suicide seeds were deployed politically to link technology to intellectual property to neo-colonial threats to the nation. Vandana Shiva and colleagues [2000:98] wrote:

> Freedom from the first cotton colonisation was based on liberation through the spinning wheel... Freedom from the second cotton colonisation needs to be based on liberation through the seed ... The freedom of the seeds and freedom of organic farming are simultaneously a resistance against monopolies ... like Monsanto and a regeneration of agriculture... The seeds of suicide need to be replaced by the seeds of prosperity.

Monsanto as target diffused as well, along with the tactic of Peoples' Tribunals. In public trials, the corporation was tried *in absentia* and convicted, preceded by press

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[5] Press Release, Asian Social Forum [Hyderabad] Seminar, 2003, "Beyond Bhopal and Bt.: Taking on the Biotech Giants." Research Foundation for Science, Technology and Ecology. Delhi. January 4. RFSTE is Vandana Shiva's creation and instrument.

[6] Male sterility in plants is commonly induced for breeding purposes through non-rDNA techniques, but this practice has to my knowledge never raised any political objections.

[7] Quoted in Dow Jones Agnet November 20, 1998; Sharad Mistry, *Indian Express*, 1998, "Terminator Gene a Figment of Imagination: Monsanto Chief," December 4.

releases and enacted with extensive media coverage.[8] Terminator seeds were specifically banned by the Government of India in response to this movement, as announced in assurances in the *Lok Sabha* and *Rajya Sabha*, and via Office Memorandum No. 82-1/98 PQD, dated May 25, l998. None of these assurances stopped the campaign against terminator technology.

The campaign targeting terminator technology and monopoly power proved politically powerful. Even today, people all over the world firmly believe that farmers cannot save and replant "GMO seeds," despite extensive evidence to the contrary [Herring and Kandlikar 2009]. Ironically, in the Indian Bt cotton case, Monsanto's Cry1Ac gene for insect resistance in cotton was spreading widely underground among farmers, being back-crossed and constantly regenerated, despite the best efforts of the mythical terminator and without the knowledge of Monsanto or Delhi [Herring 2005]. The original import of *Bt* cotton seeds into India was one-hundred grams; there were by 2006 millions of acres under dozens of unauthorised transgenic cotton varieties in the field.[9]

Campaigns and Brokers: Credibility and Information Costs

Campaigning works against empirical tethering of knowledge claims. Nuanced findings and conditional conclusions do not work in advocacy politics dependent on clear messages for media releases and campaign slogans [Bob 2005]. Some claims against GMOs seem bizarre in retrospect but have persisted and diffused. Vandana Shiva, for example, claimed that Bt cotton seeds in India were not only "suicidal," but "homicidal" and finally "genocidal." Transgenic cotton caused the

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[8] See Pimbert and Wakeford 2002 for an explanation of "citizen juries" as a mechanism to counter-balance established "experts" with knowledge of the people. For an example Monsanto on trial before the Permanent Peoples' Tribunal in Rome, < http://www.grisnet.it/filb>, accessed June 15, 2009, report published 21 June 2001 in the *Law, Social Justice & Global Development* Electronic Law Journal.

[9] No one knows precise numbers. Data from Navbharat Seeds, progenitor of the first and most successful of the underground *Bt* lines, and parent to most, puts sales at 52.45 *lakh* packets of illegal *Bt* cotton for *kharif* 2005, enough seed cotton to plant 5.245 million acres, or roughly 25% of India's cotton acreage (pers comm). Legal *Bt* sales are increasing rapidly as well. Conversations with seed producers in Gujarat suggest more stealth seeds than figures from Delhi, but they too do not know the precise acreage, since farmers are producing *Bt* hybrids on their own farms and some still use transgenic F2 seeds. See Herring 2006; Roy 2006.

