Cotton, Contaminated?

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I. CONTAMINATION FROM GMOs A REAL THREAT[1]

I. 1. INTRODUCTION

There are several instances from across the world where non-GM seed/plants got contaminated with GM seed/material - either biologically or in physical handling. There is by now the infamous example of maize seed in Mexico getting contaminated by GM maize from the USA. The recent scandal related to LibertyLink Rice in America is also a well-known example of contamination flowing out of field trials. Many instances of contamination in the past have emerged from field trials. If such contamination can flow out of small scale trials, it is not difficult to anticipate such contamination of non-GM material from large scale cultivation, as is the case with Bt Cotton cultivation in India today.

Contamination can be at the biological level through transgene flow. It could also be due to physical mixing-up in human handling of the production and post-production processes. Whatever the cause and mode of contamination, there could be many effects from such contamination at ecological, socio-cultural, economic, legal and political levels.

Why should contamination be an issue for debate at all? For one thing, Genetic Engineering is an imprecise and imperfect technology – it is also irreversible and any unplanned spread with associated contamination takes away choices for farmers, breeders and regulators. For those farmers who wish to remain non-GM and specifically, organic cultivators, even the adventitious presence of GM in their produce is a violation of their right to remain GM-Free. In the case of certified organic producers, such contamination could have economic implications as well in that certification standards do not permit the presence of GM material beyond a very small threshold limit (in some cases, not even a threshold level is allowed, as in the case of standards evolved by APEDA in India).

There are also trade security implications flowing from such contamination given that today, an overwhelming majority of nations of the world reject GMOs in their farming. Further, to specifically be non-GM in a scenario where GM cultivators are in the neighborhood and along the entire supply chain, it becomes cost-prohibitive and uncompetitive even though there is a market edge in being non-GM.

There are also trans-boundary obligations to be met through international treaties like the Cartagena Biosafety Protocol where prior informed consent is to be obtained for any GMO movement – there will be liability and redressal mechanisms to be met under such obligations. There is also much discourse on the threat to agro-diversity in particular and biodiversity in general with GM crops and potential contamination.

With rigid IPR systems accompanying much transgenic seed research and trade, contamination also has legal implications of violations of proprietary rights of corporations and other institutions.

A recent FAO study report sums up that the flow of transgenes from plants derived from recombinant DNA techniques has specific or special impacts on biology, ecology, agriculture, society and culture. In the case of India and Bt Cotton, it is an established and known fact that commercial cotton produce of GM and non-GM is mixed up right from the farmer's stage to international trade. This paper however, is specifically intended to look at cotton seed production and potential

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[1] GMOs are Genetically Modified Organisms

contamination of GM seed with non-GM, thus violating the rights of organic and non-GM farmers, right from the seed stage.

I. 2. CAUSES FOR CONTAMINATION

Transgenes flow with normal reproductive processes or may also be transferred by infectious processes using microbial vectors such as viruses. They can also move when a plant carrying a transgene moves to a new environment, via seeds or propagules. There is also possibility of contamination in the physical handling and human-mediated processes – what is normally termed in the seed certification parlance as 'admixtures'[2].

As part of regulatory approval processes, pollen flow studies are included into biosafety testing. However, there are many issues/factors that affect such pollen-mediated gene flow and not all of these are considered or assessed adequately during such tests.

Scale issues affect estimates of pollen-mediated gene flow, for instance. The greater the number of plants, the greater the amount of pollen being produced, increasing the likelihood of successful fertilization, and the likelihood that long-distance gene flow may occur. Large-scale release also constrains containment options. For instance, measures such as flower covers to prevent pollen dispersal are impractical for individual plants at the scale of some trials, let alone commercial agriculture (Gurian-Sherman, 2006).

Asymmetries in gene flow potential are also created by asymmetries in the size of source and sink populations. The extrapolation of pollen dispersal or cross-fertilization measurements taken from small-scale trials to general GM crop release should be done with caution, as "such a design does not reflect the real agricultural situation and is not suited to quantify the cross-fertilization levels of recipient fields of commercial size". For example, successful cross-pollination can depend on the amount of competing pollen generated by the recipient crop. A small sink population (which is the case with shrinking areas of non-GM cotton in the country, including cotton varieties) may be disproportionately vulnerable to the pollen from a large field (most cotton fields in India now being Bt Cotton fields).

The landscape distribution of transgenic plants can also influence animal pollinators. While the general characteristics of pollen flow can be described from knowing the pollinators' average ranges and preferences, occasionally animal pollinators will move much further than average in what is called "jump" dispersal. The configuration of donor and recipient populations may accentuate the impact of jump dispersal.

Even in terms of physical contamination, asymmetries in GM and non-GM populations might be an important factor. Human error or mechanical errors, even in the most careful of systems, can cause such physical contamination.

I. 3. EFFECTS OF CONTAMINATION[3]

As a recent FAO commissioned study pointed out, the effects of such contamination can be broadly categorized as impacts on biology, ecology, agriculture, society and culture.

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[2] It is acknowledged that admixtures can also be through biological reasons.
[3] This section has relied on extracts from "A typology of the effects of (trans)gene flow on the conservation and sustainable use of genetic resources", by Jack Heinemann, for FAO, 2007

Loss of biodiversity: Biological invasions are believed to be the second largest cause of current biodiversity loss, after habitat destruction. The outcome of plant invasions is exotic, naturalized populations or weeds that may cause extinction of species in extreme cases, alter ecosystem processes such as nutrient cycling, and reduce economic and agricultural productivity. GM plants and intermediate types formed from crosses between GM and other plants that can both invade and persist in an environment where they are not desired may become weeds.

It is acknowledged that multiple introductions, even of species that are already present in a new range, should be avoided because the new immigrants might contribute to invasiveness.

Gene flow creates potential heterogeneity of traits. This heterogeneity may compromise management strategies such as the use of refuges surrounding pest-resistant plants. For traits such as pesticides, heterogeneity may promote the evolution of resistance among damaging insect pests.

