Continuities Across Domains of Landscapes and Genomes: Science, Uncertainty, Public Goods[1]

Ronald J. Herring, Cornell University, Ithaca NY 14850 USA
rjh5@cornell.edu

CONFERENCE DRAFT

Please do not cite without author's permission

Abstract: This paper investigates the intersection of cultural logics and political economy in defining and attaining human collective interests in nature, without which any political ecology is theoretically impoverished. Public goods and bads in nature are of necessity embedded in normative logics that are culturally anchored but demonstrably fluid, contrary to the practice of economistic interpretations of political economy. Likewise, though "interests" form a bedrock of explanatory structure in political economy, interests are demonstrably fluid, and, more importantly, necessarily filtered through an ideational screen in order to become meaningful and thus actionable. One interest-deflecting and defining cognitive screen is science. Science continually presents new challenges to the way interests are understood by citizens and political classes that control states; the sea change introduced by the atmospheric science of ozone holes and global warming is archetypal. Transgenic organisms represent a particularly compelling illustration of these dynamics. These dynamics will be suggested by the case of Bt cotton in India. Some suggestions are made as to why some configurations of knowledge claims win politically while others lose. Politics dependent on junk science have a clear advantage as the core characteristics of science-as-method – skeptical agnosticism, tentative conclusions, replicability, validation in epistemic communities – is forgone for the reassuring simplifications of ideology. Science is inevitably a work in progress, and therefore incomplete, uncertain -- a crippling political condition.

---

[1] **Prepared for the 18th European Conference on Modern South Asian Studies, at Lund, Sweden, 6–9, July 2004**

Prelude: Monsanto and the Mud

In July 2003, at a meeting in Palakkad district, South India, to memorialize the great peasant leader Keraleeyan, agrarian activists continued to tell me and each other of threats from "the terminator." Before the formal beginning of the public meeting, I had explained carefully that the whole "suicide seed/terminator/Monsanto" narrative was a product of Delhi, a Canadian website and political rhetoric, not reality. Politely, no one told me that I was talking nonsense. At the meeting itself, P.A. Vasudevan said that the current stage of the historic agrarian struggles for which Kerala is justifiably well-known is only for "the mud," as the world of agriculture will be controlled by Monsanto and Cargill, via biotechnology; the mechanism was "the terminator." Vasudevan added that popular forces had learned how to struggle against and defeat the landlords, their goondas and the police, but they did not know how to fight globalization.[2] The emergence of the most recent farmer organization in a district already very heavily organized seems to bear out this analysis: the *Deshiya Karshaka Samrakshana Samithi* (National Farmers Protection Committee) was formed to provide protection from globalization, one prominent manifestation of which was Monsanto. A new organization was needed because "the political parties have failed the farmers."[3]

Upon probing, it appeared that the protection sought was of the familiar defensive-reaction characteristic of Polanyi-esque rejections of the wrenching confusion of market society. In this, the DKSS joined a national movement linking external threats to nation and the poor to multinational corporations and Monsanto in particular. Monsanto was [falsely] accused of owning a patent on a terminator technology, of planning to unleash this bio-cultural abomination on India via the field trials of Bt cotton. What is technically gene use restriction technology

---

[2] Vasudevan's perspective on the historical uniqueness of agrarian struggles in Kerala is accurate in comparative terms. See Herring 2003.

[3] See National Farmers' Protection Committee, Plan and Budget 2003, Palakkad, India. "The primary objective … is to ensure farming to be a remunerative and honorable vocation and restore to the Indian farmer his lost dignity and societal recognition [p2]."

(GURT) was dubbed the "terminator," evoking a fairly dramatic image for those familiar with the internationally popular film of the same name.[4] The term itself, and the alarm to India, originated with the Rural Advancement Foundation International (RAFI) of Canada. RAFI linked terminator technology to "suicide seeds." 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.[5] 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. Monsanto was powerful, American, and carried baggage of its checkered history. Clubbed together with Dow Chemicals, which together "brought us Bhopal and Vietnam,"

---

[4] For a technical explanation of the terminator, G.V. Ramanjaneyula and A. Ravindra, l999, **Terminator Logic: Monsanto, Genetic Engineering and the Future of Agriculture**. Science for People/Research Foundation for Science, Technology and Ecology. New Delhi. January. A futile attempt to explain that there was no terminator in India, or anywhere else for that matter, and that Monsanto had no patent on the technology, was contained in a report of an interview with the firm's chief in India: Sharad Mistry, **Indian Express**, 1998, "Terminator Gene a Figment of Imagination: Monsanto Chief," December 4.

[5] In a ***Communique*** of February-March 2000, and a news release of February 20, 2000, RAFI produced a refutation to the notion that the terminator had been stopped. "Terminator 2 Years Later: Suicide Seeds on the Fast Track." RAFI International Office, Winnipeg, Manitoba, Canada. RAFI noted that the international campaign to renounce the technology had been endorsed by many governments and by the Director General of the United Nations Food and Agriculture Organization (FAO) Jacques Diouf. Nevertheless, RAFI notes that research on the terminator continues. See also, "Terminator Technology Not Terminated," 2000, Agra/Industrial Biotechnology Legal Letter. Vol. 1, No. 1, pp. 4. January. These perspectives were consistent with author's experience in discussing the technology with activists opposed to GMOs in various parts of India.

Monsanto was accused of planning to "unleash genetic catastrophes."[6] Real attributes of the firm's record were combined with a false attribution to Monsanto of property rights for engineering sterile seeds -- the terminator. A social tragedy deepened this symbolic opening. A rash of suicides by debt-ridden farmers -- most notably in Warangal district, Andhra Pradesh, but widely spread -- was linked explicitly by activists to globalization of agriculture and new technologies. Vandana Shiva, with colleagues, produced in 2000 a volume **Seeds of Suicide**, "dedicated to the farmers of India who committed suicide." Deepening dependence on hybrid seeds of multinationals – variously called "seeds of death" or "suicide seeds" -- did not distinguish transgenic seeds from other hybrids; nevertheless, field trials of transgenic cotton in l998 were tainted as an opening wedge of terminator technology in India.[7] 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. Neither the non-existence of the threat nor these official assurances stopped the campaign.

In a losing cause, Monsanto's marketing director for India responded that the farmers' suicides had nothing to do with Monsanto at all, but ironically might have been prevented by its technology. With transgenic cotton, Monsanto argued,

---

[6] 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.

[7] On the debt nexus as a cause of suicides, see Centre for Environmental Studies Warangal, l998, **Citizens' Report: Gathering Agrarian Crisis – Farmers' Suicides in Warangal District (A.P.) India**. Kishanpura.; Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, 1998, **Report of the Study Group on Distress Caused by Indebtedness of Farmers in Andhra Pradesh**. New Delhi. September; Glenn Davis Stone, 2002,"Biotechnology and Suicide in India." **Anthropology News**. May; Shiva et al (op. cit. 2000), pp.64-110; Srinand Jha, 2001, Seeds of Death, GMO Cotton, India. www.tompaine.com May 30; interview with Devinder Sharma, 2001, "The Introduction of Transgenic Cotton in India." **Biotechnology and Development Monitor**. No 44. March. pp.10-13.

farmers would have had less debt from pesticide purchase and less loss of yield – less poverty, fewer suicides. Glenn Stone (2002:1) noted that "India is a key battle line in the global war over GM crops, and both sides interpret the Warangal suicides as supporting their position."

It was the extra-national vector of introducing transgenics into India that provided a handle for mobilization of farmer opposition. Indeed, it is a fascinating counter-factual to imagine the politics had the GMOs come through the Indian public sector – as is now unfolding with both Chinese and Indian versions. But in the event, biotechnology and globalization were joined at the hip in social-movement constructions; the technology was inseparable from the property. Though tactically astute, this construction was conceptually and strategically problematic, but pervasive. Vandana Shiva's **Biopiracy: The Plunder of Nature and Knowledge** was published in l997; 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, concern with intellectual property rights and corporate power was married to cultural and nationalist themes of self-reliance, nonviolence, local knowledge and biodiversity.

Stealth Seeds: The Discovery of Transgenic Cotton in India

Opposition to transgenics in India had elided "suicide seeds" with "the terminator," and conjoined both with a rash of suicides of cotton farmers, particularly in l998 [Herring, in press; Herring 2003b; Visvanathan and Parmar 2002, Parmar and Visvanathan 2003]. The vicissitudes of cotton in India are extreme. Yields are the lowest in the world, the area under cotton the highest [James 2002]. Insect infestations are worse than those of many competing cotton areas in other parts of the world. A bitter irony in the farmer suicides is that insecticides unable to protect crops were sufficiently strong to kill farmers ruined by the debts incurred to purchase pesticides. Sharad Joshi, leader of the largest independent farmer organization in India, the Shetkari Sanghatana wrote in a manner typical of the farmer suicide epidemic: "It [2001] was a year of miseries

for the cotton growers of Maharashtra. Neelkanth Mankar, a cotton grower in Yavatmal district, unable to face creditors, committed suicide."

But in neighboring Gujarat: "Through a lucky stroke a nondescript seed company managed to play Robin Hood and smuggle into Gujarat one line of anti-bollworm gene. For three years nobody noticed the difference and then came the massive bollworm rampage of 2001." There was no way to distinguish transgenic lint or seeds from their opposites, but the fields indicated the difference:

> " Gujarat saw all its traditional hybrid cotton crop standing devastated, side-by-side the Bt-gene crops standing resplendent in their glorious bounty. The Government was upset and ordered destruction and burning of the bountiful crop."[8]

Neither NGOs waging the "Cremate Monsanto" movement nor the Government through its Genetic Engineering Approval Committee in Delhi noticed the transgenic cotton. Monsanto's Indian partner MAHYCO did, and turned Robin Hood over to the Sheriff of Nottingham in Delhi.

