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Politics of Biotechnology: Ideas, Risk, and Interest in Cases from India

Ronald J. Herring
Cornell University

Much of the literature on agricultural biotechnology is agro-economic. How material facts on the ground relate to a unique set of politics determining deployment of the technology is less discussed. This article begins with the global rift over biotechnology in agriculture generated by national and transnational political forces. Rival sides of the rift evoke radically divergent positions on potential, performance, and outcomes. India has been influenced by and contributed to both global discourse and political forces. India's national experience helps in understanding the relative roles of ideas and interests in driving politics around rDNA plants and regulatory outcomes: what can be legally grown where and under what conditions? *Ideas* have been especially important in a distal and enabling way by legitimating regulatory law that subjects GMOs to a politics of risk, in which normal science is vulnerable. Nevertheless, despite distinct political advantages, risk politics as driven by ideas of threat and danger confront material economic *interests*. Interactive effects mutually drive outcomes, critically mediated by political structure where regulatory power is located within the state. Limits to risk politics are clearly illustrated in the brief history of Bt cotton in India, in which farmer interests overcame both regulatory precaution and campaigners organized around ideas of risk and rural catastrophe. Hypothetical or anticipatory risks did, however, block India's second transgenic crop—Bt brinjal (eggplant)—despite approval by state science, not because of retail politics but rather because of the structure of regulatory power consistent with precautionary logics prominent in international risk politics.

Key words: agricultural and natural resource economics, environmental and ecological economics, biotechnology, risk, innovation, technology, India.

Performance, Potential, and Concerns in India: Bt Cotton to Bt Brinjal

The conference from which this collection emerged was to focus on 'performance, potential, and concerns' in agricultural biotechnology in India. For a keynote address, I tried to set the context in which these factors interact in India and globally. Of necessity, we must begin with Bt cotton and follow with the so-far abortive case of Bt brinjal (eggplant, aubergine; *Solanum melongena*). Cotton was India's first, and still only, officially authorized transgenic crop. To assess *performance*, the normal science of assessing technology looks to field studies and adoption rates on farms to get an aggregate picture of how well and on what dimensions this implementation has met expectations of *potential* and *performance*. The fact that empirical assessment proved politically controversial indicates the unique ideational nature of disputes around agricultural biotechnology (Nuffield Council on Bioethics, 2004; Pinstrup-Andersen & Schioler, 2000). This outcome should serve as a caution for the seemingly simple advocacy of 'science-based policy.' What seems a technically neutral and fact-based exercise—admittedly of great complexity—is to powerful social forces opposed to biotechnology no more than a conspiracy of powerful interests (Herring, 2013; Kuruganti, 2009; Stone, 2012, 2003).

Much has been written about Bt cotton in India and around the world (James, 2002). The case has been important in global discussion of both realized potential and catastrophic concerns about agricultural biotechnology: reports of higher yields and aggregate production compete with stories of farmer suicides and dead sheep (Kloor, 2014). What is made of performance of Bt cotton therefore has global and national implications for the future of agricultural biotechnology in general. Reciprocally, India's political divisions on biotechnology did not spring forth on an empty world stage, but rather reflected existing forces in an already formed field of contestation—a global rift—between a catastrophic framing ('suicide seeds') and a frame of technological optimism ('silver bullets'). Performance, potential, and concerns cannot be understood without this embedding and its consequences. Pre-existing rival networks had different stories to tell—centering on either technological threat or promise, Promethean science, or Pandora's box (Herring, 2007a).

By customary canons of empirical assessment, the Bt cotton story has a clear trajectory: fulfillment of potential—promised in theory, evidenced by field trials, and international experience. The decisive weight of evidence from field studies, farmer adoption behavior, and aggregate performance indicates that Bt cotton has been an agro-economic success over the decade of 2002-2012.[1] One corollary of this empirical case is refutation of prominent concerns voiced about biotechnology in early social commentaries. Few innovations have had such a powerful impact on the farm and in the aggregate in Indian agriculture. In a sense, the evidence has been in the fields, and farmers have voted with their plows, with virtually unanimous consensus. That evidence of performance should in theory smooth the way for application of the same technology—recombinant DNA (rDNA) insertion of genes for the expression of *cry* proteins for insect resistance—by illustrating through performance a unique potential, and simultaneously alleviating many of the concerns raised in civil society. For example, there was concern—in India and internationally—that biotechnology could not work for small and marginal farmers; Bt cotton in practice proved quite the opposite, not just scale-neutral but of greater benefit to farmers unable to purchase adequate crop protection measures in the market (Herring & Rao, 2012).

Yet India's second transgenic crop faced active social forces proclaiming 'the failure of Bt cotton' as a reason for halting further development of agricultural biotechnology (Qayum & Sakkhari, 2005; Sahai & Rahman, 2003; Shiva & Jafri, 2004). That narrative of failure and catastrophe—centered on a reported epidemic of cotton farmer suicides—is widely distributed globally (Kloor, 2014; Shiva, 2006). It affects positions on agricultural biotechnology in other nations, as well as future prospects in India. The transgenic brinjal carried the same Bt transgene (cry1Ac) used in early and dominant Bt cotton hybrids and promised parallel benefits through an insect-resistant trait (Choudhary & Gaur, 2008; Kolady & Lesser, 2012; Krishna & Qaim, 2007). If the failure and suicide narrative for cotton were true, performance of Bt cotton would indicate only negative potential for Bt brinjal; concerns would overwhelm promise of potential.

