Global Technologies and Local Distress: Towards Sustainable Farm Livelihoods in Rainfed India

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Abstract

Ending a long standing controversy regarding GM crops the Indian government has allowed field trials of 10 GM crops. This follows the adoption of Bt cotton, produced by agro-transnational Monsanto, in India's cotton belt, which now covers 90-95% of cotton area. Reports suggest that the productivity increase after introduction of Bt cotton is so remarkable that this signifies a structural shift in cotton production. However, in rainfed areas growing cotton, a suicide epidemic, continues; leading to some implicating GM technology into farm suicides. How can these two phenomenon co-exist? This paper compares the case of two different cotton growing regions- Maharashtra, the hotspot of farm suicide vis a vis Gujarat, a state that did not witness any farm suicides. Under what conditions is technology successful in creating sustainable farming livelihoods? The paper outlays a political-ecological understanding of the role that new technologies play in affecting farm livelihoods, by examining ecology, agrarian structure, role of state and public policies, social movements or agrarian institutions and nature of technology. It finds that more local specific research is needed, to understand the exact effects of new technology on hotpots of farm distress. It also suggests that a more critical area of enquiry is the ecological conditions such as water scarcity, pest dominance, pesticide pollution, than uncertain environmental risks on biodiversity to ascertain the effects of Bt cotton. Such an analysis can be useful in understanding the effects that new GM crops will have on farmer's livelihoods.

Keywords

Bt cotton, GM crops, Gujarat, Maharashtra, rainfed India, political ecology, farm suicides

Introduction

Indian environment Minister Veerappa Moily, in 2014 cleared GM crop trials of four varieties of rice, two each of wheat and cotton, and one each of maize, sorghum and groundnut based on

state approvals. This will allow nearly 200 GM crops to be under trial for commercial release. Former environment minister J. Natarajan had put these trials on hold and her predecessor Jairam Ramesh had introduced a clause that companies which get the go-ahead from Genetic Engineering Action Committee (GEAC) will have to approach state governments since agriculture is a state subject.[1] This is a landmark decision that preceded a prolonged debate on benefits and risks of GM crops in general in India and abroad and which will change the way agriculture is practiced and farm livelihoods in rainfed areas.

The debate

The move to go ahead with GM technology — especially food crops — has been a subject of hot debate among the scientific community, governments, NGOs and civil society groups. The broad contours of the GM crop debate pitch increased productivity and income benefits of GM crops vis a vis environmental risks especially to species in biological centers of origins. On one hand, GM crops are expected to usher in a second Green Revolution (Pratibha Patil 2008; Lipton 2007; Pingaley and Raney: 2005) while on the other hand, they can give rise to superweeds, terminator seeds and monopoly control of seeds by MNCs (Sanvido, Romies and Bigler 2007Shiva;).

As the debate on GM crops continued both globally and nationally, news of farm suicides started coming to fore in Indian newspapers in 2005 (Sainath, various; Hardikar; various). .

Farm suicides, first noticed in Maharashtra, and now in many parts of rainfed India continue to rise, in intensity and spread (Vasavi: 2012). According to P Sainath: "Suicide rates among Indian farmers were a chilling 47 per cent higher than they were for the rest of the population in 2011. In some of the States worst hit by the agrarian crisis, they were well over 100 per cent higher."[2]In another article, Sainath states that while states such as Kerela have shown a

[1] http://timesofindia.indiatimes.com/india/Veerappa-Moily-okays-field-trials-of-GM-crops/articleshow/31134978.cms

[2] http://www.thehindu.com/opinion/columns/sainath/farmers-suicide-rates-soar-above-the-rest/article4725101.ece

decrease in suicides in the past 16 years, others such as Andhra Pradesh have shown a consistently upward trend in suicides.[3]

Many causes have been cited regarding farmers suicides. For instance, the Commission of Farmers Welfare set up for the central-western state of Andhra Pradesh in 1998 noted,

> Farming is in an advanced stage of crisis. The problems of farming are evident, ranging from frequent droughts and soil degeneration, to lack of institutional credit and insurance leading to excessive reliance on moneylenders, non-availability of reliable and reasonably prices inputs to problems of marketing and high volatility of crop prices. But crisis is also reflected in other features of the rural economy: the decline in agricultural employment and stagnation of employment, leading to reduced food consumption and forced migration of workers and forced migration of workers. Drought affected areas in Telangana and Rayalseema bear the brunt of the burden, even though irrigated farmers are also affected. (Ghosh et al. 1998)

Suicides are mostly seen amongst cash crop farmers of cotton. The increased planting of cash crops is cognizant of the changing trends in Indian agriculture wherein from a simple two-crop cycle largely dominated by foodgrains like wheat and rice, farmers have begun to branch out into cash crops like high-yielding cotton.[4]these crops promise lucrative returns, especially when farmers plant two crop cycles per year but are also risky, in terms of yield and price, especially in rainfed regions.

Cash crop cotton or white gold is largely grown under ecologically sensitive rainfed conditions (65%) in India, mainly in nine states namely Andhra Pradesh, Karnatka, Gujarat, Punjab, . The yield of cotton varies substantially from about 430 kg. per hectare in Punjab and Haryana to 100 to 125 kg. per hectare in Gujarat and Maharashtra.

Cotton productivity undertook a seachange in 2002. This was when Bt cotton, India's only commercilaised genetically modified crop, was introduced to reduce pesticide use, and kill bollworms, leadng to increased cotton yields[5].