The stealth seeds were known as Navbharat 151. They were originally detected in Gandhinagar district of Gujarat in six locations. Press reports typically said that the extent of coverage was over "10,000 hectares" [or sometimes "10,000 acres"] in extent, and this has crept into academic accounts. Either estimate is groundless. Precisely because these were underground seeds, no one knows exactly the extent or location of plantings. The GEAC investigated during the last week of September, and found to their great surprise that MAHYCO's charges were true. The cotton was indeed transgenic, containing the Cry 1A[c] gene in the construct of Monsanto. The head of Navbharat, Mr. D.B. Desai, was summoned to Delhi for the October 9 meeting of GEAC to explain violation of the biosafety guidelines: no

---

[8] Joshi 2001; his account of discovery conforms to accounts given me by two people who toured fields in Gujarat at the time as part of their jobs. Purvi Mehta-Bhatt and Deviprasad Mishra, personal communications. See also Jayaraman, 2001b; Shaik, 2001.

transgenic crop could be planted without a complex series of confined and open-field tests and final approval by the GEAC. Mr. Desai claimed he did not know there was a Bt gene in the plant and did not appear at all. On October 12 the GEAC met again and ordered the Gujarat Government to act: but Gujarat state had not set up a biosafety committee, as all states are supposed to do, and the GEAC itself has no police powers.[9] Farmers were mobilized. The crop stood.[10]

The GEAC ordered not only burning of the crop, as the farmers' organization notably scorned in their resistance, but also 1) a public warning in regional newspapers; 2) retrieve seeds from farmers' houses and ginning mills and destroy them; 3) collect the lint, store it in steel containers, send it to the Central Institute of Cotton Research in Nagpur for testing; procure all yet-to-be harvested crops from farmers 5) uproot and burn the standing crop and sanitize fields. But these seeds had to have come from somewhere. By first week of November, it was discovered that there were 460 acres of seed farms scattered around the Kurnool and Mahabubnagar districts of Andhra Pradesh. [11] But it was widely believed that other stands of parent seeds were growing in Punjab and Maharashtra (which would make sense in terms of the alacrity with which the *Shetkari Sanghatana* moved on the issue). Six months later three varieties of the Monsanto official variety of Bt were approved for a three year provisional period.

There is no space here to explore the complicated issue of welfare implications for farmers in the evident political victory of Bt cotton technology –

---

[9] Minister for Environment and Forests, Shri T.R. Baalu, "Cultivation of Bt Cotton Using Navbharat Seeds," Government of India, *Rajya Sabha* Unstarred Question No 205 to be answered on 01.03.2002.

[10] On the politics of the *Shetkari Sanghatana*, see Omvedt in Katzenstein and Ray, ed (in press); Herring (in press). The account in the text is also complemented by a discussion with Mr. Raju Barwale, Managing Director of MAHYCO, May 28, 2004.

[11] Minister for Environment and Forests, Shri T.R. Baalu, "Restriction of Production and Sale of Bt Cotton," Government of India, *Rajya Sabha* Unstarred Question No 206 to be answered on 01.03.2002.

which could be reversed officially, but probably not in the underground seed market. Critics of the erstwhile suicide-seed coalition continued to hail the "failure of Bt cotton" but the farmers were not listening. Actually, there is no such thing as "Bt cotton." There are multiple cultivars of cotton with the Bt gene. None of the claims of failure that I have seen compare two isogenic varieties, one with and one without the Bt gene. Rather, all disadvantageous variance across cotton crops is attributed to the Bt gene; there is no biological evidence for this at all.[12]

It is not known how many "Robin Hoods" – in the construction of Sharad Joshi – are active in rural India. There are at least ten name-brand Bt cottons in circulation: *Sarathi*, *Rakshak*, *Maharakshak*, *Viraat*, *Agni*, and simply "151" playing on the original Navbharat 151 variety, among others.[13] There are also F2 generations of the various Bt varieties: these are off-spring of the suicide seeds, giving a lesser Bt expression but still, in some estimates, about 75% protection.[14]

There is of course irony in this spread of the Monsanto-Mahyco implementation of Bt technology: their seeds are much more expensive, and their market share is almost certainly going to decline, as numerous entrepreneurs continue to make transgenic backcrosses with local varieties. Monsanto has only the three varieties, and these seem not to be the best varieties on the market. The

---

[12] One claim is that the Bt cotton has short fibers, and thus is not saleable. In fact, some cultivars have longer fibers than others, but all are very close; rather than a penalty, Bt farmers receive a premium on their sales because the bolls are less damaged by insects. Barwale, op cit; Roy personal communication.

[13] "GM is Cottage Industry; Hybrid Seeds Flood Gujarat Fields," Rajkot/Junagadh, May 28, 2003 SeedQuest NewsRelease; K. S. Jayaraman, 2001b.

[14] Hybrids do not usually breed so true, but in this case the behavior of bollworms contributes to the effectiveness of the Bt lines. Bollworms, unlike stem borers, move from plant to plant; not every plant has to be expressing the Cry 1A[c] gene for the crop to receive a lot of protection. As the "loose" unnamed seeds (so-called because they do not come in the neat packets of the official seeds) are much, much cheaper, this strategy may be better for some farmers and in some years (of low bollworm infestation).

gene is of course not patented in India. The long development costs and time – estimated to be around $8 million -- put the official seeds at a disadvantage in the market. Monsanto would like a strict regulated capitalism promulgated by the GEAC in which only its seeds are legal. But farmers vote with their plows; the outcome is an anarcho-capitalism without rules. This outcome is not in the interest of seekers of innovator rents via state protection of intellectual property – in this case both Monsanto and Navbharat.

Bt cotton has been in the field for too short a time for definitive assessment. Kameswara Rao's measured piece is tellingly entitled "One Swallow Does Not a Summer Make [2004]." More and more data are being compiled, much of it rejected by the suicide-seed coalition on grounds of being tainted by Mahyco-Monsanto sponsorship, and none of it long-term enough for robust conclusions. But unless we think farmers irrational, there are clear evidences of the Bt technology's having effects in India that are similar to those in China, where both the Monsanto and public-sector versions of Bt cotton are adopted rapidly by small farmers [James 2002; Pray et al 2002]. They do this for higher yields, less pesticide application against bollworms, and higher profits. In addition, unpublished data from Mahyco indicates that farmers who purchase seeds come back and purchase more the second season. This outcome is rather surprising given that Mahyco's Bollgard is much more expensive than the "loose" seeds of dubious origin – many off-spring of Navbharat 151, F2 generations, farmer-generated back-crosses and new small-firm products – at least a dozen of which have now been detected in the fields.[15] Farmers are experimenting widely with different varieties of Bt seeds, and

[15] Devparna Roy's field observations are contained in "Cotton Wars: Gujarat Farmers and the Land Question" draft ms, Cornell University 2004. A study sponsored by Mahyco is described in ACNielsen. 2004a. "Nationwide Survey by ACNielsen ORG-MARG Underscores Benefits of Bollgard™ Cotton." Press Release. ." AC Nielsen ORG-MARG. Mumbai; ACNielsen. 2004b. "Performance of Bollgard Cotton in 2003." PowerPoint produced by ACNielsen ORG Centre for Social Research. Mumbai (March 26). Results of Matin Qaim and David Zilberman, 2003, "Yield Effects of Genetically Modified Crops in Developing Countries," **Science** 299. pp 900-902 are probably exaggerated in terms of the size of farmer benefit because of the level of pest infestation in the year of study, but even so gives a sense of the insurance function of more expensive seeds that provide real protection.

with non-Bt seeds. Neither duped nor passive puppets of multinational monopolists, Indian cotton farmers are continuing the primordial struggle of agriculture against the bugs.

And the elaborate institutional biosafety regime that was to have prevented this genetic anarchy? A. K. Dixit, Director of Agriculture for Gujarat, said: " It is impossible to control something at this large a scale. When we go tot the fields, we become targets for trying to take away a beneficial technology from farmers." The state government, and by default the national government, lets the genetic roulette wheel continue turning.

Revisionism:

It would be wrong to conclude this sketch of the Bt cotton story without coming full circle to the opponents of the technology. What knowledge have they acquired in this conflict? The spread of the suicide seeds seems interminable, contrary to the dominant construction of opposition. And yet, when I presented this story to activists against transgenics in Palakkad district in the summer of 2003, the response was largely that the farmers had been duped or coerced; if they were buying transgenic seeds, they were falling into the trap of the monopolist Monsanto.

But there are other strands of resistance. Responding to a BBC story that portrayed the farmers of Gujarat as clever pirates of Monsanto's intellectual property – as implied by Sharad Joshi's Robin-Hood characterization – the Research Foundation for Science Technology and Environment [headed by Vandana Shiva] rebutted:

> "This rumour about piracy is initiated by Monsanto whose Bt cotton has totally failed throughout the length and breadth of the country and to divert attention of the public and policy makers from the failure of its genetically

> engineered seeds, Monsanto is trying to focus on the outstanding success as unjust and illegal of an indigenously bred cotton variety."[16]

"Indigenously bred," perhaps, but equally transgenic. Despite charges of failure, demand for the Mahyco/Monsanto varieties continues to grow, despite their tremendous price disadvantage to the illicit seeds with the same gene.[17] The charge of genetic pollution and the saving construction of indigenous breeding may salvage the opposition's story but sits uneasily with the facts. Just as the "terminator" construction of Monsanto's seed threat came from a website in Canada, so too does the revisionist political response of the anti-transgenic forces bear a striking resemblence to the construction of Canada's most famous practitioner of biopiracy – in Monsanto's view – or martyr to corporate power – in the opposition's view. Percy Schmeiser's defense in the case that he lost repeatedly, most recently in the Supreme Court of Canada in June of 2004, is that he has not been a thief but a victim. Mr. Schmeiser argues that he did not violate intellectual property rights via transgenic canola seed production on his farm, but rather was the victim of genetic pollution.[18] The revisionist reconstruction of RFSTE makes the same argument. This reconstruction allows Navbharat – and Navbharat's Desai -- to remain a hero of indigenous plant-breeding. The major trait responsible for Navbharat's success – resistance to bollworm – now becomes

---

[16] Press release of June 20, 2003, New Delhi.

[17] Unpublished data from Mahyco-Monsanto show not only more transgenic acreage planted in the aggregate, and more farmers using the technology, but second-time buyers buying more seeds the second time around. Devparna Roy's findings (2003) suggest that the Robin-Hood Bt seeds may be growing faster than the sanctioned seeds, as they are cheaper, and often give better or at least acceptable results.

[18] Conversations with Percy Schmeiser, January 27-28, 2004. The formal presentation of the history in this complicated case is in two federal court judgments currently available outline: Federal Court of Canada Ruling of March 29, 2001, http://decisions.fct-cf.gc.ca/fct/2001/2001fct256.html and Federal Court of Appeal Ruling September 4, 2002, http://decisions.fct-cf.gc.ca/fct/2002/2002fca309.html last accessed May 5, 2004.

incidental to its success and an accident of horizontal gene flow. The Monsanto Bollgard construct, clearly present in Navbharat 151, is thus explained away.