India's politics of cotton achieved global prominence. Prince Charles' declaration that genetically modified (GM) crops are responsible for Indian farmers' suicides in 2008 reflected widespread anxiety and outrage. National and international media have successfully promulgated concerns for a posited epidemic of farmer suicides in India (Kloor, 2014). Films with telling titles such as *Cotton for My Shroud* achieved international acclaim and distribution and valorized crusades to ban Bt cotton from India as a model for other countries. Despite the small numbers of activists engaged, mobilization to halt diffusion of agricultural biotechnology often succeeds. One reason for this success in retail politics is diffusion of risk narratives in transnational advocacy networks. Both elements are critical: diffusion could not happen without the networks, and specific criticisms of transgenics would not have power without authoritative knowledge claims resting on locally embedded social movements. More important, small numbers even with wide diffusion could not have such large effects without the leverage of administrative choke points created by bio-safety institutions consonant with international treaties framing agricultural biotechnology as posing unique but indefinable risks—the genetically modified organism (GMO). We will subsequently consider both knowledge claims and choke points in India specifically. The theoretical point is that the global political opportunity structure created by the invention of the GMO provided both a target of mobilization and levers for effective action.[2]

Since the failure and catastrophe narrative of Bt cotton is not true objectively, its persistence and power create a puzzle. Most important, these global politics explain both the origins and path-dependent effects of an institutional structure that followed from the very

1. *As this article forms part of a collection, I will not detail field studies in this article. For a summary and meta-analysis reflecting the author's reading of that literature, see Herring and Rao (2012), Herring (2013), Rao (2013) and the references in these works to a broader literature. On village-level effects and poverty, see also Subramanian and Qaim (2009, 2010). On the importance of longitudinal as well as cross-sectional assessment, see Rao and Dev (2009, 2010).*

2. *For the sociological theory on framing and diffusion that is politically relevant, see Givan, Roberts, and Soule (2010). For non-governmental organization (NGO) incentives in global networks, see Cooley and Ron (2002) and Heins (2008).*

idea of a 'GMO,' and consequentially the power of ideas in politics around rDNA plant breeding. These politics center on ideas of unique risk and associated regulatory regimes.

Ideational Engineering: The Lumping and Splitting of Gene Splicing

The GMO rift grew out of transnational social-movement politics and reciprocally spawned transnational advocacy networks (Bonny, 2003; Schurman & Munro, 2006, 2010). Europe was the center, but production of the GMO frame was truly global. After initial enthusiasm for a modern technology, European politics propelled a U-turn in the late 1990s around construction of rDNA techniques in agriculture as uniquely susceptible to environmental risk, threats to human health, and corporate control (Jasanoff, 2005). Pharmaceutical, medical, and industrial rDNA technologies were exempt from the GMO frame, and entered the more conventional stream of technical innovations—adjudicated on a case-by-case basis by the criterion of risk-benefit ratios. This conceptual and political split, pioneered in European politics and fueled by social movements, proved path-dependent and generative. From the GMO framing emerged international soft law, national regulatory institutions, trading regimes, and social-movement objectives. GMO-free zones began to proliferate globally, sometimes even faster than GMOs themselves. This strategic attribution of threat and risk to some plants and not others, some biotechnologies and not others, came to dominate global networks of transnational advocacy and their domestic partners. This is a rare example of retail politics in collective movements altering not only the course of biotechnology in the EU, but around the world via global soft law.

Rival networks formed around this global rift. Proponents promoted acceptance of biotechnology with similar but countervailing appeals to authoritative knowledge. *AgBioWorld*, for example, introduced its website with: 'More than 3,400 scientists support the use of biotechnology to improve agriculture in the developing world, including 25 Nobel Prize winners.' Rival political forces reflexively form each other: the anti-biotech narrative inverts, for example, proponents' framing—from 'GMOs: Tested and Safe' to 'GMOs: Unsafe and Untested.' Each network claims success. Some nations have approved or promoted biotech crops through the logic of the developmental state: China first and most vigorously. Others countries prohibit biotech crops altogether or regulate so heavily that a *de facto* ban is in force; some approvals have been reversed in response to politics. Europe after 1998 has been the epicenter of opposition, but moratoria are contested globally—from Poland to Japan, India to California.

For these mobilizations to have political effect, a necessary condition is some object of contention. International non-governmental organizations (INGOs) and some European nations succeeded in framing products of agricultural biotechnology as uniquely risky plants in global soft law, entailing special surveillance and regulation via the Cartagena Protocol on Biosafety.[3] This framing produced a new object of contention, surveillance, and control—the GMO. Though this framing is now completely naturalized in public discourse, there was—and is—nothing inevitable or natural about this outcome. Alternative framings were both available and arguably necessary to provide precise meaning to different applications of rDNA techniques. Framing of products of genetic engineering in agriculture as GMOs reflected a specific episode of contentious politics defined by a specific period in history and the social forces then operative (Schurman & Kelso, 2003; Schurman & Munro, 2010; Tait, 2001).

Framing strategies are known to have strong effects on the success or failure of social movements. For biotechnology, framing enabled global divisions of trade, intellectual property, bio-safety institutions, legal claims, and institutional development. The unique power of this particular frame is illustrated by its acceptance even by proponents, who explicitly recognize that all agricultural plants are genetically modified but use the GMO framing out of necessity—to be understood, to participate in the public discourse. Agricultural biotechnology thus enters national debates in countries such as India already framed and packaged with attendant political valence attached.