suicides of tens of thousands of Indian farmers [Shiva 2006a,b] – subsequently escalated to over 100,000. Diffusion of this narrative enabled and fortified Prince Charles' pronouncements on farmer suicides that gained international press attention, and thus reinforced the urgency of global opposition. A more recent article from Dr. Shiva appeared in *The Huffington Post*,[10] raising the death toll significantly and stating flatly that organic farmers "are earning 10 times more than the farmers growing Monsanto's Bt-cotton." The article contains egregious errors of fact and interpretation, but Dr. Shiva has achieved the status of epistemic broker for all things Indian in much of the Western media. Fact-based refutations [e.g. http://www.geneticmaize.com/2009/06/shameful-shiv/] have appeared in what the Bush administration sometimes dismissed as the "reality-based community," but nothing with the prominence of Dr. Shiva's original. Few *Huffington* readers will search out Narayanamoorthy and Kalamkar (2006) or Gruère, Mehta-Bhatt, and Sengupta (2008). Information costs are so high that few of us cross networks and compare sources. And though there is strong media selection for extreme events, it is also important that the GMO frame itself provides resonance for extreme claims: these plants are fundamentally different from all other plants, and carry special risks. The special nature of rDNA plant breeding is of course reinforced by patent claims in countries that allow patenting of plants: it is part of an intellectual property strategy that has a boomerang effect.

Brokers work at the intersection of networks; their mutual dependency is clear from the asymmetric relationship. Funders need local partners, local NGOs need resources and legitimation [Heins 2008]. They function as hinges in several dimensions, most critical for the puzzle at hand is epistemological. The hinged-brokerage dynamic can be illustrated with one example. Warangal district in the state of Andhra Pradesh, South India, is the most widely cited location of catastrophic effects of GMOs [Bt cotton] on local people.[11] From a ground view, Warangal also seems very densely populated by agricultural NGOs, though comparative data are not available. The Centre for Sustainable Agriculture [CSA] in the regionally cosmopolitan city of Secunderabad, for example, funds four local NGOs in Warangal district, including CROPS, which oversees the "GMO-free zone" of Eenabavi – a hamlet of 30 families sustained distally by Oxfam Trust, HIVOS-Netherlands, and AEI Luxembourg. The Deccan Development Society

[10] http://www.huffingtonpost.com/vandana-shiva/from-seeds-of-suicide-to_b_192419.html Accessed June 4, 2009. For sources contrary to the extreme claims in the article, Herring 2008b.

[11] See Shiva et al 2000; Stone 2001; 2007; Herring 2008b.

[DDS] of Secunderabad, also active in study and work in the district, lists 18 international funders, all in Europe or Canada, and 6 Indian government agencies. Both CSA and DDS reports figure prominently in critical assessments of Bt cotton in India in a major publication by Friends of the Earth International [2006], *Who Benefits from GM Crops?*

From Warangal emerged internationally circulated stories of "failure of Bt cotton," suicides of farmers and finally reports of sheep dying from ingestion of Bt cotton leaves. Sheep-death reports are less subject to external validation than are stories of agronomic failure, especially when the new technology spread so rapidly in the district [Stone 2007]. Sheep-death reports were attributed to mobile shepherds and publicized by state-level NGOs; they entered the global political and policy stream via INGOs that fund national and state-level organizations in the area. A press release from Dr Mae-Wan Ho was entitled "Mass Deaths in Sheep Grazing on Bt Cotton". Dr. Ho is leader of the Independent Science Panel in London [http://www.i-sis.org.uk/MDSGBTC.php] and the author of *Genetic Engineering: Dream or Nightmare* [2000]. *The Guardian* published a week later John Vidal's "Outcrop of Deaths" citing 1,600 sheep killed by Bt cotton leaves on 10 May, 2006 [http://society.guardian.co.uk/societyguardian/story/0,,17...]. Sheep deaths came back to metropolitan and English-reading India via the GM Watch report: "Mortality in Sheep Flocks after grazing on Bt Cotton fields - Warangal District, Andhra Pradesh." http://www.gmwatch.org/archive2.asp?arcid=6494 . Americans read the account via the Organic Consumers Association of Finland, Minnesota, which campaigns for "Health, Justice, Sustainability, Peace and Democracy." Their coverage was entitled: "More on Mass Death of Sheep in India After Grazing in Genetically Engineered Cotton Fields," accompanied by a line "Straight to the Source." The source was the Centre for Sustainable Agriculture, Secunderabad. The link was dead when an attempt to access was made in 2008, though the story itself remained online. In direct interviews, leadership at CSA Secunderabad backed away from published claims: the number 1600, the certainty of diagnosis, the evidentiary base.[12]