Percy Schmeiser may or may not have illegally appropriated Monsanto's intellectual property claims: the courts say yes, his international following says no. But no one thinks of Percy Schmeiser as a Robin Hood; he runs a very large commercial operation as was not out to give to the poor, by his own account. To the contrary, Sharad Joshi's Robin-Hood construction of Desai and Navbharat is explicitly heroic: it celebrates what was almost certainly a calculated act of seed stealth followed by excellent plant breeding. But there is no evidence at all for the proposition that the Bt cotton spreading around Gujarat is a somehow accidental. Rather, it is the predictable result of anarchic capitalism in which farmers know their interest and have means of resisting both international capital and domestic state. This is in part because of the inherent complexity of natural systems, whether of landscapes or genomes: the science of ecology teaches us that there are unexpected and often imperceptible interconnections among all elements that make up systems, across vast scalar differences, from microbial to atmospheric. This complexity and the core commitment of real science, again in the sense of Meera Nanda, to skeptical agnosticism with very high standards of validation, combine to produce political impotence. The history of global warming discourse represents a telling case in point. Real science is inevitably incomplete; junk science has ready answers. It is not necessarily that purveyors of junk science do not have knowledge, but rather that they do not care about knowledge – the analogy to George Bush is too apt to ignore. They are not epistemologically curious. Consider the position on burning test trials meant to find out if there is danger in transgenics.

In terms of knowledge claims, the political vulnerability of genetic engineering is the acknowledged incompleteness of any firm estimate of risks: the honest scientist admits to uncertainty, a more troubling position than that of risk. Probability distributions are unknown; the unknown is inherently frightening, and the elision of uncertainty to anxiety is an easy cognitive path. As we have long known, anxiety is the condition under which we expect the most powerful effect of symbolic politics, which is the terrain of narratives.

In the specific case of Bt cotton, the junk science and social science of terminator genes, monopoly control, and suicide seeds has been decisively defeated on the ground by the farmers themselves, in whose name multiple

narrators speak. That seems clear. What is not clear is whether or not this outcome poses socially acceptable risks. The triumphalism of Monsanto and its supporters to the contrary, much about the long-term effects of the genomics revolution remains uncertain. There are no real answers with any degree of certitude approaching that approaches the standards of real science, at least not yet.

Just as the Bt controversy began with a nationalist (and Gandhian) theme of resisting foreign threats to India, so too has the conclusion of this phase – ending in official approval of three varieties for cultivation – ended on a nationalist note. *Khedut Samaj* leader in Gujarat Bipin Desai charged that the failing Bt technology has been approved by the government, but the successful one, the home-grown Bt variety [Navbharat 151], has not been approved. The Vice President of the organization, Labshankar Upadhyay, said: " The BJP talked about *Swadeshi*. But it promotes a foreign company at the cost of an Indian firm. And we [farmers] stand to lose." The RFSTE construction permits a nationalist affirmation and attack: the Government has officially allowed, certified, approved a foreign incarnation of the Bt technology, but filed a court case against an indigenous plant breeder who is now held to be the victim of that technology [INSERT REFS]. This may or may not be good political tactics, but it certainly is better than the obvious alternative.

One outcome of the Bt conflict in India, too dynamic to treat here, is well summarized by Suman Sahai (2002), of Gene Campaign: "the market is awash with the illegal, unregulated cotton varieties, making a public mockery of India's ability to regulate and direct the use of this new and controversial technology." A Task Force to investigate biotechnology futures in India, chaired by eminent agriculture scientist M. S. Swaminathan, concluded: "Public regard and satisfaction for the regulatory systems currently in place are, to say the least, low (Bagla 2004)."

An Emergent Standard Narrative on Transgenics: Return of the Reverend Malthus and the Terminator

If the account to this point suggests that only social movements promulgate narratives in which framing is powerful, it is a misleading account. The level of uncertainty and the complexity of the empirics to date suggest that any account which seeks to be definitive will partake of the narrative form. I see a standard narrative on the public goods associated with biotechnology emerging in a space

free of multinational self-interested ideology, and parallel to the NGO narrative of suicide seeds and farmer doom. I will lay out that emergent consensus narrative through examination of one widely validated text, supplemented by commentary.

Per Pinstrup-Andersen and Ebbe Shiøler's **Seeds of Contention** [2000] won the World Food Prize for 2001. This recognition is indicative of what may now be considered an emergent standard narrative of transgenic crops and development. It is a narrative endorsed in substantial part by the UNFAO, the Nuffield Council, the World Bank's CIGIAR system, the UNDP and numerous scientific and developmental organizations in global North and South.[19] Transgenic knowledge and technique constitute a public good in this narrative for contributions to alleviating world hunger and environmental degradation, in addition to the longer established contributions to pharmaceuticals and health.

The standard narrative departs both from the apocalyptic vision of the many NGOs adamantly opposed even to the testing of transgenic crops [vide *Operation Cremate Monsanto*] and from the transparently instrumental propaganda of multinational firms selling seeds. In this construction, transgenics are neither miracle seeds nor suicide seeds. The standard narrative instead deploys the metaphor of a tool kit: transgenics will not solve the problem of "world hunger," but represent a new tool, among others, just as many of the traditional tools are proving either inadequate to the task or come with too many cumulative externalities – particularly environmental – to be sustained.

At the core of the global controversy among these narratives is not only science, but representation. Both sides have a developmental story to tell, consonant with their positions. Beginning their preface, Per Pinstrup-Andersen and Ebbe Shiøler claim to represent no one, but feel that "too many well-to-do individuals and groups from Europe and North America have taken an unacceptably paternalistic position, claiming to represent the interests of the developing countries and to know what is best for the poor within these countries." Echoing Richard Nixon, the authors suggest that there is an "almost silent majority" of people in low-income countries who are not being heard [p xi]. Of the many arguments for and against transgenics, environmental integrity has been the most contentious. Unfortunately, much is unknown: primarily the risks involved in

[19] Insert refs

horizontal gene flow in agro-ecological systems. No observer sans political agenda denies these risks, but no one knows their magnitude, nor what a decisive test to establish a range of confidence would look like. Clearly the answers have to be disaggregated by crop and region; there are objectively better reasons for Europeans, for example, to be concerned about gene flow than North Americans, as more wild relatives of some transgenics inhabit Old World bio-systems.

Proponents of transgenic crops have an environmental story to tell as well. Per Pinstrup-Andersen and Ebbe Shiøler note that increases in aggregate agricultural production have historically come from two sources other than seeds – conversions of landscapes and application of chemicals to fields. Both have serious ecological consequences. Conversions fragment and destroy habitats and disrupt eco-system services. The authors argue that "… without the scientific breakthroughs associated with the Green Revolution, the increase in India's wheat production alone between 1966 and 1993 would have necessitated plowing another 40 million hectares of land (p 20)." Of course the "green" revolution was not green at all in an environmental sense, but rather involved significant deterioration in natural systems [Conway l997]. Water, the lifeblood of nature, was diverted, poisoned, wasted.

How much environmental damage is socially acceptable depends in part on assumptions about alternatives. A dark Malthusian cloud hangs over current discussions of food policy, though it has become unfashionable among intellectuals to evoke this most dismal strand of the dismal science. Per Pinstrup-Andersen and Ebbe Shiøler argue that "once again Malthus's clash between population growth and food production looms threateningly on the horizon." But things are worse than even Malthus suspected; newly discovered threats to environmental integrity and natural resource conservation have put new constraints on agriculture. "Faced with the complexity of the problem, Malthus would surely have despaired (p 31)."

The riposte to the Malthusians -- that there is, in the aggregate, sufficient food, and therefore distribution is the problem -- is true, but facile.[20] India has

[20] The reasoning behind this position is too complex for the space. Clearly direct and proximate programs for the poor – such as land reform – should have preference normatively over aggregate and indirect approaches – such as increasing supply (which may depress food prices and harm small farmers even as

amassed considerable surpluses of food grains, yet malnutrition is continuous for large sections of the population. True, respond the Malthusians, but this aggregate plenty – which would require radical, and therefore unlikely, reform to reach the hungry – looks to be fragile. As agricultural land goes out of production in favor of higher-return uses (from golf courses to urban sprawl), and water resources are depleted, continuing increases of yield per acre is a logical collective necessity. The rate of increase in yields of major crops has been declining; there must be genetic limits to yields of existing varieties, but it is unclear what these are. Could research at the cutting edge of plant science offer tools to increase the production possibilities frontier for plants that humans have engineered as food over the last 6,000 years?

Possibly, but Per Pinstrup-Andersen and Ebbe Shiøler note a significant problem in the direction and ownership of biotechnology: multinational firms dominate. There has been a decline in the ratio of global public-sector to private-sector research; fear of multinational firms drives much of the opposition to transgenics (*vide* the targeting of Monsanto specifically in the Bt cotton conflict). But there is in principle no reason that public sector research could not yield results comparable to those of the private sector. The Chinese public-sector version of Bt cotton competes well with Monsanto's version in China, and has been extremely popular with small farmers; it is likely to come to India *via* Nath Seeds. Likewise, public sector and public-private collaborations in India promise to provide comparable technologies. Moreover, it does not seem that property rights are so easy to enforce as opponents of transgenics assert. Anecdotal evidence suggests that the best transgenic cotton variety in Gujarat is not Monsanto's, but a product of the small seed firm Navbharat, using the same transgene as Monsanto, but of disputed parentage. Research and development costs are daunting in this field, but nations such as India and China have public-sector institutions that can operate at the frontier of applied research. The multinational nexus, Pinstrup-Andersen and Shiøler argue, has been important politically but has no necessary connection with biotechnology.

Public investment in biotechnology is worthwhile, Pinstrup-Andersen and Shiøler believe, because the *status quo* is unlikely to be sustainable. There are

---

it improves the life chances of some others). See Herring 2003 for a more substantial treatment.

essentially three paths leading from this dilemma. First, humans could continue to intensify production in an industrial mode now characteristic of vast swaths of the United States. The externalities are severe and increasingly understood. As that path is widely acknowledged to be unsustainable, there is an agro-ecological approach that seeks to increase the percentage of genetic potential of plants realized by better management practices. Pinstrup-Andersen and Shiøler conclude, after weighing logical pros and cons and looking to some evidence, that "… the organic approach, while certainly a worthwhile option in regions with the space, the labor and the consumer purchasing power … is not a cure-all (p 79)." Finally there are approaches from genetic engineering that seek to bypass some of the most dangerous externalities of the "green revolution" path while avoiding the yield limitations of traditional agriculture. There is in principle nothing other than ideology that prevents a synthetic approach utilizing genetic engineering and sustainable agro-ecological practices to protect environments from both traditional attacks of axe and plow and modern assaults from synthetic chemicals.