Two dimensions of this political framing have been important in a path-dependent way: 1) lumping all rDNA crops together regardless of differences farmers and breeders find significant (what traits in what plants) and 2) splitting rDNA crops from other applications of the technology. Lumping and splitting frames created the GMO as an object of politics and governance. When we say that that path dependence matters, we mean that the frame itself became generative: without this particular construction, there could have been no campaigns for GMO-free zones as targets of movement politics; no staff positions with GM Watch; no market premium

3. *See http://bch.cbd.int/protocol.*

niche for GMO-free food; no testing industry organized to find trace amounts of GMOs in food, feed, or products. The Cartagena Biosafety Protocol reinforced these effects. First, genetically engineered (GE) plants are the sole object of the treaty, marking them as needful of biosafety oversight. The opposite of safe is risky. Second, administrative choke points are created in all countries compliant with the protocol. These new institutions—through which only GE plants must pass—provide focal points for targeting political efforts. These are forums that differentially empower political actors with appropriate skills and connections, typically not peasants.

New claims of intellectual property in seeds enabled by the genomics revolution also created potential conflicts over what can be owned, by whom, under what conditions, in which nation, with what responsibilities. Predictably, in terms of Karl Polanyi's (1944) view of the dynamics of commoditization of elements of nature, the movement toward novel property evoked a reaction of 'social protection' in many parts of civil society. The making of property from elements of 'life itself' raised the issue of threats of dominance and exploitation (Kloppenburg, 2004). Claims of novelty by firms seeking intellectual property in plant genetics reinforced the bio-safety concerns: if novel, might products of genetic engineering raise special risks in comparison with cultivars bred by different techniques? Bio-property and biosafety jointly defined a special object connoting threat: the GMO.

The social construct of the GMO thus enabled the insertion of agricultural biotechnologies into global networks with appropriate receptors. Environmental transnational advocacy networks (TANs) found resonance in and use for the bio-safety narrative; GMOs were almost universally believed to present environmental risk (for assessment, see Thies & Devare, 2007). If regulation at the national level involved the ministries of environment—as happened in India—the precautionary logic of Cartagena could make acceptance of rDNA plants especially difficult, as the case of Bt brinjal illustrates. Second, anti-globalization TANs found resonance in and use for the bio-property narrative: GMOs introduced risk of monopolization of property and subordination of poor farmers and nations (Scoones, 2008). Without these framing successes, rDNA cultivars might well have been globally naturalized and assessed on utility-risk grounds no different than those of non-transgenic products, as happened with rDNA pharmaceuticals or mutagenized plants. Both the *bio-safety* and *bio-property* narratives found resonance in professional networks legitimized by the unacceptable situation of the world's poorest nations and people. These framings produced new professional interests, anticipatory institutions, and transnational monetary flows.

How did these framings have effects on the ground? A naïve view of politics is that numbers count; this is seldom true. In biotechnology policy, small numbers have had disproportionate political impact. One reason is wide-spread ignorance of or indifference toward genetic engineering. But networks and frames matter as well. Networks are especially effective in getting their stories into affiliated media and promoting their epistemic brokers, or what Timur Kuran and Cass Sunstein (1999) call 'availability entrepreneurs.' Examples include Vandana Shiva or Jeffery Smith. Entrepreneurs in this interpretation facilitate—or create—availability cascades, a concept that extends the notion of an information cascade, in which the availability of information—however spurious or thinly held—by itself increases the credibility of the claims. The resultant availability of stories—farmer suicides, dead livestock, poisonous potatoes, rat tumors—reinforces beliefs in the necessity of achieving objectives that define the network.

In global networks, hinges between geographically disparate points enable network leaders to select, endorse, theorize and diffuse information for far-flung activists; simultaneously, these nodes provide accounts based on ground-level local knowledge to their distal international networks.[4] How else would local pro-farmer groups in India learn of the deadly effects of "terminator technology" or "biological pollution?" Because of asymmetries of knowledge and skill necessary for authoritative positions in these global networks, brokerage positions are not equally distributed, but they reinforce existing social hierarchies. Vandana Shiva is globally effective representing poor peasants because she has first-class air tickets, a website, cell phone, honoraria, computer, and speaks the English language.

These risk narratives have a sizable political advantage in opposing novel technologies, since people typically fear loss more than they value gain, but networks of biotechnology advocates are not without their own narratives, brokers, and alternative framings—from pro-poor biotechnology to sustainable agriculture and food

4. On India, see Bownas (2008); on transnational activism, see Tarrow (2005); on the social power of rumors contrary to fact, see Sunstein (2009); for application to transgenics, see Herring (2008a).

security (Herring, 2007b; Schurman & Munro, 2010: Chapter 2). These narratives proved more compatible with the experience of farming communities. Though much of the on-stage political conflict that reaches the media and mass public takes place in the streets of large cities or on websites, farmers proved less susceptible to the risk and catastrophe narratives because of pressing material interests. Working with close margins and always at risk of economic distress, farmers of necessity have a more experimental and empirical approach to seeds than urban campaigners.

A tension thus developed between the material interests of farmers in new technology and ideational interests of opponents in promulgating risk narratives. Which of these sides dominates is variable case by case and heavily dependent on the arena in which decisions are made as well as the political clout of antagonists. In India, retail risk politics was effective in the case of Bt brinjal; in Bt cotton, material interests on the ground dominated risk framings of bio-property and bio-safety.

The GMO in India: Logics of Development and *Operation Cremate Monsanto*

As nations contemplated what to do about new techniques of plant breeding spawned by the genomics revolution in biology, international concerns about biosafety and bio-property marked the GMO as uniquely risky technology uniquely conducive to exploitation of the weak by the strong. If this narrative is true, agricultural biotechnology would be incompatible with development aspirations of poor countries and poor farmers.