The Bt-dead-sheep story is biologically impossible, as recognized by Delhi's Genetic Engineering Approval Committee, the chief regulatory institution in India [Venkateshwarlu 2007]. There is no biological mechanism for the Bt insecticidal protein to kill sheep, nor any evidence that it has ever done so. There are many reasons sheep may die, but Bt cotton is not one of them. The story did, however,

[12] For team members, methods and findings, see Herring 2008b; 2009b; Rao 2007a;b.

resonate with the GMO frame in activist networks and their media contacts. The following year, reports from the same area escalated to deaths of cattle from eating Bt cotton leaves, in almost exactly the same numbers.[13]

Vertical diffusion strengthens advocacy networks in bi-directional ways. Both ends of the system need each other. But horizontal diffusion also contributes to network strength and expands GMO-free space. In neighboring Pakistan, Najma Sadeque, in *Financial Post*, May 12th, 2008, wrote a piece entitled: "After a disastrous track record in 40 countries, *Bt* cotton is 'welcomed' in Pakistan." Sadeque's article illustrates the coherent and compelling narrative of disaster from GMOs [Herring 2009b]. She wrote that in 2002 farmers in Madhya Pradesh [India] planted *Bt* seeds and "ended up with 100 per cent failure." The article asked: "How could farmers fail to see the figures that showed it really didn't make sense to grow Bt cotton? - They were deceived by false claims." The authority is indigenous: "Deccan Development Society (DDS), an Indian grassroots NGO… found [that] those who grew non-BT cotton made six times more profits than the BT cotton farmers !" Agro-economic failure was accompanied by alarming externalities: after grazing on *Bt* cotton leaves, "In just four villages in Andhra Pradesh, 1800 sheep died horrible, agonising deaths within 2-3 days from severe toxicity." The same website repeated a version of the terminator hoax long-discredited in India: "Monsanto - Genetically modified BT Cotton 'terminator' seeds being introduced in Pakistan." Ironically, Pakistan already had Bt cotton, smuggled from India, which would have laid this claim to rest had anyone checked with farmers.

The internet was a necessary condition for this diffusion of alarming claims. Web communities of knowledge and action are readily identifiable and can be mobilized quickly. Some "civil society organizations" are essentially a few individuals with access to a server; it is difficult to discern this fact distally. Without the web, there would be no counter-weight to international science panels and peer-reviewed journal publications that find no empirical support for GMO disaster narratives on the farm or in the stomach. Websites also become products to convince funders and donors that good works are being done: diffusion of knowledge claims itself constitutes a product. Press releases permit cross-fertilization of media in different sites, multiplying incidents as they go; media reports from local press then feed international coverage, lending an air of authenticity to the knowledge thus displayed.

[13] *Deccan Herald* February 7, 2007; *The Hindu* March 2, 2007; *GM Watch* March 4, 2007.

Authoritative and widely accessible reports from NGOs reinforce major themes of the oppositional narrative: supine peasants, unequal power, co-opted states. Local NGOs have credibility, partly from indigeneity, partly from the eye-witness nature of their reporting. They also have concrete interests in the failure of biotechnology; failures legitimate continuing oppositional campaigns, and new campaigns for alternatives: organic farming, sustainable agriculture and "GMO-free zones." These alternatives are popular and well-funded through European networks and official aid programs in India [Bownas 2008]. NGOs carry not only an aura of civil action [**non**-governmental], but in the contemporary international political opportunity structure, have a legitimate place at the table, and a means of acting.[14]

Extreme claims get both the instant dissemination and authoritative standing enabled by more and more distal circulation. If overwhelming farmer adoption has in effect settled the agro-economic questions around Bt cotton in India, new claims are needed to justify continuing the struggle. Reports of dead sheep are notoriously difficult to disconfirm – the animals are mortal -- and frightening. Shepherds are among the most vulnerable of the poor, and often marginalized by ethnicity. Tethering reports to distal and obscure sources prevents any decisive confrontation with facts. Ironically, Bt-dead-sheep knowledge became authoritative precisely because it was unverifiable. Keeping uncertainty alive is in the interest of all brokers in global coalitions against biotechnology, as the empirical evidence on development and poverty is settling on the other side of the cognitive rift [Herring 2007c; Pontifical Academy of Sciences forthcoming].