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[3] http://www.indiatogether.org/2011/dec/psa-suidata.htm

[4] http://www.livemint.com/Opinion/zR8V3yKF7wENz14OYBdpMN/Understanding-farmer-suicides.html

[5] Bt cotton, contain Bt bacterium, a foreign gene isolated from Bt, an anarorbic bacteria, a natural enemy of the bollworm, characterized by its ability to produce crystalline inclusions during sporulation. It protects the cotton plant

Initially planted illegally in the central western state of Gujarat (Herring, various), reports suggest that Bt cotton now covers 90-95% of the cotton area in India.[6] Bt cotton has claimed to have successfully increased productivity of cotton farming, yields have jumped from 1.5 quintal to 5 quintals, while the area under cotton has not increased.[7]India has more than doubled its production from 13.6 million bales in 2002 to 35.5 million bales in 2011. From a meager 308 kg per hectare in 2001-02, the average yield of cotton increased to 526 kg per hectare in 2008-09 and stayed above 500 kg per hectare in 2010-11 as well. This boom in cotton production in India after 2002, has transformed India into a cotton exporting country.[8] This is a significant event for India, which has the 25% of the world area under cotton and only 12% of cotton production.[9] Some have claimed that this is a structural shift in cotton production. Not only has Bt cotton transformed cotton production, but also halved insecticide use[10].

On one hand there is a boom in cotton production, on the other, there are farmers suicides How do these two phenomenon co-exist? This paper answer this question by examining two cotton growing states, Maharashtra and Gujarat, located in central western India, one which is the hotspot of farm suicide and another where there are no farm suicides. In terms of area increase under cotton, Maharashtraï's area under cotton has grown just marginally, Gujarat's has nearly doubled; and the yield of cotton is more than three times that of Maharashtra. "Cotton farmers commit suicide in Maharashtra but prosper in Gujarat". The paper then asks: Under what

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from bollworm, as the worms become lethargic or die after ingesting the Bt toxin. http://www.iimahd.ernet.in/users/webrequest/files/cmareports/6Btcottoncoordinatedstudy.pdf

[6] http://articles.economictimes.indiatimes.com/2013-12-15/news/45216500_1_bt-cotton-cotton-farming-cotton-improvement

[7] http://www.ifpri.org/sites/default/files/publications/ifpridp01170.pdf

[8] http://www.ifpri.org/sites/default/files/publications/ifpridp01170.pdf

[9] - See more at: http://www.biospectrumasia.com/biospectrum/analysis/1354/bt-cotton-the-india-story#.UrlxOtIW0Vg

[10] Yet others are cautious suggesting that apart from Bt cotton there are other factors that are important in raising yields. For instance, an IFPRI study accounts for factors like increasing use of hybrid seeds, use of fertilisers, human labor, pesticides and irrigation that have led to increased yields apart from Bt cotton although an ISAAA study suggests that 50% of the increased yield is coming from BT seeds[10]. Many studies suggest that Bt cotton has led to increasing returns to labor, income rise for farmers (more for large than small and perhaps Northern over southern ones[10/10]) [10/10] leading to poverty reduction and rural development[10] and increase in rural employment.[10]

conditions does Bt cotton lead to sustainable farm livelihoods? Such an analysis allows us to extrapolate our findings to answer a larger question: Whether introducing other GM crops in rainfed areas will lead to sustainable farming livelihoods?

Maharashtra

The northwestern part of Maharashtra, Vidharbha, a major cotton growing area came to national prominence when farm suicides were first noticed in 2005. While Maharashtra is a very rich state with high FDI with its wealth concentrated in its coastal belt, Vidharbha, is located in agricultural backwardeness vis a comprising of rural districts with very low human development index. Despite having the largest area under cotton (75% of Maharashtra's cotton), the primary problem with cotton production in Vidharbha is its low productivity, both in current times and historically (IGIDR 2006; Planning Commission 2006).[11] The productivity of cotton in Vidharbha is largely tied to the scarcity and unpredictability of irrigation water (IGIDR 2006, Planning Commission 2006).[12]Water development in Vidhrabha is only 3-4%, mainly because Vidhraba lies in the hard rock terrain being a part of the semi-arid Deccan Plateau which leads to low level of irrigation development, and small flow in rivers. Other reasons for water scarcity are highwater rates in Maharashtra (Narayanmoorthy 2007), and stalled irrigation projects.

Vidharbha's (and Maharashtra's) agrarian structure, including that of cotton growing areas, is characterized by the presence of a large class of peasant proprietors with small land holdings. According to Ashok of Syngenta seeds (Nagpur), landowners in Maharashtra known as Patils (landowners) have become small farmers due to land fragmentation (not land reforms).[13] About 82% of Maharashtra districts, primarily those practicing agriculture, have a per capita income not only below the state average, but also below the national average (Planning Comission 2006)

[11] Average cotton productivity in Vidharbha is 0.147 metric tonne/ hectare, which is extremely low compared to other states. Average cotton productivity in the state of Punjab and Tamil Nadu is 0.366 and 0.295 metric tonnes (Planning Commission 2007

[12] Depending on the climate and crop-growing period, cotton requires 700–1200 mm of water per year (over its growing period) to meet its minimum water requirements. The water requirement is low during the first 60–70 days after sowing and highest during flowering and boll development (ICAR 2003).

[13] (Interview, Ashok, Syngenta seeds, Wardha, Nagpur, July, 2006).