The GMO came to India under the auspices of Monsanto—perhaps the most vilified of all multinationals—in the form of Bt cotton, produced with a local partner, Mahyco. Controversy emerged around divergent themes consistent with global narratives: the seeds either increased farm incomes and permitted less pesticide use or precipitated the demise of Indian farmers and enslavement of India as a nation (Bharathan, 2000; Scoones, 2006; Shiva, 2006). Among the most effective arguments against biotechnology was that bio-property would overwhelm and exploit peasants: narratives of 'bio-serfdom' and 'bio-feudalism' emerged. Such a structural change would require a mechanism; Bt cotton was characterized by 'suicide seeds' containing 'Monsanto's terminator gene,' creating bio-cultural abominations: seeds that could not be saved and grown, thus disrupting the ancient self-organizing principles of peasant society. As early as 1998, before any Bt cotton was approved in Delhi, farmer suicides were associated with technological modernization in cotton (Shiva, Jafri, Emani, & Pande, 2000).

The suicide narrative posed a diagnostic puzzle: 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 arenas—take risks in acquiring and planting illegal seeds? There is a great ideational divide in answers to this paradox: the phenomenon could result from farmer choice, based on rational evaluation of options. Alternatively, rapid adoption of transgenic seeds could be explained away as a function of structure, not choice: driven by monopoly, control, and elimination of alternatives, farmers have no choice but to plant seeds contrary to their interests. In these ideological positions, farmers are cast as hapless victims of technological change rather than as active agents making choices under often severe constraints.

Neither development professionals nor farmers accepted the catastrophe and suicide account as readily as did urban advocacy networks and mass media. In direct opposition to construction of GMOs as a Pandora's box of potential disasters was a Promethean science of technical change to alleviate obstacles to development. This countervailing logic even posited a "biotechnology for the poor."[5] In this framing, genetic engineering could become part of a "toolkit" for improving agricultural production in poor places (Pinstrup-Andersen & Schioler, 2000). A cautious consensus emerged around this view of the toolkit and its potential for development among professionals and some global institutions. But even these optimistic constructions were hedged by elements of the cautionary framing of GMOs. New institutions and 'capacity building' for biosafety regimes, for example, even if expensive and unlikely to succeed, could be a necessary condition. Interaction of the Pandoran and Promethean logics converged on a governance structure for GMOs, based on common premises about the unique nature of rDNA plants, but with divergent weightings of threat and promise.

When legal turmoil around bio-safety approval delayed commercialization, farmers organized in public demonstrations. Ironically, some farmers had been operating below the radar of Delhi's regulators and activists for three years prior to official approval. Then, in 2001, "the bollworm rampage"—so dubbed by the leader of

5. *See Scoones (2002) and Herring (2007b); for an overview and critique of this construction, see Glover (2010).*

India's then-largest farmer organization—devastated conventional cotton hybrids in Gujarat but left the illegal transgenic cotton untouched and thus highly visible (Herring, 2006). The promulgator of this very effective transgenic, D.B. Desai of Navbharat Seeds, was dubbed Robin Hood in the international press but faced court charges in India for selling unauthorized seeds. His unauthorized Bt cotton hybrid (NB151) was banned, but others rose to take his place. In fact, Desai's stealth seeds became the basis for a vigorous cottage industry based on local cotton hybrids bred on-farm and distributed through farmer networks (Gupta & Chandak, 2005; Ramaswami, Pray, & Narayanan, 2011; Roy, 2006; Roy, Herring, & Geisler, 2007; Shah, 2005). These illicit seeds were ironically the Terminator's progeny, bred from transgenic cotton seeds. Stealth seeds went underground in a pattern similar to James Scott's (1985) account of 'weapons of the weak' as responses to restrictions on farmers' sphere of opportunity. The underground seeds dramatically illustrated the distance between global discourses of biotechnology on the one hand and ground realities on the other.

Diffusion of the illegal *deshi* [indigenous] Bt seeds made Delhi's approval of Bt cotton in March 2002 a political *fait accompli*. The Genetic Engineering Approval Committee (GEAC) had no real choice; two major cotton states, Gujarat and Maharashtra, had already allowed their farmers to grow Bt cotton and Delhi proved incapable of preventing it. Stealth hybrids paved the way for official approval of dozens, then hundreds, of legal transgenic hybrids from dozens of firms; most utilized Monsanto's Bt (cry1Ac) gene construct, but other implementations were used after 2006 (Herring, 2011). Prices fell dramatically; transgenic hybrids became dominant in the fields. Official estimates of adoption of Bt among cotton farmers exceed 90%; more than 1,000 hybrids have been officially approved and the underground diffusion of unofficial varieties continues. Productivity, profits, and aggregate production have risen significantly and pesticide usage against the bollworm has declined as field trials and technology developers predicted.[6]

The politics of Bt cotton illustrated the interaction of ideational forces and material interests common in global contentions around agricultural biotechnology. Opponents combined nationalist appeals, opposition to multinational capital, and rejection of genetic engineering as un-natural in one integrated critique. Opposition focused on threats: threats to national independence, in the form of dominance of agriculture by multinational firms; threats to farmers, in the form of bondage to monopoly seed corporations; threats to nature, in the form of "biological pollution" (gene flow); threats to human health, in the form of undiscovered allergens (Herring, 2005; Scoones, 2006). Disparate elements in civil society coalesced around a common target in *Operation Cremate Monsanto*, with international backing from networks opposed to both globalization and genetic engineering. Movement organizers took their case to Europe in the Transcontinental Caravan. The most prominent spokesperson was Vandana Shiva from Navdanya, a network of seed keepers and organic producers spread across 17 states in India.