Global and distal narratives of bio-property are less dramatic than mass die-offs of livestock, but exhibit similar dynamics. The narrative of a global tyranny of monopoly and patent-control globalized by Vandana Shiva [1997] and adopted by TANs, has proved inconsistent with facts on the ground, institutional evolution, farmer ingenuity and state institutional capacity.

First, property rights are not self-enforcing; states will be involved, one way or the other, by intervention or failure to intervene. Monsanto expends great energies trying to collect technology fees in Latin America, with spotty results.[15] High

[14] Chapter 27 of Agenda 21authorized the role of NGOs and other "stake-holders" around sustainable development. Article 71 of Chapter 10 of the UN Charter granted consultative status in global representation.

[15] I recently received a communication from Argentina stating that 80 per cent of the soy is illegal. This is significant because Argentina denied Monsanto a patent

prices of Monsanto's *Bt* cotton in India spurred development of the stealth-seed market. Collective action led to demands to ban Monsanto's varieties – with success in one state [Andhra Pradesh] – and compensation for crop failure [Herring 2008b]. Continuing resistance to high prices compelled the state government to pursue a case before the Restrictive Practices Commission (MRTPC) in 2006. The state government eventually won its case and fixed a price ceiling on transgenic cotton seeds and ordered all seed companies to abide by its administered price for a "trait value." Other state governments then fixed prices at the same level, a reduction of some 40-50% of the purchase price at seed shops. Some transgenes have spread so widely underground that they resemble open-access or open-source technology more than monopoly, more Linux than Microsoft. The transgenic genie is out of the bottle.[16] Even in strong property regimes such as the United States, Monsanto is forced into admittedly undesirable publicity—suing modest farmers even to bankruptcy—to increase compliance with otherwise unenforceable claims. Since it is impossible to catch everyone who violates contracts prohibiting replanting of transgenic seeds, Monsanto seeks to make examples of a few farmers for deterrence (Liptak 2003: 18). Such strong manifestations of intellectual property have not proved practicable on a global scale for reasons of transactions costs, politics and law. Global monopoly power of multinational property in biota is difficult to discern on the ground; instead, biotechnology has invigorated a vigorous anarchic and artisanal agrarian capitalism through the spread of stealth seeds (Herring 2007b).

Evidence, then, does not support a super-profit gold-mine interpretation of biotech dominance. Private firms have been decreasing their investments in agricultural biotechnology, whereas public-sector institutions in low-income countries are increasing investment [Cohen 2005]. Pray and Naseem [2007] conclude from their analysis that the primary beneficiaries of increased revenues to date are not multinationals but farmers and consumers, even in countries that enforce strong intellectual property rights.

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for glyphostate-resistant soy in 1995, resulting in the spread of stealth transgenic soy all over South America, most egregiously Brazil. Herring 2007b.

[16] Pray and Naseem (2007) note that descriptions of many proprietary laboratory technologies have been published. Moreover, '[S]ome genes are in commercial use and can be obtained through reverse engineering, and some techniques have made their way to developing countries by way of unauthorised routes'. Patents either cannot or have not been obtained in many—perhaps most—low-income countries, and are unenforceable in others.