The Green Revolution came to Vidharbha via cotton hybrids developed by Central institute of Cotton Research (CICR) and later private sector; cotton hybrids now cover 70-80% area. This led to an increased productivity and combined with high prices an increase in farmers profits. It also led to the creation of a cotton monoculture, to maximise income. However, in 1980s, the increased productivity started getting plagued with pest attacks which led to four consecutive years of crop failure (TISS 2006). Pests have now developed resistance to pesticides and continue to proliferate. The rising cost of inputs, higher cost of cultivation versus minimum support prices , variable cotton prices, adverse marketing conditions, and the dismantling of the cotton monopoly procurement scheme have led to declining returns in cotton production (IGIDR 2006, TISS 2005; Planning Commission 2006). Inadequacies of state rural credit system and state supported safety nets such as the Maharashtra Employment Guarantee Scheme (MEGS) has led to further depressed farm incomes.[14]Obviously, farmers cannot cope with such a situation by digging into their own savings; instead, they have to borrow money from moneylenders who charge high rates of interest[15]. This is over and above the debt burden that is often handed down over generations.[16] An important fact that was revealed during Maharashtra's case was that the planting of cash crop was a compulsion as farmers were unable to raise ample liquid capital from planting of subsistence crops;[17] thus cash cropping and its insidious effects become a vicious cycle. Recent crop failures and subsequent farm suicides are symptomatic of these problems .[18] The suicides have been largely concentrated amongst the small and lower caste farmers or the younger farmers. The cultivation of cotton requires extensive knowledge that was virtually new to such producers, not least because more than 58 per cent of them had been engaged in this highly competitive commercial economic activity for less than five years. Elsewhere in

[14] See TISS (2006), IGIDR (2005)

[15] This cushioning process was itself linked to access by large, medium and small producers to distinct forms of agricultural credit, and consequently to the different levels and outcomes of indebtedness. In keeping with the pattern found in many parts of rural India [Sahu, Madheswaran and Rajasekhar, 2004], large farmers borrow from formal lending agencies (cooperatives, the state) while smallholders depend mainly on informal sources for credit (moneylenders, traders, better-off proprietors.
http://courses.arch.vt.edu/courses/wdunaway/gia5434/mohanty2005.pdf

[16] http://www.livemint.com/Opinion/zR8V3yKF7wENz14OYBdpMN/Understanding-farmer-suicides.html

[17] http://www.vnss-mission.gov.in/htmldocs/Farmers_suicide_TISS_report.pdf

[18] The Green Revolution literature indicates that the initial condition of farmers is an important determinant of farmers making gains from new technology.

Maharashtra the same kind of difficulty has surfaced, in the shape of lower caste farmers being driven to suicide due to crop losses resulting from inadequate technical knowledge about the growing of commercial crops.[19]It is these very farmers who are unable to raise formal and informal loans.

It was under these conditions that Bt cotton was introduced in Vidharbha in 2002. The Bt seeds largely belong to Mahyco-Monsanto (MMB) Mech varieties, apart from the underground seeds that were circulating from the neighbouring state of Gujarat (see section on Gujarat). Due to lack of financial regulation, and monopoly of Monsanto, the seeds were priced high.[20]The price was reduced only after federal state and judiciary intervention[21]. Due to lack of other kind

[19] http://courses.arch.vt.edu/courses/wdunaway/gia5434/mohanty2005.pdf

[20] In 2002, three varieties of Bt cotton: Mech 12, Mech 162 and Mech 184, all produced by Mahyco-Monsanto, were introduced for use in four cotton growing Indian statesUnlike the ownership of the Green Revolution plant breeding material, which was held by the public sector, the ownership of Bt gene is largely held by an agro-transnational corporation, Monsanto. While Monsanto has supplied the Bt technology, sub-licensees such as Mahyco have supplied the germplasm for the seed which was already in use under Indian field conditions.The majority of Indian seed companies did not and still do not possess the technological know-how for producing the Bt gene themselves. Therefore, the ensuing exchange that took place between multinational capital and Indian capital has allowed the primary R&D capacity to stay in the hands of multinational capital (Evans 2006). This monopoly affected the final price at which Bt cotton was introduced in the market. The price of a regular Bt packet of 450 gms was 40 USD in 2002, out of which 20 USD was the royalty fee of Monsanto.This price was three times higher than the price of non-Bt hybrid seeds, and several times the costs of open or straightline (non hybrid) varieties that were being used by farmers earlier due to the high cost of intellectual property rights. The price of a non-Bt hybrid such as Ankur, which is popular in Vidharbha, is 13.33 USD in 2002."

[21] The state regulation to control prices has only emerged after activist intervention by federal states and the judiciary once the seeds have been introduced in the market. Price regulation of the expensive Bt seeds came into the picture when the state of Andhra Pradesh filed a petition to the Monopoly and Restrictive Trade Practices Commission (MRTPC) against Monsanto (Tehelka 2006). The state of Andhra Pradesh challenged the exorbitant royalties charged by Monsanto and the difference in royalty costs charged in India versus the United States. The state asserted that for every 450 gm of seeds sold, Monsanto charges 20 USD as "trait" charges from its Indian licensees while it charges 2.4 USD from its licensees in the United States (The Hindu, 3 January 2006). The state of Andhra Pradesh was supported by the agricultural ministers of seven cotton growing states ─ Gujarat, Karnataka, West Bengal, Tamil Nadu, Madhya Pradesh, Maharashtra and Andhra Pradesh as they signed a common memorandum of understanding to fight a legal battle against Monsanto (USDA 2006). Three states then ordered the sub-licensees of Monsanto to lower the seed prices to 16.66 USD. They warned the companies that if they did not lower the price, then the states would be forced to challenge them under the Essential Commodities Act (Times of India, June 2006). Monsanto approached the Supreme Court of India seeking a stay on the implementation of MRTPC's order and questioned the jurisdiction of the MRTPC to adjudicate the price issue. Monsanto argued that the "licensing of technology does not fall under the classification of goods or services." Monsanto asserted that the royalty was being charged for transfer of technical know-how and not sale of goods, which is what the commission regulates. Monsanto also suggested that the term "royalty" could not be applied because this technology does not hold a patent in India. Additionally, Monsanto said that there was an absence of rules in India for determining prices that a technology provider could charge from its sub-licensees (The Hindu, May 2006). The MRTPC case led to a reduction in the price of Bt cotton to 16.66 USD for a 450gm packet in 2006. The seed industry claims that the seed costs were high because of the lengthy process of conducting biosafety regulations by the Indian state (Pray, Bengali and Ramaswami 2005). It also claims that greater competition in the seed industry can bring GM seed prices down. In reality, Monsanto continues to have a monopoly over the transgenic seed market due to the high cost of

of state intervention, not only there were inadequate extension services,[22] but also weak expression of Bt trait,[23]spread of illegal seeds, quality checks, and lack of planting Bt refuge.[24] ``