The effects on wild biodiversity could be a reduction in the number of species on local and global scales. In plants, some existing genes might be replaced by transgenes or unmodified plants might be replaced by transgenic plants. Both outcomes can cause sweeps of the gene pool and lower its diversity.

IPRs and accompanying legal frameworks: A quantitatively new level of legal exposure for "biotech" seed producers and farmers that produce plants and plant products has been created by a combination of new international legal frameworks and the inherent biological capacity of crop plants to mix at all levels of their lifecycles (from pollen movement to co-mingling of seed at various stages). National laws, to adhere to international agreements, have been changed to allow transgenes and the processes of creating transgenic crops to be protected as intellectual property and this is an important issue for farmers who do not wish to use transgenic crops or transgenes.

International Obligations: As transgenes are the basis of international agreements such as the Cartagena Protocol on Biosafety, their presence and not just their impact is the level at which they have legal consequences. This creates new challenges for countries that enter into international trade of organisms that are meant to be free of transgenes.

Market implications: Those who grow transgenic crops either on purpose or by accident could become exposed to legal actions or market rejections. This is particularly poignant in light of recent market rejections of some GM crops based on perceptions of an inability to segregate GM and non-GM material. It is interesting to note that rejections of agricultural produce based on GM presence have mostly had their origins in field trials and not even contamination flowing from large scale commercial cultivation.

Organic certification implications: Organic certification standards, including those laid down by national authorities like APEDA in India, do not allow for the presence of GMOs and contamination therefore has implications for all organic producers.

The above effects are only a few such effects flowing out of contamination of non-GM material, while there could be many other at the individual, community and national level.

II. CONTAMINATION OF COTTON SEED IN INDIA: THIS INVESTIGATION

In recent times, cotton seed scenario in India has been changing quite drastically – varieties have been replaced quite rapidly by hybrids, private sector has taken over the hybrid cotton seed sector almost completely and the regulatory regimes around seed trade including cotton seed trade are in quite a flux (an illustration includes changes made to Essential Commodities Act from which the executive powers of state governments as licensing authorities for cotton seed marketing emerges, for example, through the Seeds Control Order). Within cotton cultivation extents, Bt Cotton hybrids are fast replacing non-GM cotton hybrids or varieties and this obviously is a picture reflected in the cotton seed sector too. This made us wonder about the non-GM status of the so-called non-GM seed and the current investigation flows from our concern with regard to GM seeds contaminating all other seed stocks.

II. a. Objective of the investigation

- To assess the status and situation of non-GM Cotton seed in India, including its "non-GM status"

Centre for Sustainable Agriculture, with the help of other institutions, took up an investigation in the months of September, October and November 2007 to assess the possibility of contamination of cotton seed in India from Bt Cotton. The following is a report based on this investigation[4].

II. b. Methodology employed for this investigation

The chosen methodology for this investigation was to look closely at the entire supply chain of cotton seed production, from the seed production plots to the retail outlets, followed by secondary data analysis. The focus was particularly on non-Bt Cotton seed. The following components were involved in this investigation:

- secondary literature review
- collecting data from seed certification agencies and analyzing the same
- field visits to cotton seed production plots in Gadwal region in Mahbubnagar district, Nandigama region of Kurnool district (both in Andhra Pradesh) and Sabarkantha region of Sabarkantha district in Gujarat
- visiting of ginning mills in Mahbubnagar, Kurnool and Sabarkantha districts
- speaking to cotton seed breeders, cotton seed growers and seed organizers in addition to seed industry representatives.

This investigation was spread over the months of September, October and November 2007.

[4] We would like to thank Glocal Research Consultants for their support during field trips

II. 1. Cotton Seed Scenario In India & Situation With Bt Cotton

India has the largest area of cotton cultivation in the world, at around 9 million hectares on an average annually. Most cotton grown in India today is from hybrid seeds (on around 75% of India's cotton land) and within this, private hybrids (also referred to as proprietary hybrids in literature) dominate. This is in contrast to the global situation, where [open pollinated] varieties (as opposed to hybrids) dominate.

Data shows that private hybrids that used to be the least important even a decade ago in 1996-97, have emerged as the most popular seed source for cotton now. In 2004-05, private hybrids accounted for 5 million hectares of cotton planted in the country whereas public hybrids were on nearly one million hectares and cotton varieties on another 2.6 million hectares. In states like Andhra Pradesh, Maharashtra, Gujarat and Punjab, private hybrids have rapidly replaced public hybrids and varieties in the recent past.

In 1996-97, public hybrids accounted for 55% of the value of cotton seed market. That is no longer the case, where public hybrid seeds add up to less than 10% of the cotton seed market in value. Private and public hybrids together account of around 95% of the cotton seed market by value now, whereas varieties account for less than 5%.

Seed markets are also calculated by volumes. The seeding rate for private hybrids fluctuates between 1.14 and 1.68 kilos per ha while that for public hybrids varies between 2.01 and 2.66 kilos per ha. The seeding rate for varieties is in the range from 9 to 11 kilos per ha. In 2004-05, proprietary hybrids occupied around 20% of the cotton seed market volumes.

The proprietary seed market is calculated in terms of number of packets sold with each packet containing 450 gms of seed. The size of the proprietary seed market was around 12.5 million to 15 million packets in 2004-05, as per an industry survey. The top firms in terms of sales include Mahyco, Nuziveedu, Rasi, Ankur, Emergent Genetics, Navbharat, JK Seeds, Syngenta and Tulasi. While these firms have an inter-state presence, there are also many companies which are strong in their own regions.

Bt Cotton has officially been approved only in the case of proprietary hybrids so far. In 2007, 167 GM Cotton hybrids were allowed for commercial cultivation, the seed of which is produced by around 25 private seed companies.