Though the picture of bio-property looks bleak for seed firms, bio-safety regimes have to some extent compensatory consolations. The weak nature of bio-property regimes on the ground means that if there is to be monopoly it will be through a strong bio-safety regime. Strict control and testing regimes raise costs of seed development beyond what is affordable by small firms, enhancing the power of deep-pocket corporations. India farmer and seed organizations have charged that bio-safety officials colluded with Monsanto to give its seeds the only status of approved hybrids, forcing everyone else to license the technology from Monsanto or give up a rapidly expanding transgenic market. There were demands for regularization of illegal transgenics, especially Navbharat 151 – the original stealth seed – and especially in Gujarat. Nevertheless, most seed firms with serious cotton markets chose to license Cry1Ac technology from Monsanto-Mahyco, even at prices they considered extortionate. This seems to have been a wise choice: lots of money has been made in Bt cotton.

Monsanto had no patent in India for the Bt seeds that were to crush "bio-serfs," nor any "terminator technology," but it did have the only technology to make it through rigorous bio-safety testing procedures. These facts are largely unknown outside specialized knowledge communities; reports of epistemic brokers in oppositional networks substituted for knowledge that incurs very high information costs. Who can track patent law in numerous countries? Who can assess terminator claims without advanced molecular biology training? Empirically, intellectual property in seeds has generally proved difficult to claim or enforce [Herring and Kandlikar 2009; Jayaraman 2001; 2004]. In the field, opportunistic appropriation of technology has been common, as with films, pharmaceuticals, music, and software [Naim 2005]. In some countries – most notably China -- public-sector research and firms have been important in biotechnology [Cohen 2005]. Public-sector universities have produced important breakthroughs – eg the virus-resistant papaya [Gonsalves, Lee, and Gonsalves 2007; Davidson 2008]. Humanitarian-use transfers offer an institutional alternative to private property, as developed in pro-vitamin A "golden rice"[Potrykus 2004; Lybbert 2003]. Epistemic brokerage within networks shields partisans from these contradictions in the narrative, just as cognitive and physical distance shields reports of dead sheep in Warangal from disconfirmation.

Knowledge diffusion in TANs is bi-directional, if often asymmetric. Local activists depend on their networks for extra-local authoritative knowledge about esoteric and complex issues: gene flow, terminator technology, allergenicity, intellectual

property. What they learn has political consequences. If local activists stand for poor farmers and sustainable development, and GMOs destroy both farmers and their environment, campaigns against GMOs are imperative. Moreover, urban cultural bias resists crediting farmer skill and agency. In India, the rural cottage-industry production and diffusion of dozens of illegal transgenic cotton varieties under the radar of Delhi and Monsanto [Jayaraman 2004; Gupta and Chandak 2005] was incongruent with narratives of peasant passivity and victimization. The stealth tactics and agency of actual farmers do not resonate with "bio-serfs" crushed by patent power of multinationals. Class matters; the radical freedom of movement leaders from the dull compulsion of economic facts means there is no penalty for getting it wrong.

Transnational advocacy networks opposed to genetic engineering built their critique in part on the presumed monopoly power of multinational corporations, with a parallel critique of bio-piracy enabled by the same genomics revolution in biology. When the BBC characterized the small Indian firm Navbharat's appropriation of Monsanto's Bt cotton gene as "bio-piracy", the rhetorical tables were turned. The assumption that genetic flow can move only from South to North was suddenly rendered problematic. Moreover, the episode illustrated concretely that only a deep urban cultural bias can construct farmers as hapless victims incapable of the kind of agency that makes the illicit sector so pervasive a global phenomenon (Naím 2005). If every urban area witnesses unauthorized appropriation of the latest technology, why should farmers be cognitively condemned to passive "bio-serfdom?"

Reports of extreme events from India – GMO-driven mass suicides, livestock deaths, crushing patents – have resonance and credibility for the reasons suggested above, but lack empirical validity.[17] Nevertheless, these outcomes attributed to GMOs violate universal values embedded in numerous global agreements – sustainability, development, equity – and thus motivate global collective action.

[17] The farmer-suicide narrative is contradicted by authoritative evidence on the economics of Bt cotton, beginning decisively with high rates of adoption. See Gruère, Mehta-Bhatt, and Sengupta 2008; Naik et al 2005; Gupta and Chandak 2005; Bambawale et al 2002; Herring 2008b; 2009b; Bennett, Ismael and Morse 2006; Narayanamoorthy and Kalamkar 2006. The dead-sheep narrative misunderstands the mechanism for the Cry1Ac insecticidal protein's effect on Lepidopterans – a mechanism that cannot function in mammalian guts [Thies and Devare 2007; Shelton 2007; Rao 2007a;b].