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developing the Bt gene. Unlike the Green Revolution period, when the state donated the germplasm to the private sector, similar state support did not exist for helping the indigenous seed sector to develop GM technology.[21] The price ceiling that was applied to the Monsanto seeds to decrease their price is disadvantageous for the Indian firms that have entered the Bt market late and are hoping to develop their own Bt gene. Such GM development would have led to a lowering of the price of Bt gene. With the release of more varieties by Monsanto-Mahyco Biotech (MMB), there is already a restriction in the market because many sub-licensees are bound to MMB by contract (Murugukar, Ramaswami and Shelar 2007). At present, MMB has licensed its Bt gene to almost all leading cotton seed companies. These firms are contractually bound to pay royalties to MMB (Murugukar, Ramaswami and Shelar 2007). Thus, competition amongst these firms cannot lead to a lowering of prices. The government has recognized the importance of inserting the Bt gene in a cheaper, public, non-hybrid variety. For instance, M. S. Swaminathan at the CSE-NCF Roundtable on Farmer Suicides noted "Bt in straightline (non-hybrid) varieties will be more effective. In China there are no hybrids in Bt cotton use." A number of straightline (non hybrid) varieties containing the Bt gene are under development at the Central Institute of Cotton Research, Nagpur.[21] However, these are yet to be released in the market. In 2002, the shelves of the local input dealers in Vidharbha were largely stocked by MMB varieties rather than public sector varieties (Author's observation, July, 2006). Whether farmers' returns are certain or not, the royalty that was being charged by Monsanto (and its associated profits) are "certain" in comparison to the farmer's profits from Bt technology. While farmer has to deal with both economic and ecological uncertainties in rainfed areas as well as the lack of a safe and predictable production environment large seed companies such as Monsanto are made sure winners in the transgenic seeds market due to the presence of laws for intellectual property rights

[22] Extension was largely available for large farmers and not small and marginal ones. In the absence of any assistance from higher castes, small farmers were compelled to rely on local dealers and private agencies for information about new methods of agricultural production. Most of the lower and medium caste farmers who committed suicide had followed the advice of local shopkeepers
regarding doses, quality and timing of chemical inputs. Not surprisingly, these commercial enterprises recommended high quantities of the most expensive inputs that were not of the best quality.
http://courses.arch.vt.edu/courses/wdunaway/gia5434/mohanty2005.pdf

[23] Bt cotton has been attacked by activists and dubbed a failure in terms of its field performance. For instance, Gene Campaign Director, Suman Sahai notes that 60% of the farmers of Bt cotton in Maharashtra have not recovered their investments (Times of India 2005). In 2002, activist Vandana Shiva suggested: The Bt cotton crop in Vidharbha has been badly affected by the root-rot disease, a disease of roots. It is believed that this disease is caused due to wrong selection of Bt genes developed in America and brought to India. Many farmers have recorded only up to 50% germination of seeds and many others had poor germination, which is suspected to be caused by both, drought and poor seed quality. (Shiva 2002). Based on these reports by activists and complaints by farmers, a study of Bt cotton expression in the commercial varieties was undertaken by senior entomologist K.R. Kranthi (Kranthi et. al. 2005) at the CICR in Nagpur in 2005. Kranthi, who carried out tests on eight commercial hybrids, namely, MECH 12, Mech 162, Mech 184,[23] RCH 2, RCH 20, RCH 134, RCH 138 and RCH 144 noted that "a critical condition for the Bt gene to take effect and lead to reduction in pests is the expression of the Bt gene." The expression of the Bt gene can vary with different hybrids, timing and growth stages of the cotton plant, different field conditions and seasons (Kranthi et al. 2005). Kranthi's study suggested that the Bt gene expression levels were the lowest in the ovary of flowers and boll rind of green bolls, which constitute the favored site for bollworms to attack. He argued that while the studied Bt cotton varieties gave greater protection than hybrids, these initial varieties did not provide as much protection as provided by Bt varieties (specially NuCOTN 33B) that are available in the United States (75–90% protection against *Helivocerpa Zea*), China (>90% against *H. Armigera*) and Australia (80–90% against *H. Punctigera*). Kranthi et al. asserted that according to their data on the above-mentioned varieties, there has been >40% survival of the Bollworm larvae on squares, >70% on green bolls and >80% on flowers. Thus, the Mech varieties are able to reduce the Bollworm presence by 40%, which explains the differential rate of survival of Bollworm larvae in many parts of India, including Vidharbha. Kranthi et. al. (2005) further argued that the commercial Bt-cotton hybrids in India expressed less than the critical levels of Bt gene required for full protection against Bollworms late in the season and also in some plant parts such as the boll rind, square bract, bud and flower, which are the main feeding sites of

This leads to an enhanced risk factor in the planting of seeds,a fact that has been highlighted the Planning commission report on farm suicides and bt cotton: " As farmers adopt new and untried technology, and increase input intensities, they also face larger risks. These risks are often not well understood owing to lack of knowledge of the specific requirements of new seeds and other new technology for achieving productivity gains. All farmers do not have the ability to bear downside risks and this is evident from the spate of farmer suicides when new seeds fail to deliver expected output, or expenditure on bore wells proves infructuous, or when market prices collapse unexpectedly" (Planning Commission 2006bb.