There are no official numbers of Bt Cotton area planted in India, it is worth noting. Many officials are seen quoting figures from industry sources in their own papers and presentations.

As per industry data, the area of Bt Cotton within proprietary cotton hybrids was around 14.4 million acres in 2007-08 (5.8 million hectares – around 65% of India's cotton cultivation). In value terms, using the thumb rule of one packet per acre and at the rate of Rs. 750/packet, this is a market that is worth more than a thousand crores in 2007. In this year, Monsanto's proprietary brand of stacked GM cotton called Bollgard II is supposed to have been planted on 1.2 million acres (0.49 mn hectares).

That brings us to the other 2.7 million hectares of non-GM cotton – where is the seed for this being produced and how?

II. 2. Organisation Of Cotton Seed Production In India

There is literature available to show that even though hundreds of brands of cotton hybrid seed have been marketed in India with some of the brands barely lasting one or two seasons, the parental lines are actually very few. As in the case of all seed stock, the origin of these parental lines is from farmers' fields, later appropriated through the agricultural research establishment by private seed companies.

Farmers experience several levels of deceptiveness in cotton seed products (Stone, 2005). On the one hand, there is often variation among packs of a single brand. Different seeds are known to have been packed as a single product and sold to the farmers. On the other hand, seeds sold under different brand names may actually be identical. In places like Warangal in Andhra Pradesh, it has been documented that seed brands that have lost their popularity have been brought back into the market in a new name, capitalizing on the farmers' penchant for newer brands each season. These introductory paragraphs are just to give a glimpse into the need for regulation of the cotton seed market, before moving into a description on how cotton seed is produced in India.

Private seed companies first make a market assessment of how much seed is needed for the coming planting season, based on farmers' preferences, current year markets, competitors and their brands and markets etc. Based on this, they plan their seed production areas (extents, where to outsource the actual production, extents for different brands of each company etc.). A company also makes an assessment of which hybrid brand should they grow in how much extent etc. within the portfolio of brands that each company has. Smaller seed companies, in earlier years, were also into production and marketing of notified public-bred hybrids and varieties. These days however, even the smaller companies are engaged in producing their own brands of cotton hybrids. Companies have a choice of either obtaining a certificate from the Seeds Certification Agencies (for released/notified seeds only) or sell as 'truthfully labeled' seed. In either case, the companies are expected to adhere to minimum standards prescribed.

In the case of cotton varieties, seed is saved from the crop by farmers themselves. While some of them choose seed for next year's planting carefully by selecting good bolls on the crop, others just get back a handful of seed from their produce from the ginning factories. In some cases, local seed dealers may market such seed, which is obtained through ginning factories. In the case of foundation seed, local agriculture research stations produce the seed in their own campuses and supply it to the needy – it could be private firms or individual farmers.

In the case of public hybrids, the seed production is taken up by State Seeds Development Corporations which follow a system of certification through the Seed Certification Agency while actual seed production is done by seed producers registered with the Seeds Development Corporation.

Seed companies approach Seed Organisers, who act as the middlemen between the companies and the seed producers. It is the seed organizers that the farmers interface with and not the companies directly. Very often, there are no written contracts between the company and the seed producing farmer. Seed producers receive an advance from the organizers (who in turn might or might not obtain the same from the seed company – many of the seed organizers are also into seed retail business running Dealer shops; such organizers are also ones who are risk-taking and capable of extending cash advances to seed producing farmers.). Companies, to reduce their transaction costs, deal with seed organizers who in turn deal with contract seed growing-farmers.

Seed producing farmers come in different forms (different kinds of landholdings, social backgrounds, management capacities, financial status and different kinds of lands). Most of them are small-holding farmers who depend on hired labour in this labour-intensive industry.

Foundation seed is supplied through the seed organizers to contract seed growers in certain pockets of Andhra Pradesh, Gujarat, Tamil Nadu and Maharashtra for crossing and production of seed. Some villages in particular districts of these states specialize in seed production even as they grow cotton for commercial market also.

II. 3. Hybrid Cotton Seed Production

This basically involves cross-pollination between male and female parental lines. Cross-pollination involves two separate activities: emasculation and pollination. Crossing is done by placing pollen grains from one genotype - the male parent on to the stigma of flowers of the other genotype, the female parent. The removal of stamens or anthers or killing of pollen grains of a flower without effecting in any way the female reproductive organs is know as emasculation.

Emasculation work on buds/flowers that are ready to open happens in the afternoon in the female parental plot. Early in the morning, the flowers are cut from the male parental plot and pollination done onto the stigma of flowers that have been emasculated the night before. Markers are hung to all such flowers for easy identification and crossing. For those flowers in the female plot that are not emasculated, one might find later on that "selfing" has occurred.

Emasculation and crossing has to happen every day in the seed production plots, three to four months into cultivation of the cotton seed plot. The duration of cross pollination activity could be seventy to hundred days and could require around ten to fifteen agricultural workers each day, per acre.

In this labour intensive activity of cross-pollination it is now well documented that 90% of the total labour expended is done mostly by children, that too girl children mostly. Seed producing farmers try to cut their costs by employing child labourers and by extracting long hours of work under exploitative conditions from them. The seed that is formed from such crossing work is F1 seed, sold in the market as hybrid seed.

Foundation seed stock of companies is also maintained (such plots are usually kept a secret for fear of such parental lines being stolen, says a seed organizer) in farmers' fields especially for smaller companies which don't have their own campuses. When it comes to R & D by smaller companies, they are reported to pick up germplasm for their experimentation wherever they find good standing crop.

To overcome the problem of hand emasculation which is a labour intensive process, Genetic Male Sterility (GMS) and Cytoplasmic Male Sterility (CMS) systems are employed to produce male sterile plants which are used as female parents. However, in cotton, the male sterility systems are in infancy. The advent of multi-national companies into cotton seed market has increased the use of GMS and CMS systems. However, most cotton hybrid seed is still produced using conventional system with hand emasculation.