The normative structure is largely consensual: no one wants poor farmers or their livestock to die. It is not normative dissensus, but dissonant knowledge claims that drive opposition to GMOs. The urgency generated by these reports from the field quite reasonably motivates remedial actions: mandatory labeling, moratoria, GMO-free zones, and financial contributions to NGOs furthering these objectives.

Comparative Politics of Illicit Seeds

One could argue that mis-information, exaggeration and spin are present in all politics: there is nothing unusual about extreme claims as tactic. Indeed, Saul Alinsky captured the dilemma of social activists in his *Rules for Radicals*: if you lack numbers, make a lot of noise; if no one listens, "stink up the place."[18] Nevertheless, GMO brokerage does differ from that in other networks. *Human Rights Watch* and *Amnesty International*, for example, rest their credibility on factual accounts that face intense scrutiny and refutation by interested authoritative sources: national governments. They strongly resist diffusion of erroneous claims, even to the distress of their supporters. INGOs involved with biotechnology work in a field in which cognitive distance of supporters from science and from agriculture are significant, and the possibility of decisive refutation is perceived to be remote. Torture, we intuitively understand; how insecticidal proteins kill sheep is inaccessible. Because genetic engineering is cognitively distal, it requires interpretation, mediation by expertise: people who understand gene networks, horizontal gene flow, gene-use restriction technology [*aka* the terminator]. The distance of this discourse from ordinary experience necessitates epistemic brokerage; if nothing else, information costs for most of us are very high. Certain brokers command trust because of their position in networks united by ideological commitments. Fox News viewers received very different knowledge about weapons of mass destruction in Iraq compared to readers of TomDispatchBlogspot.com. All citizens of our species depend on trusting the right brokers on global warming and economic recovery.

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[18] "if your organization is small in numbers, then do what Gideon did: conceal the members in the dark but raise a din and clamor that will make the listener believe that your organization numbers many more than it does. Third, the nose; if your organization is too tiny even for noise, stink up the place." Noam Cohen, Know Thine Enemy, New York Times, August 23, 2009. WK 5

Moreover, transgenic technologies entered world history at a point when transnational social networks opposed to corporate power and environmental irresponsibility were connected and active [Schurman 2004; Schurman and Munro 2006]. Such networks offered skills, personnel, finances and legitimacy – and authoritative knowledge. By partnering with selected brokers in national and local networks in the poorer world, the transnational coalition against transgenics enhanced its claims to authority and legitimacy through dissemination – and celebration -- of knowledge "from below" [Assayag 2006]. Despite the importance of Europe in this global dynamic, the GMO narrative has been a truly global production. It has been remade by diffusion through transnational networks of solidarity and trust. GMOs came to India authoritatively coded as a threat of corporate monopoly imposed through a terminator technology; epistemic brokers legitimated by their command of this new and esoteric knowledge incorporated this modular component into existing networks seeking farmer welfare and autonomy [Herring, In Press; Bownas 2008]. They in turn released into the same networks accounts of transgenic failure, debt, dependency, suicides, and dead sheep.

New technologies are especially susceptible to both framing and epistemic brokerage for valence and evaluation; cognitive screening is inevitable and necessary. The great cognitive divide often settles on risk: is risk to be balanced against benefit, as with surgery or air travel, or is the very presence of risk a cause for resistance? European consumers split rDNA foods from rDNA applications in industry and medicine on grounds of utility. Indian farmers exhibited the same utility orientation of European consumers; they quickly adopted Bt cotton to reduce pesticide costs and improve profits. When faced with regulatory obstacles, they stood up against the state and simultaneously took local control of the technology in a transgenic cottage industry. This information did not diffuse widely, in large part because the story Prince Charles believes and promulgates took center stage. A small number of thin networks succeeded in making global disaster stories of Bt cotton authoritative. GMOs returned to Europe from India as not only "suicidal" but "homicidal," and finally "genocidal," killing off a hapless and supine third world peasantry and their livestock as well. This return flow of local knowledge was legitimated by the indigeneity of local activists and by brokers of global stature in trusted networks. Disaster stories reinforced the master narrative's core of risk, and confirmed with hard numbers, names and places the devastating effects of the GMO, effects not even imagined at the time of Europe's U-turn on transgenic technology in agriculture [Tiberghien 2007].