Why do farmers continue to buy these seeds despite their high costs? According to Keshav Kranthi, entomologist, Central Institute of Cotton Research, Nagpur, this situation exists because "these were the only varieties available for addressing the pest menace that had been affecting cotton production for over a decade and no sustainable solution had been found to

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Bollworm larvae. Moreover, bolls in Bt-cotton F–1 hybrid plants contain segregating seeds, among which only an estimated 75% would express Bt gene. Because seeds form the most preferred food source of Bollworms, at least 25% of seeds in bolls of a Bt-cotton hybrid field could support susceptible Bollworm populations, if infested. The decline in expression also varies according to the parental varieties or germplasm (short or long duration). Economist Vinayak Deshpande, at Nagpur University, Maharashtra, argues that "The expression of the gene has been tailored for short-term American Bt varieties. Since a number of varieties in which the Bt gene was introduced were medium to long duration (160–180 days), and these were in turn adopted in Vidharbha, these were more susceptible to expression decline of the "Cry 1ac"Bt gene and consequently pest attacks." (Interview, Vinayak Deshpande, 2005). According to Kranthi et al. (2005), medium-to-long duration hybrids, as was evident with Bollgard-MECH-162, Bollgard-RCH-2 and Bollgard-RCH-20, experience a decline of Bt expression faster than the rest of the varieties mentioned above which are short term in duration. However, farmers, especially in South and Central India, prefer these hybrids for their big boll size and superior fiber properties. It can be safely said that uncertainties exist in the expression of the Bt gene under different field conditions and choice of the different field conditions and choice of the germplasm or parental varietyKranthi et. al.(2005) add that Bt cotton hybrids in India may require more supplemental insecticide sprays than those used on Bt-cotton varieties by farmers elsewhere in the world. In the event of lack of regulation or extension mechanisms to bridge these uncertainties in the farmer's fields, the problems are left to the farmer to deal with, causing an increase in pesticide use and uncertain production costs. Scientifically, while Bt cotton might reduce the need to spray insecticides, it does not completely eliminate the need to spray, as the toxin might not be able to express itself fully. Even while a farmer might have planted Bt cotton, there might be a need to spray pesticides and in a more precise manner. After planting Bt cotton, the farmer needs to scout for larva weekly in the fruiting parts of the cotton plant. According to Narayanmoorthy and Kalamkar's (2006) empirical study of 150 farmers on adoption of Bt cotton in two Vidharbha districts, farmers continued to spray pesticides due to lack of information and fears of pest attacks. They also sprayed pesticides on Bt cotton because there had been pest attacks. While the cultivation costs in this study were found to be higher in the case of Bt cotton versus non-Bt cotton, due to increased productivity, the profits from Bt cotton were higher.

[24] In order to ensure environmental and health safety, the biosafety regulations prescribe planting a refuge of five rows of regular cotton around each Bt cotton plot, or 20% of the area has to be covered with non-Bt cotton. According to Keshav Kranthi (2005), entomologist at CICR, Nagpur (Maharashtra), the strategy ensures that an appropriate area of non-Bt crops is cultivated in the vicinity of the Bt-transgenic crop in order to ensure the survival of susceptible insects. Non-Bt cotton planted within or around a Bt cotton field acts as a ''refuge'' for Bt-sensitive insects that will breed with Bt-resistant insects, thereby minimizing or delaying the development of Bt-resistant insects. The refuge of non-Bt cotton is also supposed to act as a ''pollen-sink'' or border to prevent out-crossing of transgenic Bt cotton pollen.
Available studies indicate that this procedure has not been a top priority of cotton farmers, especially small and marginal ones. The reason for this is that the size of the fields is too small.

date." Furthermore, according to farm activist, Vijai Jaywandhia of the Shetkari Sangathana, Wardha, Maharashtra, these new seeds were marketed aggressively through advertisements in local newspapers and field meetings held for farmers by the local seed companies. "The seed companies put large advertisements which said that the Bt will fight the bollworm with all its might[25]."Pankaj Shiras, old time seed dealer, JK seeds, Nagpur, adds: "the Bt seeds created a hype amongst farmers due to the controversy that surrounded Bt seeds, leading to greater sales of Bt seeds[26]."

Even while Bt cotton continues to be adopted, suicides also continue in Vidharbha. It is important to note, that these suicides are mostly affecting small farmers[27], young farmers or farmers of lower castes[28].

An important ecological issues is addressed by a new study by the Council of Social Development (CSD) titled 'Socio-economic impact assessment of Bt cotton in India.' It raises the question of whether the marginal land of Vidarbha is suited for Bt cotton at all.[29]The studysays, "70 per cent of the farmers stated that irrigation expenditure was more on Bt cotton than on non-Bt cotton." Though it claims that productivity increased by 4.49 per cent from the pre-Bt to post-Bt period, costs too increased: especially fertilizer costs, which increased from 29 per cent in the pre-Bt period to 71 per cent in the post-Bt period.

A last important point worthwhile noting is the political power of the Maharashtra farmers- is that cotton farmers of Vidharbha are not powerful as compared to the sugarcane farmers of West Maharashtra. While there is an activist movement regarding cotton farming suicides, it is not

[25] Jaywandhia, Interview, Nagpur, MH, 2006

[26] Shiras, Interview, Nagpur, MH, 2006

[27] http://courses.arch.vt.edu/courses/wdunaway/gia5434/mohanty2005.pdf

[28] Field evaluations of farmers committing suicide by the government run IGIDR in Mumbai (2006), show that a large proportion of those committing suicides are younger farmers who have relatively low experience in farming but who have been educated and could not find suitable employment. Others such as those belonging to low castes also continued to engage in cotton farming, even though they did not have the skills to farm cotton, but they have received extra land holdings from the government in the form of wastelands or surplus properties through the implementation of land ceilings (Mohanty 2005).