There is much at stake for the environment in selection among paths. Recent debates in India have highlighted the environmental dangers of a groundwater supply saturated with some of the most toxic chemicals ever produced by humans – insecticides in bottled water and soft drinks, for example.[21] It is clear from the longer Chinese experience, and from early results in India, that India's first approved transgenic – Bt cotton – reduces pesticide load significantly, to the benefit of farmers and the environment. The first victims of environmental degradation are typically the poor, who depend more on natural resources for livelihoods and have fewer exit options than the rich.

Each side in the genetic engineering debate has a poverty story to tell, but they point in different directions. The consensus on poverty that is emerging in the standard transnational narrative is sketched in Pinstrup-Andersen and Ebbe

---

[21] While I was in Kerala in the summer of 2003, Parliament banned the sale of Coke and Pepsi for unacceptable levels of pesticides. Activists in Palakkad district had been opposing the soft-drink giants in public protests in any event, and were pleased to find one more reason to reject them. But when I suggested that the groundwater contamination raised a much larger issue – saturating crops with pesticides – to which Bt transgenics offered a potential solution, there was no interest whatsoever. The terminator construction was winning.

Shiøler's Chapter 5; more recent empirical work buttresses the authors' arguments. Genetic improvements in seeds are typically scale-neutral, meaning there is no lumpy investment necessary (contrast tractors or tube-wells) and thus poor farmers can improve incomes even if transgenic seeds are more expensive. If not, they will not buy them. Second, the most important contribution of biotechnology to the poor may well be in bio-fortification. Because the poor consume the cheapest calories available, endowing inexpensive foods with better nutritional properties is pro-poor. Media hype surrounding the so-called "golden rice" has muddied the waters, but the potential is clear. The argument that more diverse diets are superior to bio-fortification of staples is true but irrelevant. If the poor could afford better diets, they would probably buy them. Malnutrition continues to ravage health, longevity and fulfillment of human genetic potential, no matter how often well-fed critics suggest that the poor need only eat more mangoes. Marie Antoinette's infamous response to reports that the poor had no bread -- "let them eat cake"-- is almost certainly apocryphal; the contemporary equivalent saturates the media.

It is on the subject of risk and uncertainty that the standard narrative has the most fragile walls. Pinstrup-Andersen and Shiøler's final chapter is entitled "Moving Forward: Handle with Care." This characterization is a good summary of the standard narrative's normative stance. The authors are sensitive to the problems of concentrated control by unaccountable firms, endorse ethical scrutiny of each step in evaluating transgenics, stand for "free and informed choice" for consumers and farmers, and "extermination of a terminator (p 135)." This final desideratum circles back on the first comments the authors make about representation and science. Like most of the developmental establishment,[22] Pinstrup-Andersen and

---

[22] Despite its prominence in discourse, 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. Syngenta seems to be the current leader in GURT technologies but has not deployed it in any crop. 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

Shiøler oppose terminator technology because so many farmers save seeds for replanting. The great irony in India is that the so-called terminator seeds of Monsanto (falsely said to own the patent and equally falsely accused of bringing the technology to India) turned out to be incredibly fertile.[23] The 'suicide seeds' sprouted so vigorously that they and their progeny have enabled a kind of genetic roulette in the cotton belt of India. Transgenic cotton seeds are being bred and cross-bred by farmers, small seed firms and charlatans, resulting in both real Bt cultivars that farmers find attractive alternatives both to Monsanto and to traditional seed choices – as well as spurious "Bt" seeds with no transgene at all. Somewhat surprisingly, even F2 generations of the underground seeds, whether saved or purchased – suit the risk preferences of some farmers, since they are much cheaper than the approved Bt varieties, though often not as effective. Fears of Monsanto's "monopoly power" deploying "terminator technology" seem quaint in

---

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, though this fact did not change the global protest focus on "Monsanto's terminator."

[23] The increasingly famous farmer who refused to have his test plot of Bt cotton burned by the KRRS, Shri Shankarikoppa Mahalingappa, stressed in a conversation with me that he could not count on the KRRS explanation of the new technology, but had to see for himself. He then asked for and received police protection for his crops. Mahalingappa found that the "suicide seeds" actually sprouted – at a 95% germination rate – and called arguments of Professor Nanjundaswamy about the danger of the transgenic seeds "a cheap publicity stunt." Neighboring farmers watched his experience closely and were eager to obtain the new seeds. He noted that the foliage did not harm insects other than the bollworm, nor mammals; as far as he could tell as a farmer, there was no danger from the new seeds. He still grows Bollgard cotton, now legal, because "it makes money for me." See also Madsen, 2001; The Hindu (Shimoga Edition) January 3, 1999; Deccan Herald, 1998, "Operation Cremate Monsanto: Raitha Sangha to Burn Bollgard Cotton in Bellary." December 2. Bangalore.

the anarchic agrarian capitalism that has sprouted from transgenic cotton seeds in India.[24]

But hoaxes and political symbolism aside, the terminal irony noted by Pinstrup-Andersen and Shiøler is that the only certain response to environmental risks of horizontal gene flow is something like the terminator technology – perhaps a practicable technology in the field, though to date there have been no applications for field trials. If the technology works, it would avert the most serious environmental externalities. (The notion that terminator genes themselves would spread is obviously a non-starter: sterile seeds spread no genes at all). But political opposition to this technology has pulled it back from the frontier. At the same time, the anarcho-capitalism of both Gujarat and Rio Grande do Sul suggests that if intellectual property rights are to be enforced, it will take stronger stuff than the fears of Vandana Shiva: the terminator technology is the logical biological solution to this political and institutional problem. Again, we find ourselves on the terrain of political ecology.

Political Ecology and "Development"

Political ecology has many definitions, but all converge on the political economy of nature. Political economy, in turn, is the study of who gets what and how, or the dynamics of interests within structures. Agentless structures and structureless agents are equally inadequate as explanatory frameworks. "Interest," however, turns out to be more problematic than most social theory suggests, inevitably bringing the culture problematic into discussions of robust political ecology -- how nature is conceptualized, valued, and understood as a dynamic system. This relationship is widely accepted among self-identified practitioners of political ecology.[25]

---

[24] See Joshi 2001; Sahai 2002; Herring in press.

[25] See for example, Dryzek, John, 1997, **The Politics of the Earth**. New York. Oxford University Press; Peluso, Nancy and Michael Watts, ed, 2001, **Violent Environments**. Ithaca. Cornell University Press. Richard Peet and Michael Watts, ed., **Liberation Ecologies:**

The association of economic growth with “development” is so pervasive that we often forget the profound differences, both in rigorous analytics and in common language.[26] Development has been naturalized; “developing countries” has become the common designation for a vast range of societies with aggregate low incomes: some doing better over time, some doing worse, some collapsing, -- but they are all “developing countries.” The tendency to equate development with economic growth, though attenuated in response to the distributional critiques and "basic-human-needs" approaches of the early l970s, remains dominant. But development etymologically means an “unfolding,” as in the development of an embryo. Because societies differ on what the end state can or should be, development itself is profoundly normative a concept.

Growth-centric conceptualizations have confronted a fundamental critique with the rise of ecological science in mainstream discourse. Unlike distributive outcomes, environmental externalities are unequivocally market failures. Moreover, environmental resources -- and perhaps more critically but less understood, environmental services -- are demonstrably necessary for economic activities: growth prospects depend on natural systems, however one values human health or biodiversity. One consequence of the conflict has been the emergence of the much-disputed concept of "sustainable development."[27] Sustainability has something to do with maintenance of natural systems, but no one knows precisely what.

Ecological science has certainly complicated the notion of sustainability, and introduced the conceptualization of interdependent systems in which there are threshold effects, fragility, resilience, cascading causation, indeterminacy – and continuous change. This understanding makes very difficult a politics of opposing anything as “unnatural.” Though the transgenic debate treats transgenic organisms

---

Environment, Development and Social Movements Routledge 1996.

[26] See James Ferguson, **The Anti-Politics Machine** or selections from Wolfgang Sachs, **The Development Dictionary** for a subversive history of the concepts.
[27] A foundational document is **Our Common Future** from the World Commission on Environment and Development [Oxford University Press, l987].

as novel, agriculture itself, along with its novel organisms, has altered ecological systems and their dynamics beyond recognition, often with quite radical means, such as chemical or radiological scrambling of plant genomes to produce potentially useful mutations for "traditional" plant breeding.[28]

All solutions to nature/development conflicts, or claims to public-goods provision, presuppose some system of legitimated power, or authority -- the basis for governance.[29] This is true whether we are talking about a village commons or an international regime. The roots of authority are tangled in worldviews of nature, the state, right livelihoods and social organization. The primary **normative** argument for the very existence of states is market failure: the inability of self-seeking individuals to provide the level of public goods they individually desire. States are in one sense the solution to the collective action problem. Yet states have interests that derive from the logic of state-ness itself -- reproduction of systems of power. Authority to govern nature runs up against resistance by those whose livelihood routines are criminalized by conservation policy. There is suspicion in the villages that states' claims of special expertise and disinterested concern for public goods ring false.[30]

The most important feature of ecological systems for the analyst of states and institutions is that boundaries seldom coincide. Most obviously, planetary interests in particular values such as biodiversity or climate change have ramifications in remote localities, unconnected institutionally or inter-subjectively. It may well be that recognition of common interests will be more spurred by a defensive reaction to the globalization of pathogens [see Pimentel et al 1998], but to date transgenics have dominated invasive species. This is curious: an invasive

---

[28] For an excellent discussion, see Winston 2003.

[29] For an expansion of these ideas, see my "Politics of Nature," Harvard University Center for Population and Development Studies Working Paper Series Number 7 (Cambridge, October l99l).

[30] Some of this literature is summarized in Herring 2002 "State Property Rights in Nature (With Special Reference to India)," in John F. Richards ed., **Land, Property and the Environment;** see also [add refs]

species brings a whole genome to an ecological system, a transgenic crop a single gene. It would seem that the former is likely to be more disruptive – and cases of enormous economic losses are established and continuing to appear. But the cultural construction of recombinant DNA technology has dominated globalization's spread of truly destructive invasive species. The test may be: if one had a marginal dollar to spend on regulation, would it be better spent in preventing invasive species or transgenic crops from spreading?