II. 4. Post-Production Processes

Farmers store the cotton produced along with the seed in their homes until it is time for ginning. The seed organizer informs the seed producing farmers about the ginning dates for a particular hybrid and farmers then transport their cotton to the ginning factories [between September to January, depending on the time of sowing].

Seed producing farmers attend personally to the ginning and cleaning process, until some samples from their seed lots are sent for the "GOT tests" [Grow Out Tests]. Ginning factories often times have cleaning facilities/services too, for de-linting with sulphuric acid.

The seed companies undertake the GOT tests in their laboratories. Here, the germination percentage and genetic purity are ascertained. *It has to be noted here that GOTs on seed samples do not test the seeds for any GM presence, adventitious or otherwise.*

After a seed lot passes the GOT, farmers are paid around May to July the subsequent year. After the GOT tests, seeds are treated by the companies by seed treatment chemicals, packaged, transported to distributors/dealers and then sold, along with multiple marketing strategies deployed to vie with competitors.

The farmers are paid anywhere between Rs. 230/- to Rs. 260/- for one packet of cotton seed produced, with the unit being 750 gms per packet. The seed, when sold by the companies at the retail end, to consumer-farmers, is sold at Rs. 750/- per 450 gms, if it is Bt Cotton.

The cycle, in a sense, begins with the way the parental lines/foundation seed material is maintained, followed by seed production practices by farmers, storage at the farmer level, transportation to the ginning factory on given dates, ginning factory processes and finally, packaging and selling.

The above mentioned processes apply to Bt Cotton seed production too, as with any hybrid cotton seed production.

II. 5. Cotton Seed Production Extents

Hybrid cotton seed production (and this includes Bt Cotton hybrids) in India is concentrated in five states – Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. These five states account for more than 95% of the area under cottonseed production in the country. During 2003-04, nearly 54,000 acres were under cottonseed production in the country, out of which Gujarat accounted for 26,000 acres, Andhra Pradesh 14,000 acres and Karnataka 4,000 acres. In 2006-07, the area is estimated to have increased to 60,300 acres of hybrid cotton seed production. Of the total 60,000 acres of cottonseed production in India in 2006-07, Gujarat has the largest area covering nearly 25,000 acres (41.6% - Gujarat incidentally had only around 18000 acres under cotton hybrid seed production in 1999-2000), followed by Andhra Pradesh with 16,000 acres (26.6%), Tamil Nadu with 9,000 acres (15%) and Karnataka with 5,000 acres (8.3%).

In 2003-04, the extent of Bt Cotton seed production within cottonseed production area was reported to be around 9% (5,000 acres out of 54,000 acres) which has increased to nearly 66% (40,000 acres out of 60,000 acres) in 2006-07.

III. WHAT DO BIOSAFETY TESTS SAY ON COTTON SEED CONTAMINATION?

Given that biological contamination from GM seeds to non-GM seeds is a potential risk from cultivation of GM crops, pollen flow studies are undertaken to assess the level of risk of contamination. It has to be noted that such assessments do not necessarily reflect real growing conditions – for instance, in today's cotton production scenario in India, the potential for biological contamination flowing from large source populations of Bt Cotton to smaller sink populations of non-Bt Cotton – nor do such studies assess the contamination risk flowing from physical handling processes.

As part of the regulatory approval processes, Mahyco did a pollen flow study in its own farm in Jalna (Maharashtra) between August 2000 and March 2001. The objective of the study was to evaluate cross pollination between Bt Cotton and non-Bt cotton in the presence of honeybee pollination agents. For this study, transgenic cotton was planted in a central plot measuring 20m X 20m, surrounded by non-transgenic cotton in 5m X 5m blocks in all directions. The Bt Cotton line in the central plot was of the okra leaf type while the non-transgenic pollen trap rows were of normal leaf phenotype.

Later, seed sample lots were selected from the non-transgenic blocks and subjected to a Grow Out Test (GOT) in addition to a PCR analysis for detection of the presence of Cry1Ac gene.

The study reported that events of cross pollination were detected ***upto a distance of 15 meters***, both by the GOT and pooled sample PCR.

An official summary on the Genetic Engineering Approval Committee's website (GEAC's) concludes the following on pollen escape/outcrossing studies taken up by the crop developing company:

"Multi-location experiments conducted in 1996, 1997 and 2000 revealed that out-crossing occurred only upto 2 meters, and only 2% of the pollen reached a distance of 15 m. As the pollen is heavy and sticky, the range of pollen transfer is limited. Also there is essentially no chance that the Bt gene will transfer from cultivated tetraploid species such as the present Bt hybrids to traditionally cultivated diploid species".

It is interesting that while there are arguments made emphatically that "there is essentially no chance that the Bt gene will move from the cultivated tetraploid species (G hirsutum) to cultivated diploid species (G arboretum, G herbaceum), in Mahyco's own pollen flow studies, the PCR analyses findings matched the GOT findings on pollen flow, that there is indeed cross pollination detected upto a distance of 15 meters.

Elsewhere, in a legal submission, the following observation is made based on Mahyco's "Updated Summary Document on Bt Cotton (Incorporating studies as directed by GEAC vide their letter no. 11/2000-HSMD dated July 19, 2000 and 10/7/2001-CS dated June 29, 2001)" [February 2002]: *"Outcrossing studies with Bt Cotton showed that outcrossing of the Cry 1Ac gene from Bt Cotton to non-transgenic G hirsutum varieties is low and similar to the normal outcrossing frequency for conventional cotton plants. Crossing of the Cry 1Ac gene to other cultivated G hirsutum genotypes is possible should the plants be in close proximity. However, this occurs at a very low frequency. Also, this is not considered to be a concern, as the safety assessments of Bt Cotton presented show that such outcrossing is unlikely to cause any adverse impact to the environment".* This last statement is callous and does not take into consideration the rights of those farmers who wish to remain GM-Free and to be organic.

