National Consultations
on

Bt Brinjal

A primer on concerns, issues and prospects

CEE
Centre for Environment Education

Government of India
Ministry of Environment & Forests

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Contents

Introduction

What is Bt Brinjal?

Bt Brinjal is a transgenic brinjal created by inserting a gene c*ry1Ac* from the soil bacterium *Bacillus thuringiensis* into Brinjal. This is said to give the Brinjal plant resistance against lepidopteran insects like the Brinjal Fruit and Shoot Borer *Leucinodes orbonalis* and Fruit Borer *Helicoverpa armigera*.

What is the controversy about?

Bt Brinjal has generated much debate in India. The promoters say that Bt Brinjal will be beneficial to small farmers because it is insect resistant, increases yields, is more cost-effective and will have minimal environmental impact. On the other hand, concerns about Bt Brinjal relate to its possible adverse impact on human health and bio-safety, livelihoods and biodiversity.

What is the official response to the controversy?

The Ministry of Environment and Forests (MoEF) has a statutory body called the Genetic Engineering Approval Committee (GEAC) which has recommended the environmental release of Bt Brinjal in India based on the recommendations of the Review Committee on Genetic Manipulation (RCGM), a statutory body and two expert committees constituted by the GEAC between 2006 and 2009. However the Minister of State (I/C) for Environment and Forests, responding to strong views raised both for and against the introduction of the Bt Brinjal, has called for public consultations across the country before taking a final decision on this issue.

The Centre for Environment Education, an autonomous organization engaged in Environmental and Sustainability Education, has been entrusted with the task of organizing these consultations.

What are the objectives of the national consultations on Bt Brinjal?

The main objectives of the consultation are to

- Provide a forum to various stakeholders to express their views and concerns related to Bt Brinjal at venues across the country;
- Provide appropriate inputs to the Minister before a final decision is taken.

How are the consultations being structured?

The consultations are planned at seven locations in the country, so that people across the country can be heard. These consultations will be open to all members of the public. Additionally, stakeholder groups representing diverse viewpoints on the issue will be invited to the consultations to ensure the widest possible participation in the discussions. The consultations will be conducted in the local language of the area in addition to Hindi and English to secure the active participation of all stakeholders. At least 250 representatives from a range of groups such as farmers, scientists, agricultural experts, farmers organizations, consumer groups, citizens forums, NGOs/CBOs, Government officials, media, seed suppliers, traders, doctors, lawyers and others will be invited to each consultation. Advertisements will be placed in the local media before the event to ensure that the public is fully informed about the event.

The Minister of State (MoS) MoEF Mr. Jairam Ramesh will chair the consultations at all locations.

The Brinjal in India

Why is the brinjal important to India?

The brinjal *Solanum melongena* is said to have originated in India and is known to have been cultivated for over 4000 years. Second only to the potato in terms of the total quantity produced, the brinjal continues to be an important domestic crop cultivated across the country accounting for 9% of total vegetable production and covering 8.14% of the land under vegetable cultivation.

Kingdom	:	Plantae
Class	:	Magnoliopsida
Subclass	:	Asteridae
Order	:	Solanales
Family	:	Solanaceae
Genus	:	*Solanum*
Species	:	*melongena*

There are approximately 2500 varieties of brinjal in India of various shapes extending from oval or egg-shaped to long or club-shaped; and colours ranging from white, yellow, green and purple to nearly black. Many popular commercial varieties of brinjal available today are derivatives of older varieties from India and China. The brinjal is low in calories and fats and contains mostly water, some protein, fibre and carbohydrates. It is also an excellent source of minerals and vitamins and is rich in water soluble sugars and amide proteins among other nutrients.

The brinjal is a popular component of the Indian diet across the country. It is an important ingredient in Ayurvedic medicine and is of special value in the treatment of diabetes and liver problems.

The brinjal is known to be consumed both cooked and raw. Some of the most well-known brinjal dishes in India include the *begun bhaja* of Eastern India, the *gutti vankaya kura* of Andhra Pradesh, the *katharikai kozhambu* of Tamil Nadu, *upperi* in Kerala, *vangi bath* in Karnataka, *wangyacha bharit* in Maharashtra, *olo, bharatu* in Gujarat and *baingan jhonga* in Bihar.

Folk songs in different parts of the country such as *Guthi vankya kooroyi baava* in Andhra Pradesh, Konkani songs in Maharashtra, Jaina in Karnataka, Bihu folk songs in Assam often allude to the brinjal.

The role of brinjal in religious rituals is best exemplified by one of the traditional varieties in Udupi District of Karnataka called the Mattu Gulla. This particular variety has been cultivated in the region for at least 500 years and is used as an offering to the main deity of the region at the Sode matha temple.

What are the known features of the brinjal crop in India?

The brinjal is usually self-pollinated. However, it has been reported that the extent of cross-pollination can range from 2% to as high as 48%. It is thus classified as a cross-pollinated crop. While the biological structure of the anthers favours self pollination, the stigma projects beyond the anthers, thus providing ample opportunity for cross-pollination. The genotype, location, and insect activity further determine the actual rates of natural cross-pollination.