Operation Cremate Monsanto failed. Bt cotton technology spread rapidly and widely in India, both above and below ground. The idea of Bt cotton as a GMO that threatened rural life proved to have little resonance with cotton farmers. What proved important was whether the bollworm-resistance trait conferred by the transgene would work in the field, not how the trait entered the plant. Would it reduce pesticide costs and improve revenues as promised? In general, Indian farmers—like Chinese farmers—found in Bt cotton a trait that proved broadly useful in terms of agro-economics and limiting environmental damage. Though opposition failed to prevent virtually universal adoption of Bt cotton in India, networks built in the campaign against Bt cotton provided a political base for the campaign against Bt brinjal, which contained the same transgene in 2010. These forces had proved politically impotent in the face of material interests of a significant farming community invested in Bt cotton. But in the next round of politics, Bt brinjal lacked this importance to the national economy and the numbers and power of its farmers, as well as the demonstration effect of stealth seeds. Moreover, Bt brinjal proved susceptible to a risk politics surrounding food crops within a biosafety structure in which a single politician had veto power. That singular power was the institutional manifestation of the ideational construction of Bt plants as GMOs.

Interests and the Limits of Successful Ideas

GMOs came to India authoritatively coded by global networks as a threat of corporate dominance imposed by

6. *For a summary of extensive empirical evidence from field studies and meta-analysis, see Rao and Dev (2009, 2010) and Herring and Rao (2012). On the empirical evidence on claims of farmer suicides, see Gruère, Mehta-Bhatt and Sengupta (2008) and Gruère and Sengupta (2011).*

a terminator technology and threatening a 'genetic holocaust.' Epistemic brokers legitimated—by their command of this new and esoteric knowledge incorporated—this modular component into the practice of existing networks seeking farmer welfare and autonomy (Bownas, 2008). These brokers in turn released into the same networks accounts of transgenic crop failure, debt, dependency, suicides, livestock deaths, and human illness. Specific accounts of disaster reinforced the master narrative's core of risk with hard numbers, names, and places. Such stories cumulatively presented a disaster scenario not even imagined at the time of Europe's U-turn on biotechnology in agriculture in the late 1990s but very much anchored in and often funded by Europe (Heins, 2008; Paarlberg, 2008).

Farmers, firms, and activists determined their interests in expansion of biotechnology and acted accordingly, but ordinary citizens cannot easily sort *their* interests or a national interest given conflicting narratives of threat and promise. The esoteric nature of genetic engineering makes information costs very high, necessitating epistemic brokers who mediate between the technology and its effects. Idea brokers theorize connections between specific concerns about genetic engineering and universal values such as safety, sustainability, and social justice (Schurman & Munro, 2010). Concepts and mechanisms of genetic engineering are cognitively distal; complex concepts such as gene flow, 'terminator technology,' and epigenetic effects require translation to common language and imperfect analogues to common experience in order to form the basis for determining interests and behavior. For example, gene flow becomes 'biological pollution,' evoking environmental risk. Brokers also mediate between local and international networks, deriving legitimacy and influence from marrying the authenticity of concrete grass-roots accounts (dead sheep, for example) to risk narratives globally prevalent (Herring, 2010). Reports from the field of outcomes in far-flung villages carry the authority of authenticity from indigeneity: farmers speak, but only through intermediaries. Diffusion through networks and affiliated media create information cascades that build credibility.

Two examples can illustrate the abstractions in this argument: dead sheep in Warangal district and stealth seeds. The former demonstrates the ideational success of frightening stories implying that the approval of Bt cotton on biosafety grounds was unwarranted. The implication is that state science could not be trusted, and specifically that the GEAC was either incompetent or corrupt—both of which were charged in opposition networks. The second case—the underground proliferation of unapproved seeds—likewise demonstrates that biosafety regulation is inadequate in India, which served opposition interests in demanding a ban on Bt brinjal. Ironically, admission of this phenomenon undermines the most powerful critique of biotechnology in the global South—that biotechnology implies monopoly through patents and 'terminator technology,' but that contradiction remains unnoticed or strategically submerged.

First, in Warangal district in 2005, thousands of sheep reportedly died from ingestion of Bt cotton leaves, based on accounts of migratory shepherds recorded by a local NGO. Numbers of sheep—and later cattle—escalated in transmission to global media and networks around the world. Both scientists and Government of India tests refuted the claim: the cry1Ac protein has no mammalian activity. Whatever bothered the sheep, it was not the transgene. The local NGO that first reported the story retreated under questioning, the initial informants proved elusive, the autopsied carcass disappeared, and local farmers when interviewed said local sheep died for many reasons—and always had. Sheep are mortal. Nevertheless, this alarming story spread through international media and periodically appears in court cases and political deliberations far from Warangal.[7] Like fears of escaped transgenes in catastrophe accounts, the story could not be recalled once it entered international networks, where it continues to circulate and influence politics in other nations.

Second, stealth seeds do indeed constitute a grassroots challenge to formal institutions of bio-safety if there is any potential hazard from the transgene. Moreover, it is true that formal institutions did not uncover the underground diffusion of illicit Bt cotton hybrids, but rather responded to a complaint from commercial interests in civil society. There was no biological or agronomic hazard in this proliferation, however—only some commercial loss to Mahyco-Monsanto. On biosafety grounds, the failure was inconsequential but did undermine faith in the GEAC that mattered in the subsequent politics of Bt brinjal.

Stealth seeds also uncovered a fundamental tension, perhaps even a contradiction, in global mobilization to halt diffusion of biotechnology in agriculture based on a risk narrative. Opponents of the technology seek stricter regulation: there should be more restrictive bio-safety

7. *For accounts of the investigation and aftermath, see Herring (2008b, 2010).*

regimes, based on their *ex ante* assumptions of special but hypothetical risk. However, bio-safety regulations raise barriers to entry in the seed market and thus advantage firms with deep pockets, political connections, and regulatory experience—precisely the multi-national life science firms such as Monsanto that are the target of anti-globalization campaigns. Ironically, successful demands for stronger regulation of GMOs strengthen property-like rights of multinational firms that find it otherwise difficult to make and enforce property claims. Local firms and independent scientists find these barriers impassable. Bio-safety regulation then can and often does function as bio-property, as the case of Bt cotton in India illustrated (Herring & Kandlikar, 2009).