In cotton, while the crop is considered normally as a self-pollinating crop, it is commonly acknowledged that at least 5% of natural crossing occurs under most environmental conditions and as much as 50% under some conditions.

For cotton hybrids, the Minimum Seed Certification Standards in India prescribe an isolation distance of 30 meters for certified seed production and a distance of 50 meters for Foundation seed. Minimum genetic purity laid down for certified seed is 90%. During GOT, the off-type plants (other than selfed plants) such as segregants, outcrosses and plants of other varieties should not exceed more than 1.5% out of 10% earmarked for selfed plants. If there are more off-types, a seed lot is rejected by the certification agency.

IV. WHAT IS THE REALITY ABOUT COTTON SEED CONTAMINATION?

In this investigation, we first set about understanding the presence of off-types in certified cotton seed plots. We chose to look at certified plots because these are plots which use breeder seed and maintain isolation distances as prescribed. If isolation distances are not maintained for seeds seeking certification, such seed plots do not reach the GOT stage in any case. Therefore, data from certified plots is valuable in terms of understanding levels of off-types creeping in, despite isolation distances. Based on the situation with certified plots, one can extrapolate to some extent the possibilities with those seed production plots which do not even care to maintain the prescribed isolation distances.

The following is information for the last ten years from cotton seed production plots registered with Gujarat State Seed Certification Agency which gives information on total registered producers for Foundation Stage and Certified Seed Stage separately each year, followed by rejected lots. Not all registered producers would have begun with isolation distances and therefore, it is important to also look at the certified lots, vis a vis rejected lots.

Sl	Year	Foundation seed			Certified Seed		
		Total registered	Certified lots	Rejected lots	Total registered	Certified lots	Rejected lots
1	1997-98	108	22	21	39165	23862	2582
2	1998-99	294	81	113	43909	19121	2890
3	1999-00	707	339	120	73238	39916	7787
4	2000-01	1017	454	132	54618	26594	3660
5	2001-02	630	215	87	54326	24192	5278
6	2002-03	174	72	38	19050	7386	910
7	2003-04	233	99	41	17497	7848	732
8	2004-05	183	76	47	8107	2940	701
9	2005-06	209	118	25	12448	4230	493
10	2006-07	152	50	18	4214	4214	493
		3707	1526	642	326572	160303	25526
Percentage lots rejected, out of total registered:		17%, in the case of Foundation seed which lays down an isolation distance of 50 mts			7.8%, in the case of Certified seed, where an isolation distance of 30 mts is stipulated		
Percentage of rejected lots in total sample lots tested		**Foundation : 29.6% of 2168 lots**			**Certified: 13.7% of 185829 lots**		

Source: Information obtained from GSS Certification Agency, November 2007

The above table is only a pointer towards how a large percentage of upto 30% in Foundation stage and 14% of Certified seed stage gets rejected for various reasons including "self" and "off-types" being present beyond permissible limits. This is an indication of biological as well as manual factors that are in play in seed production processes which allow for admixtures, "selfed" seed etc.

While the Gujarat agencies could not give us details on how much of the rejected lots can be sub-classified as Sub Standard on Self and Sub Standard on Off-Type, the following data from Andhra Pradesh is illustrative of the situation in terms of Sub-Standard in GOTs and rejected lots because of Off Types being more than 1.5%. In Andhra Pradesh, for hybrid seed production, the average of three years (2003-06) shows that around 3% of the samples get rejected for being sub-standard and for Varieties, around 6% of samples are rejected for being sub-standard. Out of the sub-standard lots, majority of the samples are categorized as ones having higher than 1.5% of Off Types. In the case of varieties, there is no question of "self" in any case but only Off-types.

	Hybrids					Varieties				
	Total samples		Sub-Standard			Total samples		Sub-Standard		
Year	for GOT	Standard	Self	Off Type	Total	for GOT	Standard	Self	Off Type	Total
2003-04	1692	1663	9	20	29	20	18	0	2	2
2004-05	1219	1183	7	29	36	26	25	0	1	1
2005-06	1749	1683	22	44	66	5	5	0	0	0
TOTAL	4660				131	51				3
% age of Substandard amongst total samples					3%					6%

Source: Data provided by AP State Seeds Certification Agency

One of the senior seed certification officers in Andhra Pradesh revealed that it is possible to have off-types of upto 15% - 25% in some seed samples. The variations can be due to mutations or admixtures in terms of human error, according to him.

In Gujarat, with a small cotton seed company which was also into producing public-bred certified hybrids, a quick analysis was done by the author of reports of 41 samples that were analysed last year and rejected. Here, the off-type percentage of samples ranged from 1.7% to 6.1%.

While this is the situation with certified seed production plots, where GOT tests are conducted only on those plots where isolation distance if properly maintained and confirmed during the initial inspections by the Seed Certification officer, the situation with millions of seed packets being sold by the private sector is dependent mostly on their own claims and controls related to seed quality.

There is also evidence of non-GM cotton seed testing positive for Cry1Ac protein, as per material available from Gujarat State Seeds Producers Association. The Association, representing several small seed companies in Gujarat which are into cotton seed production (both their own 'research' hybrids and public sector notified hybrids/varieties) is arguing that GM contamination happened from unregulated commercial and seed production plots in addition to field trial plots. It is interesting to note that amongst those (non-Bt Cotton) seed samples that Central Institute for Cotton Research analysed for the presence of Cry1Ac protein (samples sent by the Agriculture department of Gujarat), some samples have tested positive for 25% seeds, or 50% or 60% or 88% seeds etc. Just the fact that not all seeds have tested positive strengthens the arguments of the seed producers who allege contamination. If they were intentionally producing Bt Cotton seed – i.e., unapproved and illegal Bt Cotton – all the seeds should have tested positive for Bt presence.