More generally, the literature of political ecology shows a rural bias. Victor Magagna (**Communities of Grain** l99l: I) writes: "It is ironic that the late twentieth century has seen a renaissance of rural history. The march of industrial society continues to change the institutional fabric of every region on the globe; yet, intellectual interest in rural life has perhaps never been more pronounced." Interest in "peasant society" among elites was a cold-war phenomenon. But as fears of rural breeding grounds of communist insurrection subsided in the core, worries over decimation of landscapes increased, driven by the core understanding of ecology –interconnectedness within complex systems -- theorized largely in cities with grist from reports about people living in remote places. Globalization now appears in the form of bio-safety regimes and convergence of systems of intellectual property rights. Agriculture joins these strands in a politically distinctive manner. Of great interest to the current hegemon in the international system is the acceptance of agricultural biotechnology. Of great interest to opponents to transgenic organisms are food and food systems. Biotechnology has been defined as a rural problem, one is tempted to say through a new incarnation of urban bias. People in cities do not want to give up life-saving pharmaceuticals, whether transgenic or not.[31]But the risks imposed by transgenic crops have become among the most politically disputed terrains of our time: from rejected aid to

[31] Sharad Joshi, leader of the *Shetkari Sanghatana*, in protesting against Delhi's effort to burn the unauthorized transgenic Bt cotton fields in Gujarat posed the question as one of farmers' freedom and, implicitly, urban bias: "Development should not be locked up in the cities. The marvel of technology should reach the villages." Joshi quoted in Sajid Shaik, 2001, "Farmers Decide to Defend their Bt Gene Cotton Crops," **The Times of India**. See Stig Toft Madsen's paper for this conference for the context of the transgenic seed movements in India.

Africa to rejected commodities in Europe, global market segmentation and global networks for action in the fields and parliaments.

There are obvious superficial continuities between historical struggles for definition and control of nature and contemporary social protests around transgenic organisms. There are also some genuinely new developments: the potential for creation of property at ever-smaller scales, for breeding new organisms across the lines of species – even kingdoms – and the possibilities of inducing environmental change in radically unanticipated ways at unknown probabilities: horizontal gene flow from transgenic plants. Bio-prospecting promises that new science could lay the base for a pro-poor development strategy that benefits local people and validates local knowledge; "biopiracy" is the term deployed by opponents viewing the same institutional arrangements. The landscape of social movements and developmental options has been altered. The intersection of new biological possibilities with pressures for harmonization of intellectual property rights through the WTO, WIPO and bilateral pressure produces new questions in a globalized political ecology. Because conceptualization of these dynamics is so contested, as illustrated by the microcosm of transgenics, NGOs and politics sketched above, thinking through the relative causal forces in determining outcomes becomes a challenging theoretical enterprise.

Ideas, Interests and Biopolitics:

Ideational causation occupies a dodgy space in materialist epistemology and method. Interests are typically considered derivative of structure. One of the most common conclusions is that the powerful and wealthy prefer market outcomes, the poor and weak prefer state regulation, the rigging of a sphere in which they have no power.[32] But consider the outcome of the great Bt cotton controversy in India. Monsanto/Mahyco, though firms with plausible interests in market capitalism, and clearly with power in markets, found that unrigged markets were not in their favor. They had the only officially approved seeds; it was regulation, not market, that proffered an elusive monopoly. The suicide-seed coalition's construction is stood on its head. The anarcho-capitalism of farmers pursuing better productive

[32] Beginning with Karl Polanyi, 1944/57 add refs

outcomes generated cheaper, and sometimes more effective, Bt cotton seeds.[33]

Classical political economy centers a smallish number of constituent primary and irreducible variables: structure, interest, power, collective action. Parsimony necessitates a restricted field of explanatory variables. In the hardest of political economy, ideas are epiphenomenal: this is the original meaning of ideology. A political economy of nature very quickly runs into trouble working within those constraints. Outside the field of political economy, many analysts simply assume that ideas have power. As assumption, this take is obviously problematic: ideas may well be epiphenomenal, instrumental, ephemeral, reactive, fleeting. Ideologies reflect interests. Even our seemingly "hard" data-built facades of reality often depend in the last instance on the tenuous relationship between real interest and representation in interview behavior.[34]

The strongest argument against a purely materialist political-economy view of nature is that constituents of nature have no power, yet nature sometimes wins. Not all wins are without material explanations – note the Montreal Protocol's market-rigging effects.[35] But in some cases, nature preservation wins over degradation embodying powerful interests. National parks have opportunity costs, as the Bush administration keeps reminding everyone.

Political economy deals with nature in terms of market failure and externalities. Public goods are arguably at stake. Were there no public goods, there would be no need for governments – the imposition of collective authority soaking up resources that have high opportunity costs and trampling on freedoms, as is inevitable in governance. Yet it should be clear by now that this falling back on

---

[33] Roy, 2004, on differing farmer evaluations of various Bt varieties. For a pessimistic view, Sahai, 2002; for a hagiography of the Navbharat "Robin Hood", Sharad Joshi , 2001; a less sketchy summary of the episode can be found in Herring, in press.

[34] Eg. Herring, "Data as Social Product," in Kanbur ed, **Q-Squared** 2003.

[35] For one of many treatments of this phenomenon, see Herring, "Market-Structuring Regulation…" in Dore and Mount, ed, **Global Environmental Economics.**

public goods is itself no anwer at all. Public goods and bads in nature are not self-explanatory, but embedded in a normative logic that is culturally anchored -- though demonstrably fluid. Swamps were unhealthy, and for draining; wetlands purify water and are for preserving [Herring 1990]. The great normative transformation of the ecological persuasion was to convert draining of swamps from a public good to a public bad. As the politics of nature move from landscapes to genomes, some dimensions deserve more attention.

1) **New Value in Nature**

The genomics revolution created potential, but contested, economic value in biodiversity *per se*. The lowly and common soil bacterium *Bacillus thuringiensis* lends its name in the form of Bt to large political struggles; for its supporters, it represents one means of reducing the poisoning of the earth via pesticides. Absent recombinant DNA technology, *Bacillus thuringiensis* would have nothing to contribute to corn or cotton. Whether this contribution represents progress or the first step in genetic Armageddon is the core of the transgenic debate.

So long as biodiversity is valued only in normative terms, as a desirable thing, in and of itself, its political base is fragile, everywhere in the world. This interest-deficit fragility belies the global happy-talk about conservation of biodiversity. The greatest collective material interest in biodiversity is probably eco-system integrity, providing services that are public goods – clean air and water, for example. But ecosystem services are notoriously difficult to measure.[36] Even if these services could be measured in ways that meet some threshold level of agreement socially, a means to pay for them is extremely difficult to conjure. Here political economy of public goods suggests formidable obstacles, which is why societies keep destroying eco-system services. It's not just the Bush administration or privatization – though neither helps.

One inescapable continuity is that in common understandings, valuable genetic information may depend on actually existing biodiversity [or not, perhaps, but the conventional wisdom is ensconced in policy thinking]. At the current state

[36] Eg Gretchen Daily's **Nature's Services**: **Societal Dependence on Natural Ecosystems**, Island l997.

of knowledge and technology, genetic information has value. In the contentious politics surrounding that normative spectrum from "biopartnerships," to "bioprospecting" to "biopiracy," there is an assumption that there are variable relationships between value and new forms of property [Steven R. King et al. 1996]. Just as the political conflicts around creation of property from nature occasioned the conquest of landscapes even before the "great transformation" [see Schama's **Landscapes and Memory**] which greatly intensified dynamics [eg Cronon's **Changes in the Land]**, the genomics revolution creates possibilities for conversion of nature to property on a scale unimaginable a generation ago [Hilgartner, 2002]. TRIPS is a novel property regime; disputed claims to property in nature and its knowledge are not.

Whether or not genomics will ultimately undermine the value of *in situ* nature is unclear, but for the time being the biological revolution has created new value in natural landscapes. Yesterday's pest could harbor tomorrow's miracle gene. Who is opposed to a cure for cancer? Even Vandana Shiva has not, to my knowledge, complained about transgenic pharmaceuticals that save lives – the first being human insulin, now fairly common in India.[37] Via this knowledge-based revaluation of nature, a certain monetary incentive is thus introduced into the political struggle to prevent wholesale destruction of ecosystems. For a while, the Environment Minister had something to say to the Commerce Minister when the question of affordability of conservation surfaced. [38] (After the famous Merck-INBio deal's novelty wore off, however, this prospect has decidedly dimmed.)

In the emergence of new interests at the frontier of knowledge, science itself loses its easy assumption of objectivity. There are potentially high stakes in small

---

[37] Human insulin is produced by a genetically modified organism; the alternatives involve the pancreas of dead pigs or cows, carrying hardly salubrious connotations in several world cultures. Bovine insulin in India is cheaper than human insulin, yet the latter is increasing in usage. In 2001, when the issue of comparative cost was raised in Parliament, animal-based insulins cost Rs 65 per vial, human insulin Rs 200 per vial in India. Plans for import substitution through the Department of Biotechnology were aimed at reducing the cost by eliminating dependence on American producers.

[38] See for example, Varley and Scott, 1998; Weiss and Eisner, 1998; A. Gupta l998.

findings -- hence the restrictions on international fieldwork for fear of biopiracy, or the burning of field trials of transgenics. This new value in nature has become the subject of new forms of local and global controversy, new regulatory restrictions and new claim-jumping tactics of powerful capital. More politically contentious, the value of these new commodifications themselves are dependent on social acceptability of the enabling science that certifies the safety of products and procedures.

Seldom are there objections to miracle drugs; genetically modified crops create much contention -- trade restrictions, counter-charges of protectionism, burned field trials, court injunctions, protest marches. The feedback loop becomes politically contentious as well: gene flow from "GMOs" is held dangerous as a form of biological pollution, and thus a threat to the biologically diverse landscapes from which genetic information comes. As the seed thrust of anti-GMO activism in India sputtered in the face of farmer acceptance of transgenic seeds, political opposition took to macro-environmental, landscape-scale, anxieties of biological pollution. Uncertainty is the most powerful political weapon of the anti-transgenic movement. First, the elision of and escalation from uncertainty to anxiety meets little cognitive resistance. Fearing the unknown is not only the first response, but to some extent the rational response. Second, it is logically impossible to prove an empirical negative. One cannot, for example, imagine the evidence that would convincingly prove that transgene flow will not cause major ecological damage somewhere, sometime. The science is inevitably incomplete.