[29] http://www.thehindu.com/news/national/study-questions-sustainability-of-bt-cotton-in-waterstarved-vidarbha/article3563411.ece

strong enough to provide major gains to Vidharbha farmers. For instance, the demand for Vidharbha to become a separate state, as it is rich in minerals but had a huge development backlog has not been heard. This movement does ally with the delhi based environmental movement but does not enjoy a consolidated power as the farmers movement did in the haydays of the Green Revolution.

Even though claims have been made regarding increased productivity and profits from Bt cotton in Maharashtra, the suicides continue, because the underlying social, ecological, technological, economic and political conditions remain unchanged. It is until these conditions are corrected true gains from Bt cotton are not possible in Maharashtra.

Gujarat

Gujarat is one of the more advanced cotton-growing states, with widespread access to irrigation[30]. The first cotton hybrid seed was sown in Gujarat, developed by the public sector Gujarat State University, which held sway for a long time before proprietary hybrids came in[31]. Cotton growing farmers of Gujarat are either largeor medium farmers who have the risk bearing capacity to plant cash crops[32] and resources to weather difficult economic periods.[33]There are no incidences of farm suicides in Gujarat.

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[30] **India's experience with Bt Cotton: Case studies from Gujarat and Maharashtra***N. Lalitha, Bharat Ramaswami and P.K. Viswanathan* http://www.isid.ac.in/~bharat/Research/tripp.pdf

[31] **India's experience with Bt Cotton: Case studies from Gujarat and Maharashtra***N. Lalitha, Bharat Ramaswami and P.K. Viswanathan* . http://www.isid.ac.in/~bharat/Research/tripp.pdf

[32] http://www.spuvvn.edu/academics/academic_centres/agro_economic_centre/research_studies/Report%20No.%20134%20Bt.%20Cotton%20Vis-a.vis%20in%20Gujaratr%20State.pdf

[33] http://www.cam.ac.uk/research/news/new-evidence-of-suicide-epidemic-among-indias-marginalised-farmers#sthash.ZmpnrSKl.dpuf . These are the very farmers who had adopted Green Revolution which much gusto, and Bt cotton has been inserted in thatr very technological culture (Esha Shah: 2005).

Bt cotton in Gujarat has been a unusual phenomenon, as it has been dominated by unapproved varieties of Bt seeds. The illegal seeds were first discovered in October 2001 when actual fields in thousands of hectares of illegal Bt cotton were found growing in Gujarat (Herring 2005). A local seed company, Navbharat 151, developed this illegal variety through a strain selected from an indigenous germplasm collection (Down to Earth 2006). The activities of the company were supported by the state of Gujarat, as the company got state support for seed research (Down to Earth 2006). This variety, which had already been popular in Gujarat before Bt came to the market, was fused with the Bt gene (from Monsanto) by its breeder, D. B. Desai.[34] It produced such good results in the field that during a pest attack in 2001, it was the only variety that survived and produced good yields (Down to Earth 2006). Not only was productivity good (1.2 to 1.5 Metric Tonnes per hectare), which was better than imported varieties, but also the price at which Navbharat 151 was available was 13.33 USD per packet (Down to Earth 2006) equivalent to price of normal hybrid seeds in Vidharbha. Someone filed a complaint against Navbharat that these seeds contained the Bt gene, which was Monsanto's property. Because Navbharat had no license for Bt technology, the central government ordered the Gujarat government to burn the cotton fields (Down to Earth 2006). When Navbharat–151 was banned, it went underground; farmers started circulating the seeds and small seed farmsstarted producing them (Down to Earth 2006). The farmers developed this variety through cross breeding and the strains were selling at a price even cheaper at the rate of 2.22–4.44 USD per packet (Down to Earth 2006). In the season of 2005, the Navbharat varieties and its variants covered 80% of all Gujarat area despite a pest attack (Down to Earth 2006) and could not be regulated by central and federal state.

While illegal seeds have been charged with being spurious, not all of them are poor in quality.In cases where there is a greater network among farmers or where these seeds have been operating for a longer period of time as in the case of Gujarat (see Roy 2007). The unauthorized Bt varieties are hybrids, and because hybrid seed production requires organization, capital and specialized labour. Thus unauthorized seed production and distribution is unlikely to be the outcome of individual acts of piracy. Rather, the seed is produced through a loose network of seed growers (many of whom were former contract seed growers for Navbharat) and their

[34] This was possibly stolen by Navbharat seeds from Monsanto. Interview, Bhagirath Chaudhury, ISAAA, Delhi, July, 2006.

agents. It is not clear how many people in this network obtained the Navbharat inbred parental lines, but their ownership seems fairly dispersed. As a result,there has been wide experimentation and the male parent (with the Bt gene)often has been crossed with different female lines producing a range of hybrids well adapted to local conditions.[35]

Farmers believe that illegal Bt coming from Gujarat is of good quality (Murugkar, Ramaswami and Shelar 2007)[36] and is cost effective (IIM-A Survey). The cost of seeds per hectare in Gujarat is the lowest (Rs. 3079/h and Rs. 3857ph resp.) and number of sprays and thus costs were much lower than other states in case of Bt cotton in Gujarat than Maharashtra. Further, there have been points of time when unauthorised cotton was had a higher yield that authorised cotton.

Selling of cotton done in Gujarat is done privately unlike the state scheme in the case of Maharshtra. Cotton is brought, procured and sold at market prices[37]. Farmers in Gujarat also have had a long tradition of cooperatives; in case of cotton they obtain fertlisers from the cooperatives unlike private procurement in Maharashtra.