To sum up, based on just the secondary literature, it appears that:

- the general understanding about cotton seed cross-pollination states that at least 5% to 25% of natural crossing occurs under most environmental conditions and as much as 50% under some conditions (high insect population).
- pollen flow studies undertaken by Mahyco as part of the regulatory approval processes for Bt Cotton show that out-crossing occurred upto 2 meters (6.6 feet) and around 2% of the pollen reached a distance of 15 m (around 50 feet).
- even in seed production plots registered with certification agencies and maintaining prescribed isolation distances and taking up roguing, 3% to 30% of the lots are rejected for not adhering to genetic purity standards, in the Grow Out Tests. Amongst the rejected lots, majority are on the grounds of containing "off types" which range from anywhere above 1.5% to 25%. In any case, a vast majority of seed is not run through a certification process,

since certification requirement in India is voluntary and not mandatory. Therefore, quality control is mostly left to the seed companies themselves.

- seed production and certification standards prescribe an isolation distance of 30 mts (99 feet) to 50 mts (165 feet) for cotton seed production, depending on whether it is certified or foundation seed.
- at present, no tests are conducted routinely at the GOT stage or prior to that or after that, to confirm the presence of the Bt protein in cotton seed produced.
- both in cotton seed production extents and commercial cotton production areas, Bt Cotton has larger extents than non-GM cotton, which means a large source population of GM plants and a small sink of non-GM plants, both existing next to each other.

IV. 1. CSA's Visits To Cotton Seed Production Belts In AP And Gujarat

Team members from Centre for Sustainable Agriculture visited cotton seed production plots in Andhra Pradesh (Gadwal area of Mahbubnagar and Nandyal area of Kurnool district) and in Gujarat (Idar area in Sabarkantha district), during September and October 2007. Visits included speaking to seed producing farmers, seed organizers, company representatives, speaking to cotton breeders, visits to ginning factories etc.

The following are the findings from these field visits as part of this investigation:

IV. 1. a. Complete Neglect Of Non-Bt Cotton Seed Production

In the Gadwal region of Mahbubnagar district of AP which has around 8000 acres under hybrid cotton seed production and Nandyal region of Kurnool district with around eight to ten thousand acres, it was very difficult to locate non-Bt Cotton seed plots. There were Cytoplasmic Male Sterile (CMS) lines of Monsanto and male sterile non-Bt lines of Ankur seeds, which the companies apparently use for meeting their non-Bt Cotton seed requirements. This brings to question the serious jeopardy with regard to non-GM seed availability *per se* in the cotton hybrid sector. In Andhra Pradesh, for instance, in the past two years, no public sector notified hybrid was registered for seed production with the state Seeds Certification Agency.

Even if companies were not producing non-GM cotton seed for selling it as such – it is a much acknowledged fact that non-GM Cotton seed availability is a major issue in many cotton growing belts of India today; the reasons related to large scale shift by all kinds of seed companies to Bt Cotton seed production, the larger margins available in this seed for all players involved in the seed supply chain and so on – there is the regulatory requirement from the Government of India for all Bt Cotton seed packets of 450 gms to be accompanied by 120 gms of non-Bt Cotton, as part of resistance management strategies evolved by the industry and regulators. ***That means that nearly a fourth of India's cotton seed production, even if all the cotton seed is meant to be sold as Bt Cotton brands, should remain non-GM cotton seed.*** However, we found that very little non-Bt Cotton seed plots are actually present in the major cotton growing belts. Upon inquiry with dealers, organizers and seed company representatives, it emerged that most non-Bt Cotton being supplied today as 120 gms of refuge is actually from cold storage plants, from left over stocks much of which is also public sector non-GM hybrid seed stock. This situation has been further facilitated by the Genetic Engineering Approval Committee's decision to allow the non-GM refuge seed to be any cotton seed and not necessarily the non-transgenic counterpart of the same hybrid that is sold as 450 gms of Bt Cotton in 2005. In the first three years of Bt Cotton cultivation in India, the rules stipulated that there should be the same hybrid in its non-GM version supplied by the company in a separate 120 gms packet along with every packet of Bt Cotton, as resistance management plan (refuge planting of 5 rows). Therefore, any kind of seed that is available in cold storage plants is being packed as Non-Bt Cotton seed and supplied to farmers, the inquiries indicate.

From various accounts (speaking to seed company representatives to understand how many of them have non-GM Cotton seed production plots or have male sterile lines etc.), it appears that non-GM cotton seed is being produced on around 1500 to 2000 acres in all during 2007-08[5]. While some of this might be used as the non-GM seed to be supplied as seed for refuge planting, the scenario ahead for non-GM cotton producers seems to be dire, with serious constraints on non-GM seed supply. There are already reports from Andhra Pradesh and Maharashtra to indicate that input dealers are facing non-GM seed shortages (or do not want to trade in non-GM seed since it offers lesser margins for them) and in Andhra Pradesh, civil society groups working to promote ecological farming have had to resort to placing special indents for non-GM Cotton seed directly with some companies since the local dealers are no longer marketing such seed. The 2008 planting season presents a bleaker situation for farmers who prefer to be non-GM.

IV. 1. b. No Isolation Distances Being Maintained

The study did not find a single seed production plot with the prescribed isolation distance maintained, out of the several seed production farms visited in Andhra Pradesh and Gujarat.

Photos:

On the top left, a seed producer in Gujarat who is growing non-Bt Cotton seed on the right and Bt Cotton seed on the left, with no isolation distance at all; Top Right – a farmer in Andhra Pradesh, with distance between seed production plot and commercial Bt Cotton plot of two different companies being just around 4-5 feet. Left – no isolation distance between two different seed production plots, Andhra Pradesh

[5] Karnataka State Seeds Corporation has produced around 800 quintals of non-Bt Cotton hybrid seed in 2007-08

Normal field bunds are the only distinction between one plot and the next and in several of these seed production belts, commercial cotton production also takes place. The usual distance is three to five feet. While several of them are aware of the prescribed standards for isolation, small holdings of land tempt them to flout the norms.