That this tension is little noted in advocacy politics suggests how powerfully constructs of the GMO as a unified and undifferentiated object shape distal understandings of dynamics in agricultural systems, most importantly farmer interests and agency. This mis-match between essentially cosmopolitan constructions of rural reality and farmer interests undercuts the grassroots support INGOs claim but have difficulty mobilizing. Nevertheless, every alarming account adds to the penumbra of threat hanging over biotechnology. Scientists attempting to assess such accounts are driven to expensive and time-consuming investigations no matter how implausible the claims. A dead-sheep hoax stands and diffuses until someone takes the time and effort to investigate; there are simply too many extreme claims to investigate and scientifically trained people have more important things to do. Moreover, in polarized politics, disconfirming evidence is often denied and may reinforce the commitments of believers through reinforcement of identity (Mnookin, 2011: Ch. 16). This penumbra of threat enables the construction of 'risk' even in the absence of empirical evidence of hazard. A recent dramatic illustration is that of Bt brinjal in India (Jayaraman, 2010; Rao 2010).

Bt Brinjal and Dilemmas of State Science

All science is vulnerable in politics (Oreskes & Conway, 2010; Specter, 2009; Sunstein, 2009). Scientific conclusions serve some interests and undermine others, evoking battles over studies and their meanings—how the science is done, where it is plugged into policy structures, and what role the public has in the process. Given administrative choke points that determine outcomes for biotech crops, politics concentrate around questions far removed from farmers' fields: What role should science have in democratic decision-making? What is the place of experts in a vigorous democracy of vast size and diversity? Which experts are involved, and how are they chosen? A logical consequence is contention around the question of what science and whose science counts (Bharathan, 2000; Ho, 2000).

States—both authoritarian and democratic—seek to assure mass publics that by institutionalizing science in boards, panels, and commissions dominated by expertise, authoritative knowledge is in place to protect public interests (Herring, 2014b). The political objective is to generate trust. Official science vetted by such institutions, however, creates a special problem for democracy: citizens are excluded from critical decisions on both practical grounds and for want of expertise. Not everyone can meaningfully decide whether the cry1Ac gene and its associated protein are risky or safe in food crops—or kill sheep in Warangal. Or whether gene flow creates threats to biodiversity (*Review of Agrarian Studies*, 2011). Yet law and regulation depend on settled authoritative knowledge about genetic engineering. Because the knowledge terrain is an open political space at frontiers of technical change, rival networks can deploy alternative stories about the effects of biotechnology to buttress their respective positions. In this competition, science as method is politically handicapped. From climate change to HIV/AIDS, populist mobilizations of counter-expertise have attacked official science endorsed by states, often successfully (Mnookin, 2011).

We can see the interplay of ideas and interests in science politics in the contrasting histories of Bt cotton and Bt brinjal. Global contestation around recombinant DNA technology produced ideas of special risk that enabled an administrative choke point—the 'bio-safety regime'—through which both crops had to pass. In the case of cotton, material interests and organization of farmers and State governments made this chokepoint largely irrelevant—the Genetic Engineering Committee's approval in March 2002 was essentially a *fait accompli*. Bt cotton hybrids were already in the ground and two states had approved cultivation before Delhi ruled on the basis of official science. But in the case of Bt brinjal, mobilization of interests backing the crop—both in Delhi and in the states—was feeble, almost non-existent. Moreover, the risk narrative of the GMO had clout where it counted. In 2009, the GEAC approval of a transgenic eggplant, based on nine years of testing, prompted intervention by the Minister of Environment, who called for public input to complement state science. Following public meetings in seven cities, in February 2010 the Minister overrode and officially downgraded the GEAC, imposed a moratorium on Bt brinjal, and promised new regulatory authority for rDNA crops.[8]

'Bio-safety' regimes have been established for vetting such crops; safety implies threat or risk. Safety is what political scientists call a valence issue: no one opposes safety. Regulatory science then faces a logical problem: it is impossible to disprove a negative, to prove that no potential hazard attaches to any innovation. No testing can prove that rare events will not occur in the future. This is a powerful political meme: GMOs are not *proven safe*. The dilemma for authorities is the seemingly impossible task of finding acceptable measures for risk/benefit calculations applicable across potential hazards given radically different individual risk preferences and aversions. What common metric of acceptable risk could apply to surgery, air travel, raw milk, vaccines, and novel proteins in eggplants?

Creation of a category of special risk creates uncertainty that puts state science on the defensive: how many studies are necessary? Sufficient? Who will serve on panels? To what extent is expertise a pre-condition for meaningful participation? Does special expertise inevitably coincide with special interest? What credibility could an assessment of molecular engineering of plants have without molecular biologists? However, does working in the field of molecular biology not create an interest of practitioners in future applications of the technology? Answers are not obvious; for mass publics, assessment is essentially impossible to sort independently.

Bio-safety regimes are to assure society that potential hazards in genetic engineering can be known and managed. Making credible safety claims on behalf of public interests then introduces, but only pretends to solve, the Goldilocks paradox: regulation should be not too little, not too much, but just right. If too little, a real hazard might result. Professor Séralini's science—though repudiated by the European Food Safety Authority and supported by only one paper, commissioned by Greenpeace and not peer-reviewed[9]—predicted organ failure and death from Bt brinjal. Even with no evidence of hazard, the implied attribution of risk creates a capacious political opportunity for opponents of the technology. Too much regulation, on the other hand, favors multinational life-science firms with deep pockets, professional staff, and connections able to cope with regulation. Bt cotton offered a concrete example: the only 'monopoly' Mahyco-Monsanto had was one conferred by official regulation in New Delhi; their hybrids for a time were the only ones ruled bio-safe. Their only early competition—Navbharat Seeds—was squashed by regulators not for violation of bio-property, of which there was none, but for violation of the biosafety regime (Scoones, 2006). Politically, biosafety institutions thus disproportionately empower small numbers with appropriate cultural capital, skills, and connections to unsettle official science in the minds of mass publics and politicians. These actors are typically not farmers.