2) Contingency of Property Rights

Property rights are fluid, contingent, more usefully viewed as claims than as rights – that is, as contextual as structural**.** Property rights exist on a spectrum, from your car to Monsanto's patent to state ownership of forests. Property rights in natural systems and products, whether of states or firms, are in practice less fee-simple ownership than the outcomes of dynamic negotiations (Herring 2003). In political-economy terms, this is true because information and enforcement costs are very high. In cultural terms, it is true because states' claims are not accepted locally, where both use-rights and subsistence needs have priority.

In landscapes, states negotiate property claims on the ground in episodic clashes with people using nature. Trespassers trespass, and poachers poach –

asserting in each case a property claim. Claims to rights in genetic information and products likewise demonstrate normative ambiguity and stealth tactics. The underground spread of transgenic seeds by farmers in both India and Brazil forced states to legitimize their praxis, despite lingering doubts about the science. The stealth movements of seeds belie the notion of patents as fixed property. As in the forests, property can mean only what enforcement techniques can make it mean, which is often not much. Rather, accommodations are struck. These deals are embedded in an emerging global formation of property rights that is itself contested politically -- eg, the WTOs TRIPS compulsions. Yet the intellectual property claims that seem hard facts in TRIPS discussions turn soft on the ground; seeds are hard to police. Similarly, and for the same reasons, protected conservation zones often exist as little more than lines on maps.

The fictitious nature of state claims to property in nature is well understood [Herring 2002]. At the frontier, genomics as science has enabled claims of property at smaller and smaller scale, but with high levels of indeterminacy. Whatever else the genomics revolution may bring to society, it will certainly bring higher levels of surveillance, for property rights in micro-nature depend on close monitoring mediated by high technology. In the Bt cotton case in India, Delhi could not know that the plants that survived the bollworm infestation of 2001 were transgenic and illegal until a genetic probe could be conducted. Commercial interests happily provided the knowledge that state actors could not. It is still not clear whose – if any -- property rights were contained in the seeds.

The ability of seeds to go underground via farmer stealth strategies undermines the surveillance of states and firms assumed in much of two divergent discourses of transgenics in development: Opponents fear the power of monopolization of property rights, proponents assure societies that biosafety regimes can control nature. Neither discourse is proving robust on the ground, where seeds live or die. This is in part true because both discourses are instrumental, and mis-recognize the interests of real actors in real settings. Surveillance of nature is no mean task, either macro or nano.[39]

---

[39] The parallel to James Scott's views of the astigmatism of high modernism [in **Seeing Like a State** l998] is clear; Scott's state needs visibility, but finds it hard to attain. The Panopticon is posited, but illusive.

3) **Structural Indeterminacy of Interests**

Political economy analyzes interests within structures. Structures clearly define interests – anyone who doubts structuration of interests should quiz a sharecropper about agrarian class structure, or an adjunct lecturer about academic class structure. Yet interests in nature are often difficult to determine. Ecosystem health, biodiversity, potential allergenicity, gene flow -- all are sufficiently removed from ordinary conceptual and practical knowledge of most people that reliance on experts, or congealed knowledge, or persuasive framing, or "common sense" – some tool of reduction of both information costs and uncertainty -- become inevitable.[40]

Calculating interests in nature is arguably of a different character from those of the economy. Effects take a long time to become apparent; causality in over-determined chains of dynamics is difficult to parse. As important, human lives are short in relation to potentially irreversible ecological change. If everything is really connected to everything else -- a core tenet of ecology -- figuring the effects of particular changes brought by human action is very difficult, except at the extremes – no one doubts that pollution destroys aquatic ecologies, for example, but it is hard to know how much pollution a system can take, or how resilient its components will be. Though some protagonists in nature conflicts valorize local knowledge, inability to anticipate ecological consequences of short-term interests is common and predictable. Calculation of interest in nature also confronts the problem of scale: not in my backyard. Scales of arenae and administration seldom match up with scales of perceived threat. And the science keeps changing.[41]

---

[40] This dependence is present in fields of non-nature political economy as well -- reservation wages do have a cultural logic and the effects of higher wages on demand for labor over time in a dynamic system are unknown with any degree of certainty. Yet workers have long-standing repertories of political claims, predicted and explained by their position in a class structure, and are clear in the implications of their demands for public policy.

[41] The New York Times of June 27, 2004, carried a report on a new danger to the Endangered Species Act: what constitutes a species is under challenge, in part from new tools of genomics. Since the ESA is used to protect habitat, and is under

Counter-intuitive links between refrigerator gases and skin cancer could not have been imagined by political actors even a generation ago, in the pre-Montreal Protocol days.

For social theorists, this indeterminacy introduces problems: interests cannot be read off or deduced from structural position in any *a priori* or mechanical way (as in say, Rogowski's **Commerce and Coalitions**). Often our most basic interests are, with apology to Donald Rumsfeld, dependent on unknown unknowns – we know that we do not know how soon or how devastating will be climate change, but we do not know what else we do not know. There was a time when climate change was on no one's horizon. Interests are knowledge-dependent, but the knowledge as a body is modest in its claims to certainty, and constantly in flux at the margins. Nothing illustrates this principle in practice than the concerns about horizontal gene flow through agro-ecological systems.

4) Political Science

In both landscape and molecular politics, science typically becomes a field of legitimation and conflict rather than agnostic method. There is a political-economic reason for the politicization of science: science is expensive, and there is a continuous suspicion that who pays the piper calls the tune. With privatization of scientific research, the sphere of dis-interested or public-interested science shrinks.

There is an inter-active effect of expensive knowledge with epistemological complexity. Because ecological dynamics of large systems remain unknown, perhaps unknowable, given the time and money required to delineate dynamics, much of argument about use, resilience, recovery, collapse rests on an uncertain empirical base. Reified *Science* is called in as authoritative arbiter, but quickly becomes more arena than judge. The political imperative is to claim certainty, not caution. Authoritative action requires authoritative knowledge. It is hard for states to require sacrifice without authority, but authoritative knowledge in nature is hard to come by. More problematically, science has no answers at all to normative questions. Is it acceptable to lose species? How many species' extinctions can be justified? What is the time scale? Europe lost a lot of species, now is regaining

---

constant assault from the political right, de-certifying the unique identity of small species could have major consequences at the landscape level. [add ref]

them – is that an acceptable price for an industrialization that permitted world domination? Should we expect certainty on issues of gene flow, or is some risk acceptable? How precautionary is precautionary enough?

Moreover, even normative claims are mediated by science. Assuming a baseline of normative agreement (biodiversity is good, agree a lot of people), the logics from that position diverge with the science. Though few partisans in the transgenic wars believe it, biotechnology may have some contributions to preservation of biodiversity itself [Horsch, Robert B. and Robert T. Fraley, 1998]. Even leaving aside frontier issues at so micro a scale, the biological question in India is often: how compatible is eco-system integrity with human use? Are many small protected areas as ecologically valuable as several very large ones on the American model – which are politically impossible? Ecologists in India are more likely to say yes than are ecologists in the United States. In landscapes, public science proclaims necessary restrictions on the market in nature those measures called for to protect ecosystem health. But the measures of ecosystem health, and measures of its resilience, depend on models of nature that are nowhere fully established. Need to act almost always outruns the science in state logic.

In the politics of genomic applications to products constructed from building blocks of nature, science is the bedrock of claims but shrinks from the hubris of its politicized self. Rather, the question of whose science becomes intensely relevant. "Western science" is first conjured, then attacked as "imperialist;" the countervailing attack from proponents of transgenics targets "junk science" -- of which there is a great deal.[42] Whether or not transgenic foods or crops are safe or good depends fundamentally on which science one endorses and consumes. Because science is suspected of being political, its authoritative power declines even without the partisan devaluation suggested by Meera Nanda in **Prophets Facing Backward** (Rutgers 2003).

Convergence of Narratives: Reification of Seed and State

Where the techno-optimist and anti-transgenic narratives converge is in

[42] The website www.junkscience.com is however ideologically identifiable as an anti-regulation operation. What it considers junk science is what much public policy considers the only valid science, illustrating the point in the text.

elevating – and then reifying -- seeds and states. Consider, for example, that so much discourse turns on seeds. Though there may be good reasons for centering seeds in a cultural sense (Gold 2003), the argument that seeds alone would bankrupt farmers seems an agronomic stretch. Seed costs in cotton seldom exceed 7-10% of variable costs. The discourses of miracle seeds and suicide seeds impute far too much power to the seed. The reifications of both "patents" and "biosafety regime" assume much more state than seems consistent with experience to date. If the Bt episode indicates anything at all it is that patents are not self-enforcing. Intellectual property rights that seem hard facts -- indeed weapons of capital against the poor -- in rhetoric and on paper become soggy in the soil. The Brazilian experience with GM soya makes this case internationally as Bt cotton in Gujarat made it domestically.[43]

In the optimistic narrative, state technicians will be able to make for society the cost-benefit analysis necessary to decide on which transgenics when and where. Insititutions will enforce a biosafety regime. Patents are real, and must be countered with humanitarian use transfers of technology as in golden rice or through market segmentation granting special rights to poor farmers and poor nations. Per Pinstrup-Andersen and Ebbe Shiøler [2000] follow much of this wisdom in proposing a third way: a return to the "green-revolution" political economy of international public-sector investment in research and development and state public sector expenditures for outreach and extension, as well as infrastructure development. The standard narrative assumes IPR issues can be

---

[43] See for example, Seed Quest, "Brazil Introduces Bill to Regulate GM Crops," Rio de Janeiro, Brazil, October 30, 2003. The national state has been forced to acknowledge the long-standing existence of a substantial transgenic agricultural industry, but sought to it to one state, Rio Grande do Sul, where farmers have been growing the seeds smuggled in from neighboring countries for some time. The neighboring state of Parana banned transgenic soy and seized shipments from the port of Paranagua. The politics and judicial resolution remains in the air, but it seems that there can be no "GM-free zone" in law, nor can the national state prevent the movement of seeds across international and domestic borders. Add REFS

solved through negotiation and that biosafety institutions will be robust on the ground.[44]

This narrative replicates the "tool-kit" model discussed previously. Though the standard narrative posits a seemingly sensible, and unobjectionable "risk-benefit analysis," buttressed by comforting assurances of a "bio-safety regime," the reality is that risks are unknown and seeds cannot be policed, as evidence from Gujarat to Rio Grande do Sul indicates. More generally, as Per Pinstrup-Andersen and Ebbe Schiøler [2000] recognize elsewhere, the transgenic question boils down to one of politics, not science. There is no way for science to prove a negative: that some effect will not happen. There are no probability distributions from which a true risk assessment can be derived and few imaginable means of stopping the flow of seeds farmers want – short of the terminator. Nature finds a way, and the genie is out of the bottle. There are people who worry about this and people who do not.