Going by the fact that various studies show that cross pollination could take place up to 15 meters and that at least 5% cross pollination takes place in 'normal growing conditions'[6] and given the levels of off-types even in seed plots registered for certification (which maintain isolation distances), it would be very surprising if such cross-pollination is not taking place routinely between GM and non-GM cotton seed plots in India. Different kinds of seed plots exist next to each other, without any isolation distance; further, commercial cotton cultivation and hybrid seed production also take place next to each other. Added to this is the point made elsewhere on large source populations exerting their impact on smaller sink populations (in this case, Bt Cotton and non-Bt Cotton, respectively).

It should also be noted that standard GOT tests do not test for the presence of the Bt gene/protein while assessing genetic purity of non-GM cotton seeds.

IV. 1. c. High Probability of Physical Contamination

The study team has come across many farmers who grow different kinds of cotton seeds – same farmer could be growing different hybrids/brands for the same company, different brands of Bt Cotton for different companies as well as both Bt and non-Bt Cotton seed for different companies (the photo above of the farmer from Gujarat is an illustration).

In addition to high probability of biological contamination, there is the distinct possibility of physical mixing up at all stages in all such cases. For instance, farmers store different kinds of cotton seed harvested from their plots in their house, right next to each other. While most farmers store their produce in gunny sacks, we also came across farmers who stock their produce leaving it open until they take it to the ginning factory. Farmers interviewed admitted that sometimes, there could be a mixing up of some of the produce at this stage.

[6] This information from literature was reiterated by prominent and experienced seed breeders both in Andhra Pradesh and Gujarat

Farmers also dry their produce regularly, clean it of plant and other material and do this in an open fashion, outside their houses. Even here, drying of two different types is sometimes taken up at the same time, if the dry spell is short. Some amount of admixtures could happen at this stage.

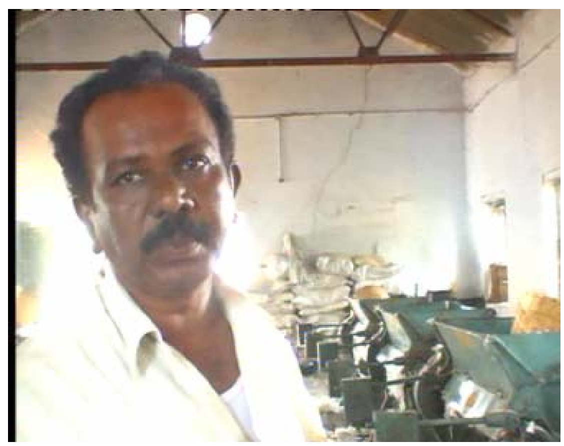
IV. 1. d. Human Errors

Several possibilities of human error leading to contamination were shared by seed producers and specialists based on real experiences. For instance, when the male parental lines' flowering is not in the required quantities, labourers are known to have used male flowers for crossing from other sources! A seed breeder also explained that if a worker handles flowers and pollen in one plot and then also goes to work in another plot, cotton pollen being sticky might lead to some contamination, however minute.

Seed producers themselves explained that given that labour costs are increasing (wage rates in cotton seed production have increased quite a bit in the recent past and activism against child labour also meant that adults are being employed with full wages) in cotton seed production, they try to make do with smaller number of workers. Economising on the number of workers had also affected quality of produce and many flowers are not properly emasculated or crossed, according to these producers. This would in turn reflect on higher possibilities of contamination.

Even altercations between farmers and workers could lead to intentional mixing up in crossing, farmers in Gujarat explained.

IV. 1. e. Post-Production Contamination



Cotton seed farmers take their produce to the ginning factory on designated days – the seed organizers let them know when a particular brand of seed is to be brought to the ginning factory. Here, between lots of one brand and the other, the ginning factory workers are supposed to clean up the equipment thoroughly, manually as well as with powerful exhaust fans etc. However, a closer look at all the machines and all the stages involved shows that some sections cannot be cleaned completely.

At the ginning factory level, there are some ginning factories which have an agreement with just one company for all their cotton while most ginning factories deal with different clients. Most ginning mills deal with both cotton seed and commercial cotton ginning in the cotton seed production belts.

While a cotton breeder felt that contamination at this stage could at the most be 1%, a seed certification inspector reported that rejected lots might get admixtures of off-types at this stage. A ginning factory owner in Gujarat did not rule out possibilities of upto 10% contamination at the ginning factory stage. Human errors, especially by ginning factory workers who work during night shifts have also been mentioned as reasons for contamination at this stage.

IV. 1. f. Situation with Open Pollinated Varieties & Foundation Seed Lines

Traditional and agriculture university-released varieties (as opposed to hybrids) are still grown in many places of the country on lakhs of acres even as they are fast being replaced by hybrids and that too, with Bt Cotton hybrids. These varieties are known to be locally adaptable, with an ability to withstand stress and less prone to pest and disease attacks. Many of these varieties are suitable for the rainfed growing conditions of the vast majority of cotton-growing tracts in India. Farmers spend very little on cost of cultivation of these varieties and therefore, net incomes are assured on these seeds.

There are some belts in all cotton-growing states where open pollinated varieties are grown by farmers. Here, they keep the seed from their crop after ginning or in some cases, through prior selection on the crop. These are the seeds that are most at threat from contamination from Bt Cotton.

Given that the cotton from such plots is meant for commercial trade, the ginning factories are not cleaned separately for this cotton and there is mixing of seed that happens between commercial Bt Cotton and such open pollinated varieties at the ginning factory stage. In Kurnool district of Andhra Pradesh, farmers shared that there is no cleaning undertaken of the ginning machines between their lot (OP variety) and other lots including Bt Cotton and they bring back seed for the next season from the ginning factory.