Finally, the structuring of state science matters fundamentally. One might ask why the Minister of Environment rules on risks to food safety. Why is the decision not with the ministry of agriculture or science and technology? In India, as in many countries, environment ministers are empowered with veto rights over GMOs and often oppose ministers of agriculture—which in fact, happened in the case of Bt brinjal. Absent the framing success of international ideational construction of the GMO, and placement of the GEAC under an environment minister (since transgenic plants are regulated under an environmental protection act, consistent with the logic of the Cartagena Protocol), Bt brinjal would not have faced so high a hurdle. Likewise, had the Bt eggplant been a genetically engineered pharmaceutical instead of an agricultural crop, it would have faced no special scrutiny or testing, but evaluated as other pharmaceuticals. As a result of both ideational and structural factors, conclusions of state science proved vulnerable to a single politician who uncovered, not surprisingly, vociferous opposition in his tour of seven Indian cities.

Why seven cities? Urban bias was a charge brought against the Minister by defenders of the GEAC: why should meetings with 8,000 people in urban India constitute public opinion in a nation of almost 1.3 billion people? Yet India is not alone in this bias: farmers receive lagged and uncertain access to products of the genomics revolution taken for granted by urban populations, and urban populations have much to say about what crops are acceptable for farmers to grow.

8. *A thorough, detailed account of the contests in the science and public sphere is available in Rao (2010). For conclusions of state science that Bt brinjal would help farmers in terms of agro-economics and environmental protection, see the analysis in Herring (2014b). This section follows that publication closely. On interests, see Kolady and Herring (2014).*

9. *See Ministry of Environment and Forests (2010), Rao (2010), Herring (2014b), and Review of Agrarian Studies (2011).*

Anticipatory Risk: Ideas and Interests in Biotechnology

One conclusion on the politics of agricultural biotechnology is that ideas have more power in specific instances than interests. There are limits to the power of ideas, constituted by interests, but even interests in this sphere are deeply dependent on ideas (Blyth, 2002). If a consumer has an interest in environmental integrity or safe food, is a transgenic eggplant in his/her interest or not? Are pesticide residues more or less risky than the cry1Ac protein? Which epistemic broker is he/she to trust? Does the Government serve her interest in a manner to be trusted? The answer is dependent on ideas about hazard, risk, and trust in science that are heavily mediated by informational and political networks to which she belongs. Of great importance in this mediation is state science and administrative integrity: how is risk detected, measured, and regulated? Acceptance or rejection of biotechnology depends on these ideational politics of risk.

Anticipatory risk is the most important—and often decisive—ideational force in politics around *agricultural* biotechnology.[10] Risk in a scientific sense derives from detection of some hazard with some probability or extent of exposure (Thies & Devare, 2007). Assumption of some hazard unique to genetically engineered plants, as opposed to plants bred otherwise, is pervasive in political discourse and administrative law, but peer-reviewed science finds no support for the distinction (e.g., European Commission, Directorate-General for Research, 2010). Nevertheless, states routinely institute regimes of special surveillance and control for genetically engineered crops that create both focal points for mobilization and choke points for effective political opposition (Paarlberg, 2008). The rationale derives from the penumbra of unique threat inherent in the invention of the GMO.

All technological innovation evokes some calculus of risks and benefits. Farmers and urban consumers in India saw these risk-benefit balances in different terms. Farmers cannot afford a lot of ideology, but must assess new traits in crops with a careful empirical eye: what works, at what cost? Benefits are measurable and critical for livelihood; interests are potentially clear (Zilberman, Ameden, & Qaim, 2007). The performance of Bt cotton in India indicated these interests through virtually universal adoption: no silver bullet, but a trait that works well against a major on-farm problem at a cost that is acceptable for the bottom line. Backed by state governments and farmer organizations and a potential national interest in exports, cotton farmers were largely immune to ideational risk narratives of opponents claiming catastrophic consequences. Farmers' livelihoods necessitate taking risks in anticipation of compensating benefits. For urban consumers, there were no such identifiable or divisible benefits in Bt cotton, but also no credible story of risks to their life-chances. Despite rhetorical fireworks, Bt cotton was adopted by farmers the way most useful innovations spread—balancing some estimate of risk against the status quo, as we all do facing surgery or pharmaceuticals, to come to a notion of acceptable risk.

Bt eggplant presented different politics. Hazards in food crops—if real—are plausibly dangerous to urban consumers. The one paper of Séralini cited by the Minister of Environment claimed organ failure and death as a consequence of *cry* protein ingestion. Though state science had concluded that no evidence of such hazard could be found, nor any other comparable to the real hazards involved in current practices of spraying eggplants, a narrative of hypothetical risk took root in urban India. As consumers anticipated no benefit from Bt brinjal—unlike farmers—there was no reason to take any risk, however small or implausible. This logic is not uncommon: in the contemporary United States, social mobilization of an autism risk narrative has resulted in lower vaccination rates, less state mandating of vaccination, and increased collective risk of diseases long conquered by vaccines (Mnookin, 2011). For the individual parent, the risk of autism, however small, dwarfs the risk of not vaccinating children when herd immunity is present.