Comparing the case of MH and Gujarat, it is clear that the technology gives results only under certain conditions. Besides, irrigation, large scale farming, private versus government procurement, presence of cooperatives, presence of cheaper unofficial cotton with a strong network of sellers and buyers, are some of the other reasons why Bt cotton has been more successful in in Gujarat than Maharashtra in increasing the wealth of cotton farmers.

Furthemore, size of landholding and irrigation matters. Average landholding in Gujarat is 6-10 hectares, % fully irrigated land is app 40%. Corresponding numbers for Maharashtra is less

[35] http://www.isid.ac.in/~bharat/Research/tripp.pdf

[36] A similar center for illegal seeds has emerged in Kurnool, Andhra Pradesh. However, Kurnool Bt has more quality problems than Gujarat Bt and also other locales might lack the same kind of trust based network that had started to emerge in the case of Gujarat (Murugkar, Ramaswami and Shelar 2007).

[37] http://www.fibre2fashion.com/industry-article/market-research-industry-reports/what-ails-cotton-industry-in-maharashtra/what-ails-cotton-industry-in-maharashtra3.asp

than 1 hectare and 5%[38]. Down to Earth notes reasons such as increase in cotton area in Gujarat from 1.5 million hectares in 2000 to 2.6 million hectares in 2009; at maximum productivity gains were notched in the new areas under cotton in Gujarat which had the benefit of more than 100,000 newly constructed check dams and had highly fertlie soils. It is a people initiative supported by the Government. New pesticides, new hybrids, new micro-irrigation systems and new areas along with Bt cotton would have effectively contributed to the cotton success story. Another major contributory factor was imidacloprid, which was used to treat seeds to protect them against sap-sucking insects. This insecticide, popularly known as Gaucho, was in use since 2000 and had helped to push up yield by 25%-30% in conventional hybrids long before Bt cotton was introduced. Kranthi points out that even the most naïve of researchers would know that without this insecticide the vast majority of Bt hybrids would not have been able to withstand the leaf hopper infestation[39].

Our findings are consistent with a number of other studies conducted at the national level regarding the importance of social, ecological and political conditions in determing the effects of technology on farm livelihoods. An IFPRI (2011) study shows that while Bt cotton contributed significantly to cotton yield growth, a total increase contribution of 19 percent over time between 1975 and 2010, but other factors were consistently significant, especially the use of fertilizers and of hybrid seeds. Human labor, pesticides, and especially the use of irrigation are also found to have had significant effects in several of the regressions.

Reports also suggest that Bt did contribute to the second increase in cotton productivity (after 2005) but remain inconsistent regarding the possible impact of unofficial Bt cotton adoption in the early years.[40] Analysis of yield also shows that impressive productivity increases in cotton have happened before Bt cotton became prevalent. In the five-year period from 2000-01 to 2004-05, yield increased by 69 per cent. In the Bt cotton period starting from 2005-06, a moderate 17 per cent increase in yield is shown over three years up to 2007-08 (554 kg per

[38] http://www.fibre2fashion.com/industry-article/market-research-industry-reports/what-ails-cotton-industry-in-maharashtra/what-ails-cotton-industry-in-maharashtra3.asp

[39] http://www.downtoearth.org.in/content/busting-bt-cotton-myths

[40] http://www.ifpri.org/sites/default/files/publications/ifpridp01170.pdf

hectare compared to 470 kg per hectare).[41].Thus there exist conditions apart from Bt cotton that have a bearing on sustainability of farm livelihoods.

GM crops and Rainfed Areas

What then could be the effect of GM crops in rainfed areas given the above analysis. A peek into dynamics of rainfed areas, suicides and nature of GM crops is given in the next section. The importance of rainfed agriculture to Indian agriculture is such that nearly 70% of agriculture in India is rainfed and 84% of all farm livelihoods depend on it, cultivating minor millets, cereals, oilseeds, cotton and pulses. Farming conditions in rainfed areas are characterized by variable climate patterns, frequent occurrence of mid-season and terminal droughts,[42] sporadic distribution of rainfall, water scarcity, low rainwater use efficiency, land degradation, loss of organic matter, soil erosion, nutrient depletion (Wani, Singh, Boomiraj, Sahrawat: 2009) leading to high variability in crop production and low yields (Raina and Vijay Shankar: 2011).[43] Consequently, high population of landless households and agricultural laborers, low land and labor productivity, and poverty is concentrated in rainfed regions[44].

Before the advent of cash crops, the traditional farming systems consisted of diverse cropping systems, that were dependent on locally available inputs, growing a number of crops that were able to withstand a drought like situation. Farming systems have however, transitioned

[41] http://climate-connections.org/2012/06/02/bt-cotton-a-bitter-harvest-for-farmers-suicide-and-despair/

[42] The drought need not be a long one, even a small one during critical growth period can cause a lot of harm. The variability of rainfall and occurrence of drought is also due to the fact that in rainfed areas, inter-annual fluctuations of rainfall are high due to monsoonal climate- characteristics of the atmospheric circulation and strong links to ENSO phenomenon in the Pacific Ocean.
http://nrlp.iwmi.org/PDocs/DReports/Phase_01/11.%20Potential%20of%20Rained%20Agriculture%20-%20Sharma%20et%20al.pdf

[43] In another instance, in Dharwad, a semi arid area in Karnataka, crops are so dependent on rainfall, that compound growth rate of crops despite application of new technologies and fertilizers, is negative and instability index is as high as 0.86 (0.71 for cotton) (Wani, Singh, Boomiraj, Sahrawat: 2009).