Further, biological contamination chances are also very high with these varieties being grown right next to Bt Cotton plots. In Gujarat's Amreli district, the study team came across many such plots co-existing with Bt Cotton plots, right next to each other with no isolation of course.

Even within organic farming, keeping with the overall philosophy of internalizing most farm inputs at the farm(er) level, traditional and open pollinated varieties are preferred as seed sources. However, these preferences of farmers and their rights to non-GM seed are now under serious and real threat.

Further, there is also the issue of foundation seed lines being maintained by seed companies. For many of the smaller companies which do not have their own campuses, such foundation lines are maintained by contract seed growers. Interviews revealed that even here isolation distances are rarely maintained, especially since such foundation lines are sought to be maintained with a great deal of secrecy (companies do not like others accessing good germplasm for their research work). Given that this is foundation material maintained as open pollinated lines, not maintaining isolation here increases possibilities of contamination right from the foundation stage. In Gujarat, farmers also maintain that insect activity has increased in recent times (they claim that this is because pesticide use has come down) which increases the possibility of contamination.

V. CONCLUSIONS AND RECOMMENDATIONS

This preliminary investigation into the cotton seed production and supply chain in India threw up clear findings on the distinct and high possibility of contamination of non-GM cotton seed supply in India with GM material. This is true for both non-GM hybrids as well as open pollinated varieties.

Biosafety assessments related to contamination only look at pollen flow possibilities and even in pollen flow studies, the protocols used are quite questionable. These assessments, as in the case of Bt Cotton, do not try and assess the risks from physical contamination.

A step by step investigation into the cotton seed production and post-production processes revealed high chances of contamination being present both at the biological and physical levels, though physical contamination possibilities are probably much higher for a variety of socio-economic reasons.

Field level investigations and interviews have revealed that prescribed isolation distances are not being maintained for seed production in addition to the fact that today, we have a large Bt Cotton source population and a small non-GM cotton sink population (when it comes to pollination possibilities), which makes the non-GM cotton plants all the more vulnerable to contamination.

One view based on the experience of seed producers is that male sterility lines in cotton seed production processes increase the sensitivity/vulnerability of the plant to contamination. Such parental lines are being used in Indian cotton seed production in the past three-four years. It is obvious that biosafety assessments done in the case of Bt Cotton have not taken such realities into consideration.

Further, at the physical handling level, right from the crossing to storage at home to the ginning factory levels, there are many possibilities for contamination all along the chain.

In the case of cotton open pollinated varieties, where farmers are used to saving their own seed from the season's produce, the threat of contamination is much more real. Such plots are co-existing with Bt Cotton plots in several places and at the ginning factory (where the seed is kept for next year's sowing), commercial cotton including Bt Cotton is ginned along with the OP variety.

There are also clear indications that non-GM cotton seed production is nobody's priority – the public sector agencies have just dramatically withdrawn from this function while the private sector is content to occupy spaces that will give the best profit margins (GM cotton hybrids, in this case). The dramatic reduction of non-Bt Cotton seed production areas in 2007 as reported by many players is a matter of grave concern. The Bt Cotton seed companies have reportedly relied on old stock of seed for the refuge non-Bt Cotton seed requirements this year which is unacceptable when quality parameters are compromised. For those farmers who wish to remain non-GM and want to switch over to non-GM cotton (in places like Punjab, farmers, after experiencing losses with mealy bug attack on Bt Cotton, are indicating that they would shift back to non-Bt Cotton), availability of reliable, good quality seed has quickly become a big issue. It took only six years for this kind of a dramatic situation to develop in the case of cotton seed that alternatives no longer seem to be available!

Based on the various interviews with farmers, breeders, ginning factory workers and company representatives, the possibilities of contamination can probably be expressed in a very conservative fashion in the following terms:

- around 5 to 15% contamination possibility at the biological level (estimates across different situations)
- around 5 to 30% contamination possibility at the physical handling level

For those farmers who wish to remain non-GM and specifically organic no amount of contamination is acceptable of course. In India, in 2007, it is reported that 175,000 hectares of organic cotton was planted. These numbers, related to organic cotton production, are poised to grow dramatically over the coming years, pushed by demand for organic fibre in the world markets. Farmers in the certified organic cotton sector also enjoy premium on the price that they receive. Certified organic production does not allow any GMOs, as is well known, as per standards laid down and ensured.

Further, under various programmes meant to improve farmers' livelihoods and by imbibing philosophies related to organic and natural farming, tens of thousands of farmers have decided to take up farming which does not consist of GMOs or chemicals but which relies on nature's principles and ecology. All such farmers now face a grave threat to their farming.

It is also worth noting that while this is the situation with cotton which is grown only on around 5-6% of India's cultivated land, GM versions of some major crops are in the pipeline, being considered for approval for field trials and commercial cultivation. Several of these crops are also crops for which India is the Centre of Origin and Diversity. This is all the more worrisome given the evidence on contamination that is already available. Given that our landholdings are mostly small and marginal; that our growing conditions and infrastructure facilities make segregation or co-existence systems impossible to set up or maintain, it is not clear how the policy-makers pushing for GM crops intend to prevent contamination and the associated losses and hazards.

Centre for Sustainable Agriculture (CSA) recommends that the appropriate authorities take up the following immediately:

- regulators should re-cast the current assessment protocols related to contamination from GM material immediately since the current protocols are completely inadequate for the task
- departments of agriculture and agriculture universities should test for the presence of Bt protein in non-GM cotton seed lots and assess the extent of such contamination
- seed agencies, in tandem with cotton farmers who want to remain non-GM, to ensure that high quality non-GM seed is available for planting from Kharif 2008 onwards
- GM regulators as well as the state governments to assess the positive potential of non-GM and organic farming and to clearly lay down guidelines for protecting the interests of such farmers
- Clear lessons be drawn up from the experience of Bt Cotton in the cotton seed scenario in India so that informed and intelligent decisions can be taken with regard to other crops.

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