Proponents of the new Bt crop in India cited international and Indian state science to argue that there was no hazard and therefore no risk. This claim did not convince everyone, and most importantly did not convince the only person who mattered: the Minister of Environment (Rao, 2010). In common with politics of biotechnology in many other nations, it was not a vote in Parliament, nor a national referendum, that decided the fate of this genetically engineered agricultural crop. Nor was it a decision by the Minister of Agriculture. Instead, the decision was narrowed to a committee of scientific experts that could be overruled—and was overruled—by one cabinet minister. One implication from

10. *Gupta (2011) evokes the notion of a 'science-society contract' as a necessary condition for legitimacy in 'anticipatory risk governance.' Where one assumes risks that can only be anticipated, not demonstrated, exists a matter of political mobilization of ideas in which the invention of the GMO has proved decisive in many cases.*

India is then that campaigns, petitions, demonstrations, and various expressions of public opinion in opposition to or support for biotechnology may remain nothing but noise in the political system unless translated into effective politics. For this to happen, there must be a common goal of political actors—not simply common interests—as well as credible mechanisms to pursue those goals and access to an arena where these goals can be achieved (Elster, 1989).

This was not the case for Bt brinjal. Mobilization of scientists both national and international proved unequal to the attitudes toward risk and science of a single politician (Herring, 2014b). The global war of ideas about biotechnology mattered fundamentally, but in a distal not proximate way. The critical ideation achievement was in lumping and splitting of biotechnology to create the GMO and subsequently establishing national institutions with Cartagena logic. In these forums, questions of risk are dominant. The Cartagena Protocol was a global agreement implementing a framework Convention on Biological Diversity, not food and agriculture, nor farmer welfare. It originated in the politics of nominally environmentalist forces hostile to biotechnology on grounds of hypothetical risk.

Much of the academic literature on GMO politics is about the science. And indeed, science by its very epistemological commitments is vulnerable to politics: all findings are tentative, subject to revision. Scientists see field trials as a necessary means of assessing risks and benefits of new crops; opponents oppose or destroy field trials armed with the conviction that the answers are already known—nothing in the trials could produce countervailing information sufficient to change minds of fundamentalists. It is hard to find effective answers to fundamentalism: there is no space for evidence. Mobilizations of counter-expertise in civil society rooted in such *ex ante* certainty have successfully opposed science endorsed by states in numerous episodes. *State* science is also vulnerable on grounds of political interests: the motives of those anointing the experts can always be questioned, as well as the objectivity of political appointees. Finally, science necessarily involves money; there is always the suspicion that individual ambition or financial dependence skews results.[11]

11. *Former President of India Abdul Kalam surprised students at the National Science Congress on January 3, 2012 in acknowledging this fact of life. Asked how he could reconcile his dual roles as a person of science and one of politics, he answered that science requires a lot of money, and politicians of necessity are the source of such money.*

The GEAC in New Delhi proved vulnerable to such critiques during the campaign against Bt brinjal. As a result, approval of a modest vegetable split the cabinet, produced structural changes in India's governance of biotechnology, and resurrected political forces sidelined by wholesale farmer acceptance of Bt cotton (Herring, 2014b; Jayaraman, 2010; Rao, 2010). Were brinjal farmers not so few, small-scale, unorganized, and politically powerless, their interests might have prevailed despite urban mobilization, as was the case with Bt cotton. Were Bt plants not subject to so high a burden of proof of innocence, facing a veto player in the Ministry of Environment, their lack of organization and political clout would not have mattered.

But even without effective attacks on state science of the kind illustrated in Bt eggplant, even the most robust science must remain agnostic on issues important to mass publics. Science has no method to determine appropriate levels of risk aversion. As there will always be some uncertainty in science, and certainly fringe scientists in every field, operative politics revolves around construction of risk. The implication is that risk politics—once instigated—cannot be answered with science decisively. Moreover, there is no normative answer to how precautious is cautious enough; the precautionary principle is not helpful. Opponents of technical change construct this inevitable uncertainty as 'anticipatory risk governance' (Gupta, 2011). Any level of risk aversion, however poorly founded in evidence of hazard, is therefore likely to slow innovation (Herring, 2014a). This is not because numbers count in democracies, nor because of seriously disputed science, as commonly believed. Rather, uncertainty inherent in all technological change has been successfully coded as risk in places that count, including regulatory institutions created by that very *a priori* assumption itself. How do we know that traits introduced by molecular techniques are risky? In a curiously circular institutional logic, rDNA crops demand special surveillance and control because there are biosafety institutions created for that very purpose and for that purpose alone.

Anticipatory risk is then an expansive and untethered claim in politics, needing no confirmation, or even specification, to have effect under certain structural conditions. Risk politics around Bt cotton were largely about agrarian risks centered on unsupported claims of agronomic failure. Farmer interests were sufficiently strong, however, that risk politics of campaigners had little purchase. Bt eggplant presented a more capacious opening for risk politics; food crops are more responsive to anxiety framings than are fiber crops. The new Bt crop elicited a rational strategic change in oppositional politics, away from risks of agro-economic catastrophe to hypothetical risks centered on biodiversity and urban consumers, neither identifiable. As a consequence, concerns about Bt brinjal proved more telling than either potential or performance, producing strong headwinds against agricultural biotechnology in India. These headwinds would not have mattered so much, however, had regulatory authority been structured into ministries other than environment, or had a different minister of environment been in office. That outcome makes the future of agricultural biotechnology particularly uncertain. If determined by the grounded assessment of farmers—their settling of concerns, their experience with performance, their projection of potential—rather than by a distal state or urban critics connected to even more distal global networks effectively wielding risk narratives—there will be more cases like Bt cotton and fewer like Bt brinjal.

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