Opponents fear the same reifications the techno-optimists posit as the groundwork of their argument. Intellectual property rights are reified as a force against the farmer – as if patents were somehow self-enforcing. "Monopoly" by seed firms is taken to be an argument against transgenics, even as small and large sector firms in India increasingly cooperate with the public sector research in transgenics. Farmers participate in the unofficial seed breeding *mela* as well.[45] The market is reified in oppositional discourse as danger as well, yet it is the biosafety

---

[44] Minister of Environment and Forests explained the government's tests of the Cry protein in Rajya Sahba, Unstarred Question No. 2782, to be answered 14.12.2001: "Ill Effects of Bt Cotton." Monsanto/MAHYCO reports increasing compliance with the refugia requirements for biosafety, but still considerable non-compliance. Anecdotal evidence suggests farmers using the unofficial varieties follow no biosafety procedures at all.

[45] Unpublished data from Mahyco-Monsanto show not only more transgenic acreage planted in the aggregate, and more farmers using the technology each season, but second-time buyers' buying more seeds the second time around. However, Devparna Roy's findings (2004) suggest that the Robin-Hood Bt seeds may be growing faster than the sanctioned seeds, as they are cheaper, and often give better or at least acceptable results.

regime that privileged Monsanto's Bollgard over the indigenous Navbharat transgenic. When the BBC characterized Navbharat's appropriation of Monsanto's Bt gene construct as "biopiracy," the rhetorical tables were turned; the assumption that flow can only move upstream, from South to North is clearly problematic.

Science of transgenics is thus political in specifiable ways: there are interests, but these remain mediated by science. Farmers and multinationals may not care much about gene flow, but there is a societal externality that is simply difficult to parse at the current state of knowledge. The parsing itself is suspect to all interested parties as the science is considered tainted by source. NGOs in India demanded the field trial data continuously while simultaneously telling investigators such as myself that no one would believe the data if it were released.[46] Property disputes are demonstrably subject to conciliation, bargaining and compromise -- familiar terrain for the political economy of interests. Disputes about the nature of the natural, and consequent risks of the unnatural, take on a different politics, dependent on an expertise that is asymmetrically distributed both locally -- on the ground within movements -- and globally. These latter questions create a new politics less susceptible of ordinary bargaining solutions, but it is an inescapable politics generated by the genomics revolution.

[Tentative] Conclusion: **The Political Impotence of Real Science**

The science of ecology discovers continuously unexpected and often imperceptible interconnections among all elements that make up systems, across vast scalar differences, from microbial to atmospheric. This complexity, and the core *desiderata* of real science – methodological and epistemological commitment to hypothetico-deductive empirical investigation that is replicable and exhibits high standards of validation -- frequently combine to produce political impotence. The history of global warming represents a telling case in point. Real science remained sufficiently uncertain for the most powerful political actor in the international system -- the United States – to sustain a plausible claim that "more research is needed before action is justified." The problem with real science is that more research is always needed; the fit to the need of human beings to act raises the

[46] Mark Winston, himself a biologist, found that secrecy of the firms dealing in transgenics was a major source of distrust outside the firms, but was experienced as an imperative by the holders of inside information (2002).

unbridgeable gap between uncertainty and risk, and hence subjectivity.

Where ecological science is inevitably incomplete, junk science has ready answers. Consider the position on burning test trials of crops meant to find out if there is danger in transgenics: the opposition knows the answers before collecting the evidence. More radically, despite continuous increases of sales of the MAHYCO/Monsanto Bollgard Bt seeds, and the scramble for unapproved transgenic competing seeds, "the failure of Bt cotton" – in an agronomic and economic sense – continued to fill press releases of opponents of transgenic crops.

In terms of knowledge claims, the political vulnerability of genetic engineering is the acknowledged incompleteness of any firm estimate of risks: the honest scientist admits to uncertainty, a more troubling position than that of risk. Probability distributions are unknown; the unknown is inherently frightening, and the elision of uncertainty to anxiety is an easy cognitive path. As we have long known, anxiety is the condition under which we expect the most powerful effect of symbolic politics (Edelman 1962), which is the terrain of narratives.

A second conclusion concerns politics of framing: there is no doubt that framing has enormous power in a field of high anxiety and low information. Activists in Palakkad district in 2003 recounted to me as fact the suicide-terminator-Monsanto construction of Bt cotton against any evidence I could produce. If farmers actually bought transgenic seeds, I was corrected, they did so because they were duped. If they planted such seeds, they were ruined by Monsanto's monopoly. Any other construction was ideological – pro-market, pro-globalization, pro-multinational. The fear of globalization strikes deep, whether in Cleveland or Palakkad; resistance to markets in farming communities comes from centuries of experience. In OECD countries, this resistance succeeds.

But the suicide-seed-terminator-Bt discourse ultimately lost politically. Is the case at hand a refutation of the conclusion above? Not necessarily. Framing is bounded, ultimately, by interests. Farmers in India face transgenics through the mediation of rumour, NGOs, public intellectuals. Opposition NGOs in particular imposed a powerful dramaturgical frame on the conflict [Parmar and Vishwanathan 2003]. But for this political intermediation to be successful, both framing and objectives must resonate with enough of the world as experienced by farmers to generate support. The micro-economic and biological success of Bt

cotton outweighed the more indirect, distal and hypothetical arguments about foreign control and dangerous genes. In short, the discourse outran the interests. Farmers had no interest in pursuing the societal externality points on which the scientific discourse is weak: the uncertainties of the new technology agro-ecologically.

Despite the triumphalism of the pro-biotech treatment of the Bt outcome, there remains the unresolved question of incomplete science and unresolved risk. For all the romanticization of local knowledge and the *Volk*, it is not clear that the sons of the soil always know best. Farmers adopted insecticides as a response to their insect problems before the insecticides became biologically and economically unviable. They did so not after considering the science and the social externalities, but rather because they had to protect their crops. The uncertainties of Bt cotton are probably not a prelude to serious environmental degradation, though there are unresolved questions.[47] But it is not in the interest of cotton farmers to investigate; they understand the deadend nature of the pesticide alternative and seem unwilling to invest in the huge risks of organic alternatives. The uncertainties are left for societies as a whole.

How do societies deal with uncertainties of change that promises public goods when there are known risks in continuing with the *status quo*? Pesticide loads in India have reached intolerable levels, with severe externalities, typically for those least able to protect themselves. The prior question to be asked is fundamental to development studies and risk-benefit analysis in general: to whose benefit, at whose risk? With regard to both landscape-level ecologies and micro-level transgenics, the answer depends on how one conceptualizes the public, how one couches the alternatives, the normative position one takes on uncertainty and risk, and the projections one makes from an inevitably incomplete science.

[47] See Thies, forthcoming, on soil structure and root exudates; add REFs

References

Pallava Bagla, 2004, "Report Says India Needs Stronger, Independent Regulatory Body," **Science** 11 June 2004

Geeta Bharathan, 2000, Bt-Cotton in India: Anatomy of a Controversy. **Current Science**. Vol 79. No. 8. 25 October. Pp 1067-1075.

N.R. Birasal, **Times of India**, December 5, l998 "Haveri Farmers Will Resist KRRS Destruction Trial."

Dionne Bunsha, "A Can of Bollworms," **Frontline** Vol 18, Issue 24 November 24-Dec 7, 2001.

Centre for Environmental Studies Warangal, l998, **Citizens' Report: Gathering Agrarian Crisis – Farmers' Suicides in Warangal District (A.P.) India**. Kishanpura.

Ha-Joon Chang, 2002, **Kicking Away the Ladder: Development Strategy in Historical Perspective**. Anthem Press. London.

Dan Charles, 2001, **Lords of the Harvest**: **Biotech, Big Money, and the Future of Food.** Cambridge, Massachusetts. Perseus Publishing.

Confederation of Indian Industry, 2001, **Biotechnology on the Fast Track**. Unpublished conference proceedings. New Delhi.

Gordon Conway, 1997. **The Doubly Green Revolution: Food for All in the 21st Century**. New York: Penguin Books.

Darryl D'Monte, "Gandhi's Disputed Heritage," **Unesco Courier**, 2000, pp 1-4

Kristin Dawkins, 1997. **Gene Wars: The Politics Of Biotechnology**. Seven Stories Press (Open Media Pamphlet Series)

Darshan Desai and Sonu Jain, "Government Gets Cotton Farmers To Pay For Its Incompetence." **Indian Express**, October 21, 2001

Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. 1998. **Report of the Study Group on Distress Caused by Indebtedness of Farmers in Andhra Pradesh**. New Delhi. September.

Department of Biotechnology, Ministry of Science and Technology, Government of India, l996, **Revised Guidelines for Research in Transgenic Plants and Guidelines for Toxicity and Allergenicity Evaluation of Tansgenic Seeds, Plants and Plant Parts**. New Delhi. August.

Department of Biotechnology, Ministry of Science and Technology, Government of India, 2001, **Biotech News** Vol 2 Issue 2. November.

Department of Biotechnology, Ministry of Science and Technology, Government of India, 2001b, **Biotechnology: A Vision**. New Delhi.

Department of Biotechnology, Ministry of Science and Technology, Government of India, 2002. **Annual Report** 2001-2002.

Deccan Herald, 1998, "Operation Cremate Monsanto: Raitha Sangha to Burn Bollgard Cotton in Bellary." December 2. Bangalore.

John Dryzek, 1997, **The Politics of the Earth**. New York Oxford University Press.

Murray Edelman l962 **The Symbolic Uses of Politics**. Champagne/Urbana. University of Illinois Press

Greenpeace-India, 2001, "Bt Cotton Saga Takes a Ludicrous Turn." Greenpeace Newsletter. Vol 11. December. New Delhi.

Ann Grodzins Gold, 2003, "Vanishing: Seeds' Cyclicality." **Journal of Material Culture** 8 (3) pp.255-272.

Anil Gupta, 1998. "Rewarding Local Communities for Conserving Biodiversity: The Case of the Honey Bee." **Protection of Global Biodiversity: Converging Strategies**. Lakshman D. Guruswamy and Jeffrey A. McNeely, ed. Durham: Duke University Press, pp.180-189.

Ronald J. Herring, 1990, "Rethinking the Commons," in "Development Pressures and Ecological Constraints: The Sundarbans Coastal Forests of India and Bangladesh," Special Issue of **Agriculture and Human Values** 7:2 1990.