Boomerang Politics and Property Puzzles

Intellectual property claims of commercial firms raise prices of official, approved transgenic seeds; bio-safety regulations restrict access. Strong bio-property rights and demanding bio-safety regimes drive high prices of official seeds, and thus invigorate underground markets. Both artifacts drive farmers to seek illicit seeds whenever these provide agronomic advantages but are too expensive to buy or prohibited by law. Illicit seeds are thus the products of the particular and peculiar political economy of biotechnology.

The pervasive character of stealth seeds embarrasses both sides of the global political divide on transgenics. Bio-property critiques of opponents are centered on monopoly and control by MNCs. Bio-safety assurances of states and firms promoting the technology assume a rural Panopticon with enforcement powers. Both arguments presuppose a stronger state vis-à-vis rural society than is typical in nations with large agricultural populations. The meeting of these narratives in Terminator Technology offered in theory a way out: the "monopoly" and "patent" construction of corporate power over farmers and nations presupposed the biological mechanism of terminator technology. How else could patents in seeds have power? Gene use restriction technology [GURT] could enforce property claims that were politically and legally unavailable in most countries. But the Terminator remains curiously on the shelf. Its political framing outran the technology; there is today no parallel in seeds to copyright protection built into DVDs, music, and software. Biology is hard to control; nature finds a way, to paraphrase Dr Malcolm in *Jurassic Park* -- with a little help from interested agents.

Political opposition to biotechnology has been successful in many parts of the globe, especially in proportion to numbers [Herring 2008a]. It constructs a coherent story that combines bio-safety and bio-property critiques based on alarming but resonant exemplars – from dead sheep to farmer suicides. The objective of this politics is strict regulation or prohibition of transgenic seeds; the dramatic expansion of "GMO-free zones" globally is one consequence. The greatest success of this mobilization, combining EU member states and international social movements was the Cartagena Bio-safety Protocol [Falkner 2000; Herring In Press]. The strong presumptions in the language of the protocol, if implemented, would create an even greater transgenic divide globally. The poorer the state, the less likely that it can create bio-safety institutions. Likewise, compliance by the smallest seed firms would be extremely difficult, if not impossible, whereas multinationals with bases in rich and highly regulated nations

have demonstrated capacity to operate under strict regulation. Regulation can function as property if the costs are high enough to restrict entry and monitoring regimes can enforce rules. The more stringent the regulation, the greater the selection for firms with deep pockets, staying power, political connections and compliance experience. This *de facto* assignment of property rights by regulatory authority then rests fundamentally on a biological argument that "GMOs" require more regulation than other crops; to date, this is an argument without scientific basis [Pontifical Academy of Sciences forthcoming; Batista et al 2008; Millerand Conko 2000]. The special status of the GMO is a political, not biological, outcome, and one that empowers states and their regulatory agents over farmer interests. Because regulation applies only to rDNA plants, and no others [mutagenics, for example], the bio-safety regime advantages large multinational biotech firms over small and indigenous ones.

There is then a central contradiction in the politics of opposition to biotechnology. Bio-safety regulation generates *de facto* bio-property. The case of India is illustrative. Bt cotton took eight years to come to market legally; the stealth seeds were available at least three years earlier. Tying up of capital, along with costs of compliance with Delhi's bio-safety regime, meant that obtaining approval for Cry1Ac cotton cost about US$2 million before a single seed could be sold [Pray et al. 2005]. Regulatory restriction conferred property-like rights on holders of approved transgenic cultivars: Monsanto and its partner Mahyco [MMBL]. Because only their seeds were legal [adjudicated bio-safe], monopoly rents became available to MMBL in licensing their technology to competing seed firms. Advocates for small firms accused the Genetic Engineering Approval Committee of market-rigging via expensive and onerous regulation. But the GEAC was acting in accordance with global norms around transgenic plants, though additional delays and significant costs were added by successful by social-movement mobilization demanding more stringent testing [Herring 2005].