[44] http://nrlp.iwmi.org/PDocs/DReports/Phase_01/11.%20Potential%20of%20Rained%20Agriculture%20-%20Sharma%20et%20al.pdf

from[45] subsistence farming to growing of high value crops such as cotton, which are dependent on costly inputs such as fertilizers, seeds, irrigation etc. Cotton productivity increased substantially with use of hybrids in cash crops introduced in late 1980s, generating more output from the same piece of land and leading to more lucrative returns. The more risk taking farmers even started generating two crop cycles in a year. While the high-yield cotton improved the financial prospects for the farmer, they led to a substantial increase in risks—particularly of yield and price. Yield is not only vulnerable to the vagaries of weather but also to pests, besides the fact that the input costs can also go up dramatically.[46].

Since the period before liberalisation and after liberalisation, there has been an expansion of cash crop cultivation in these areas. These areas did not have subsidies and support like Green revolution areas, thus cash crops were grown at the farmers risk. Farmers suicides are prevalent in many of these areas and so has been claimed in many government evaluationsThe 2007 Report of the Expert Group on Farmers Indebtedness, written by economist R. Radhakrishna for the Ministry of Finance notes: "Indian agriculture is passing through a period of severe crisis. Although some features of the crisis started manifesting themselves in 1980s, the crisis assumed serious dimensions in the middle of the 1990s" (Ministry of Finance 2007). Similarly, the 2005 National Commission of Farmers[47] report titled "Serving Farmers: Saving Farming" notes, "The acute agricultural distress now witnessed in the country, occasionally taking the form of suicides by farmers, is the symptom of a deep-seated malady arising from inadequate public investment and insufficient public action in recent years." Commenting on the nature of the farm crisis, Professor R. B. Singh, member of this commission, and previous Additional Director General of FAO commented that "we need to raise farmer's income. No government can afford to ignore the needs of the agricultural community."[48]

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[45] http://nrlp.iwmi.org/PDocs/DReports/Phase_01/11.%20Potential%20of%20Rained%20Agriculture%20-%20Sharma%20et%20al.pdf

[46] http://www.livemint.com/Opinion/zR8V3yKF7wENz14OYBdpMN/Understanding-farmer-suicides.html

[47] This Commission was established under the Ministry of Agriculture in 2005 after news of the agrarian crisis spread in the media.

[48] Interview, R.B. Singh, Member, National Commission of Farmers, July, 2007.

Apart from the popular reasons, a very unique and critical observation has been made by sociologist AR Vasavi (2012). He suggests that, that the states where maximum suicides have occurred are states that have high economic growth. The sociological factor that distinguishes these states from others is the shift in agrarian social structures and economic mobilities of various class and caste groups. For instance, in Andhra Pradesh, Telangana region exhibited interesting trends in land holding and cultivation patterns. Although cotton cultivation has been introduced in the region since the past two decades, the region has witnessed significant changes in agricultural patterns and in the agrarian social structure, where a small minority of persons owned large landholdings and large mass of landless workers cultivated the land. This has changed to intense cultivation of commercial crops by migrant landowners in the coastal belt of the state. The successful landed elite have moved to cities for better occupations, leading to high tenancies and decreasing size of landholdings, with backward castes and marginal farmers have taken to agriculture, thus occupying the spaces left over and becoming full time agriculturists. Many of them, typically non cultivating castes have sought to emulate the Green Revolution model as beneficiaries of the Green Revolution have moved to better occupations.

Thus Green revolution is accepted not only as a mimicry but also a form of modernity and social mobility. This has led to a triple crisis, in form of increasing costs of cultivation, of increasing vulnerability of marginal agriculturists and intensification of natural resource depletion (Vasavi; 2011). Volatile commodity prices and unregulated markets prevalent under the new liberal policy regime, have created suicide hotspots. In this regime, agricultural subsidies have remained to the benefit of irrigated large farmers and rainfed areas continue to suffer from a lack of subsidies regarding inputs, credit etc which are linked to irrigation.

There are yet other authors who link the suicides to the larger adoption of the Green Revolution seds-fertlisers- irrigation model in semi arid rainfed areas. According to Venkateswarulu (2011) the predominance of this model has led to an agricultural policy paralysis, which means that Green Revolution inspired external input intensive technological approaches are to be transferred to the rainfed areas despite their increasingly diverse and highly integrated agricultural systems. Raina (2006) notes that farmers in the dry tracts look for higher

yields, but only amongst other traits like grain to fodder ratio, crop duration, seed quality, drought tolerance and pest resistance. The rainfed rural economy has adapted to the inherent instability in crop yields by cultivating diverse crops, engaging in several livestock based and other non-farm options. In these areas, fodder yield is considered more important than grain yield especially in the dry villages subject to severe seasonal stress. However, plant breeding as a discipline on which the Green Revolution based has limited capacity to understand the varietal selection and livelihood options in the drylands and has become entrenched in even semi arid systems.

It is in these contexts that the new GM crops stand to be adopted. What is the nature of new GM crops and what effect they might bear towards sustainability of farm livelihoods? The earlier section in the Vidharbha case shows that the nature of competition in the GM cotton seed industry is such that given the high production costs of GM crops, the future development of the GM seed industry will be driven by big private sector players. Are these crops for drought prone, ecologically sensitive region, small and marginal farmers it remains to be seen. Will young, less experienced and lower caste farmers be able to gain from them?

Conclusion

A comparative analysis of two states, Maharashtra and Gujarat, suggests that political-ecological conditions such as irrigation, presence of local hybrids, nature of seeds, mechanisms of cotton procurement, indebtedness, matter in determining the the role of bt cotton on creating sustainable livelihoods. Thus, an analysis of the dynamic performance of the technology over an appropriate period of time across different agroclimatic conditions could throw more light regarding effects of GM crops and also help us study the associated effects on the ecology and

environment.[49] Given the example of the adoption of Bt cotton, it remains to be seen whether the new GM crops will be suitable for the fragile rainfed regions and livelihoods dependent on this natural resource base in India.

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