Ronald J. Herring, 2000, "Authority and Scale in Political Ecology: Some Cautions on Localism," in Louise Buck et al, eds, **Biological Diversity: Balancing Interests Through Adaptive Collaborative Management** (Boca Raton: CRC Press, 2000) pp l87-205.

Ronald J. Herring, 2002, "State Property in Nature," in John F. Richards, ed, **Land, Property and the Environment**. Oakland. Institute for Contemporary Studies.

Ronald J. Herring, 2003, "The Political Impossibility Theorem of Agrarian Reform: Path Dependence and Terms of Inclusion." in **Changing Paths**: **The New Politics of Inclusion**, edited by Mick Moore and Peter Houtzager, University of Michigan Press, Ann Arbor, Michigan.

Ronald J. Herring, 2003b, "Underground Seeds," Paper for the Conference Transgenics and the Poor, Cornell University, November 4-6, 2003, posted on http://www.einaudi.cornell.edu/conf/2003/gmopoverty/ .

Ronald J. Herring, in press, "Miracle Seeds, Suicide Seeds and the Poor: GMOs, NGOs, Farmers and the State," in **From State to Market: Poverty and Changing Social Movement Strategies in India**, Edited by Mary Fainsod Katzenstein and Raka Ray. Rowman and Littlefield.

Stephen Hilgartner, 2002, "Acceptable Intellectual Property." **Journal of Molecular Biology** 319, 943-946.

Horsch, Robert B. and Robert T. Fraley, 1998. "Biotechnology Can Help Reduce the Loss of Biodiversity" **Protection of Global Biodiversity: Converging Strategies**. Lakshman D. Guruswamy and Jeffrey A. McNeely, ed. Durham: Duke University Press.

Yousouf Ismael, Richard Bennett, Steven Morse, 2001, "Biotechnology In Africa: The Adoption and Economic Impacts of Bt Cotton in The Makhathini Flats, Republic Of South Africa," Paper presented for AfricaBio ConferenceBiotechnology Conference For Sub-Saharan Africa 26 -27 September 2001 Johannesburg South Africa.

Sonu Jain, 2001, "Bt in Bt Cotton means Blocking the Seed, Trashing the Fact," **Indian Express**, October 27, 2001

Clive James, 2002, **Global Review of Transgenic Crops: 2001 Feature: Bt Cotton**. ISAAA Briefs No. 26. ISAAA: Ithaca, NY.

K. S. Jayaraman, 2001a, "Illicit GM cotton sparks corporate fury," http://www.poptel.org.uk/panap/latest/btindia2.htm

K. S. Jayaraman, 2001b, " Illegal Bt Cotton in India Haunts Regulators," **Nature Biotechnology**, Dec 2001 Vol. 19 No.12 p 1090

Srinand Jha, Seeds of Death, GMO Cotton, India. www.tompaine.com May 30 2001

Sharad Joshi, 2001, "Unquiet on the western front," **The Hindu**, Business Line, December 19.

Steven R. King et al, "Biological Diversity, Indigenous Knowledge, Drug Discovery and Intellectual Property Rights: Creating Reciprocity and Maintaining Relationships," **Journal of Ethnopharmacology**," 51, l996 pp 45-57.

Jack Kloppenburg, Jr. and Daniel Lee Kleinman, "Seed Wars: Common Heritage, Private Property, and Political Strategy," Socialist Review 95 (Sept-Oct) l987 pp 7-41.

Smitu Kothari and Michelle Chawla, ed. 2002, **U N DeePer in the Techno-Corporate Mire**. Kalpavriksh, Lokayan et al. New Delhi.

Leissinger, K.M., 2000, "Ethical Challenges of Agricultural Biotechnology for Developing Countries," in G.J. Persley and M.M. Lantin, eds., **Agricultural Biotechnology and the Poor**. Consultative Group on International Agricultural Research. Washington, D.C.

Adam Liptak, 2003, "Saving Seeds Subjects Farmers to Suits Over Patent," **The New York Times**. November 2. P 18.

Lipton, Michael with Longhurst, Richard, 1989. **New Seeds and Poor People**. Baltimore: Johns Hopkins University Press.

Stig Toft Madsen, 2001, "The View from Vevey," **Economic and Political Weekly**. September 29, 2001. Pp 3733-3742.

Vinod Mathew, "India's GM Cotton Story Gets Bigger - 'Uproot & Destroy' Begins on Gujarat Farms," **Hindu - Business Line** , Oct. 20, 2001;

Alan McHughen, **Pandora's Picnic Basket: The Potential and Hazards of Genetically Modified Foods**. Oxford. Oxford University Press. 2000.

Parvathi Menon, "Waking Up to GM Cotton," **Frontline**, Vol 18, Issue 23, Nov 10-23, 2001.

Sharad Mistry, **Indian Express**, December 4, 1998, "Terminator Gene a Figment of Imagination: Monsanto Chief."

Ashis Nandy, l990, **Science, Hegemony, and Violence**. New Delhi. Oxford University Press.

Professor Nanjundaswamy, 1999, "Statement of Professor Nanjundaswamy at the Demonstration Against the World Economic Summit, Cologne, 19th June l999." GreenFiles, WWF-I, New Delhi.

Robert L. Paarlberg, 2001, **The Politics of Precaution: Genetically Modified Crops in Developing Countries**. Johns Hopkins University Press. Baltimore.

Elinor Ostrom et al, 1999, "Revisiting the Commons: Local Lessons, Global Challenges," **Science** Vol 284 9 April pp 278-282.

Chandrika Parmar and Shiv Visvanathan, 2003, "Hybrid, Hyphen, History, Hysteria: The Making of the Bt Cotton Controversy," IDS Seminar on Agriculture Biotechnology and the Developing World, Sussex, UK. October 1-3.

G.J. Persley and M.M. Lantin, ed., 2000, **Agricultural Biotechnology and the Poor**. Washington, D.C. Consultative Group on International Agricultural Research.

Per Pinstrup-Anderson and Ebbe Schioler, 2000, **Seeds of Contention: World Hunger and the Global Controversy over GM Crops**. Johns Hopkins University Press. Baltimore.

David Pimentel et al, "Ecology of Increasing Disease," **BioScience** 48:10 (October) l998 pp817-826.

Michael Pollan, **The Botany of Desire: A Plant's Eye View of the World. New York. Random House**. 2001.

C.S. Prakash, 2001, "The Biotech Miracle," **Indian Express**, Letters to the Editor, Nov 5, 2001.

Matin Qaim and David Zilberman, 2003, "Yield Effects of Genetically Modified Crops in Developing Countries," **Science** 299. pp 900-9002.

R. Ramachandran, 2002, "Green Signal for Bt Cotton." **Frontline** Vol 19, Issue 8. April 13-26.

G.V. Ramanjaneyula and A. Ravindra, l999, **Terminator Logic: Monsanto, Genetic Engineering and the Future of Agriculture**. Science for People/Research Foundation for Science, Technology and Ecology. New Delhi. January.

Rediff.com, 2001, "Bt Cotton Will Kill Farmers, Financially and Literally" An Interview with Devinder Sharma. December 12.

Reid, Walter V. 1996. "Gene co-ops and the biotrade: translating genetic resource rights into sustainable development." **Journal of Ethno-pharmacology**. (51) pp.75-92

Suman Sahai, ND, "An Open Letter to the WTO Chief Mr Ruggiero." Gene Campaign. New Delhi.

Suman Sahai, 2002, Bt Cotton: Confusion Prevails. EPW Commentary **Economic and Political Weekly** May 25, 2002 [also posted on AgBioIndia Mailing List June 19, 2002].

Vandana Shiva, 1998, " Monocultures, Monopolies, Myths and Masculinization of Agriculture," a paper prepared for the **International Conference on Women and Agriculture.**

Ian Scoones, 2003, "Regulatory Manoevres: The Bt Cotton Controversy in India," IDS Working Paper No. 197. Brighton. UK. August.

James C. Scott, 1998, **Seeing Like a State**. New Haven. Yale University Press.

Sajid Shaik, 2001, "Farmers Decide to Defend their Bt Gene Cotton Crops," **The Times of India**. Oct 31, 2001

D. Sharma, 2001. "The Introduction of Transgenic Cotton in India." **Biotechnology and Development Monitor**. No 44. March. Pp 10-13.

Shiva, Vandana. 1999. "Ecological Balance in an Era of Globalization." In Nicholas Low, ed. **Global Ethics and Environment**. Routledge. London. pp. 47-69.

Vandana Shiva, 2000, **Stolen Harvest: the hijacking of the global food supply**. South End Press. Cambridge, MA.

Vandana Shiva, 2001, **Patents: Myths and Reality**. Penguin. Delhi.

Vandana Shiva, Afsar H. Jafri, Ashok Emani and Manish Pande, 2000, **Seeds of Suicide: The Ecological and Human Costs of Globalization of Agriculture**. Delhi. Research Foundation for Science, Technology and Ecology.

Simpson, R. David, Roger A. Sedjo and John W. Reid, 1996. "Valuing Biodiversity for Use in Pharmaceutical Research" **Journal of Political Economy** Vol. 104, No. 1, pp163-185

Glenn Davis Stone, 2002, "Biotechnology and Suicide in India." **Anthropology News**. May.

Hanne Svarstad and Shivcharn S. Dhillion, eds, 2000, **Responding to Bioprospecting**. Spartacus Forlag AS. Oslo.

M.S. Swaminathan, GM to Do Good to Agri and Food Security, **The Economic Times**, November 13, 2001.

Tanksley, Steven D. and Susan R. McCouch, 1997. "Seed Banks and Molecular Maps: Unlocking Genetic Potential from the Wild" **Science** Vol. 277 (August 22) pp 1063-1066.

Reungchai Tansakul and Peter Burt, "People Power vs. the Gene Giants," **Bangkok Post**. August 1, l999.

Times of India, 2000, "Farmer Suicides Lead to GM Moratorium Call," September 26, 2000

United Nations Development Programme, 2001, **Human Development Report: Making Technologies Work for Human Development**. New York.

Ashutosh Varshney, l995, **Democracy, Development and the Countryside: Urban Rural Struggles in India**. Cambridge University Press, 1995.

Varley, John D. and Preston T. Scott, 1998. " Conservation of Microbial Diversity a Yellowstone Priority" **American Society for Microbiology News** Vol. 64, No. 3, pp147-151.

Weiss, Charles and Thomas Eisner, 1998. "Partnerships for value-added through bioprospecting" **Technology In Society** Vol. 20, pp 481-498.