Navbharat Seeds – a small firm in Gujarat -- lacked the resources to go through the regulatory process Monsanto sustained for 8 years. It produced the first and ubiquitous stealth seed of India – Navbharat 151. This hybrid was typically preferred by farmers to Monsanto-Mahyco seeds[Roy et al 2007] , but was ruled illegal and banned for failing to obtain bio-safety approval from Delhi. Banning NB 151 on bio-safety grounds left the field open to Monsanto-Mahyco to license their technology to other seed firms at high prices, in effect to operate as a monopoly in a nation with no patent rights on genes or seeds. But the ban simultaneously prompted the vigorous cottage industry in illegal cottons using the NB 151 germplasm in new combinations with new names: *Agni, Luxmi, Rakshak*, *151*, etc. Had bio-safety institutions worked better, the

underground market would have been suppressed and MMBL's monopoly would have been strengthened.

One cannot end a discussion of intellectual property in seeds without attention to the Terminator puzzle. Given the prevalence of stealth seeds, why do firms not enforce their claims with terminator technology? Political pressure forced firms to commit to not deploying the technology, but why should this promise have been kept for 11 years? Are seed capitalists more reliable than banks? The losses from stealth seeds globally must be enormous. Monsanto in particular failed famously in Argentina in l995, and has given up trying to enforce property claims in China, where anarchy prevails among transgenics. The firm has been reluctant to deploy new technologies in India after noting the ease with which the Cry1Ac transgene was appropriated by farmers and cottage-industry seed producers in the Bt cotton episode.

Moreover, it is difficult to see how more effective enforcement of seed claims over time could happen. Politics works against bio-property claims in much of the world. First, in nations where farmers have political power, such as India, patent protection is not likely, enforcement unthinkable. Second, bureaucracies are notoriously open to alternative incentives, perhaps especially in rural areas where media exposure is less likely. There will be no seed police in the villages. Third, multinational firms are not popular. Consequently, a biological means of enforcing intellectual property has great attraction to a profit-maximizing firm. The "terminator" patent application called the invention a "technology protection system." It would seem to be in the material interest of firms with intellectual property claims in seeds to deploy the terminator. Moreover, the terminator is the only real answer to the gene-flow problem that is the core of the bio-safety regulatory regime – itself extremely expensive, with high opportunity costs and little capacity to prevent gene flow in any event. Bio-safety regimes are likewise embedded in local society and national political systems; causes for failure are quite obvious. If firms could answer doubts about bio-safety, acceptability of their products would almost certainly improve. The terminator seems quite attractive to the most powerful actors on this stage.

And yet the terminator sits un-utilized. The explanation for this outcome has always been political: opposition would be strong. The so-called T-GURT form of terminator technology would allow farmers to save seeds minus the transgenic trait, and would thus incur less opposition, but the bio-cultural abomination of terminator technology remains, evidently, politically untouchable. Though we have [grudgingly] come to accept terminator-like controls in software, videos and music

– with much resistance among the young -- the biological expression of termination seems to cross some threshold of hubris and abomination [Gold 2003]. It could be that this construction around the un-natural exhibits decisive threshold effects, defining what Prince Charles called "realms that belong to God and God alone." But I doubt it. After all, the world has almost universally accepted rDNA pharmaceuticals and industrial products. It may be that the real explanation is less culturally driven and more biological: perhaps the terminator, despite its international notoriety, simply does not work in the field. This is the final boomerang effect: firms need to claim not only novelty to gain patents, reinforcing the notion that transgenics differ fundamentally from other plants, but miracles to obtain venture capital. It would not be anomalous if claims for terminator technology outran reality, ironically handing opponents of biotechnology their most potent political tool.

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