Pests affecting the brinjal crop include the brinjal fruit and shoot borer, the brinjal stem borer, the mealy bug, lace wing bug, leaf hopper, leaf rollers, red spider mite, leaf-eating beetle, jassids, aphids, white fly and root knot nematodes. Amongst these the brinjal fruit and shoot borer is the greatest threat and can cause a major loss in the marketable yield.

The brinjal crop is typically grown in small plots or as inter crop. The major brinjal producing states in India are West Bengal, Orissa, Bihar, Gujarat, Maharashtra, Karnataka, Uttar Pradesh and Andhra Pradesh.

Depending on the variety and the season, the average yield of brinjal varies from 15 to 30 tonnes per hectare. Many of the hybrid varieties have shown a potential yield of upto 50 tonnes/ha. The brinjal is generally considered a high value crop yielding high net benefits for the farmer. Studies have shown an input-output ratio of 1: 2.01. The total area under brinjal cultivation in 2006 according to the National Horticulture Board was 0.55 million hectares, with a total production of 9.13 million tonnes. In 2007-08, India exported 338 tonnes of brinjal worth Rs 1.92 crores. The United Kingdom is the largest importer (258.84 tonnes worth Rs 1.38 crores) followed by countries like Saudi Arabia, France and Germany.

Genetically Modified Crops and the Bt Brinjal

What is Genetic Engineering?

It is a technique involving transfer of a selected piece of genetic material capable of performing new functions from one organism to another. Genetic Modification (GM), Genetic Manipulation and Genetic Engineering (GE) all refer to the same thing. It is also known as recombinant DNA technology.

What are Genetically Modified (GM) crops?

A genetically modified (GM) crop is a plant that has been altered by an external process which alters the genetic make-up of the cells. The modification is accomplished by the insertion of a gene from a different species through genetic engineering. The process of traditional breeding involves finding individual plants with favourable characteristics and crossing them with each other. The final plant variety or breed of plant will have the desired traits inherited from its ancestors along with the associated genes for those traits.

GM technology is used because it can change the genes of an organism in a way not possible through traditional breeding technology. Consequently only GM can engineer totally new plant varieties with traits that range from the ability to survive adverse environmental conditions and pest attacks to a longer shelf life and enhanced nutritional value.

What is the history of GM crops in India?

In the 1980s, the Indian government took proactive steps to build up the country's R&D capacities in biotechnology through setting up the Department of Biotechnology [DBT]. Recognizing the potential risks in the indiscriminate use of modern

biotechnology in healthcare, agriculture, environment and process industries, the Ministry of Environment and Forests (MoEF), Government of India notified the rules 1989 of the Environment Protection Act (EPA) 1986 to regulate products derived from modern biotechnology.

The belief that agro-biotechnology tools like Genetic Engineering could help increase agricultural production in a country where agriculture is the mainstay for the majority of its population has strongly driven government funding and promotion of Genetic Engineering and GM crops.

Genetically Modified Organisms (GMOs) were first put on the global market in the early 1990s. Over the past two decades the development of biotechnology tools like Genetic Engineering and Marker Assisted Breeding have opened up new possibilities in increasing agricultural production. The new techniques for understanding and modifying the genetics of living organisms have led to large investments in agro-biotechnology research and development.

While Bt cotton is the only transgenic crop which is being commercially cultivated in the country, according to currently available information, 12 crops (11 of which are food crops) are under different stages of development.

The focus of GM research in India is to develop crops that can withstand

(a) Biotic stress: Pest and disease resistance crops and management of weeds

(b) Abiotic stress: Crops tolerant to flood, drought and salinity

(c) Product improvement

How are plants genetically modified?

Genetic modification involving the copying and transfer of genes from other organism to a plant is possible because of the presence of a molecule called deoxyribonucleic acid (DNA) in every cell of all the organisms *(Figure 1)*. Genes are discreet segments of DNA that encode a set of instructions in the cell and contain all the information concerning the form and functions of all living cells that give characteristics to an organism including plants. The complete set of genes in any plant is called the plant genome. All the cells in a plant carry an identical and complete genome, which means every cell contains at least one copy of every gene, although it may not be active. By switching different combinations of genes on or off

cells develop into different types e.g. leaf, root and flower cells in plants.

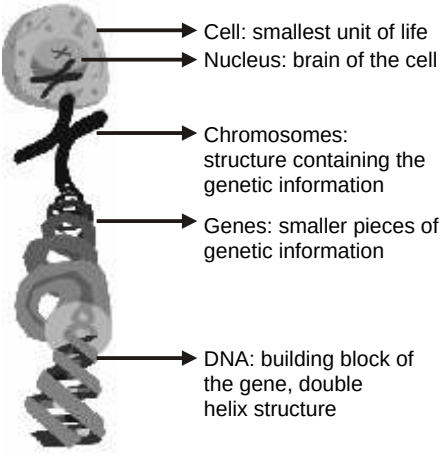

Figure 1: Organization of DNA in the cell

The DNA of all organisms is made up of the same building blocks and is encoded in exactly the same way. Therefore, it is possible to transfer a copy of DNA sequence (or gene) that codes a particular characteristic into the cell of a different organism such as from bacteria into plants. Once the gene is incorporated into the genome of a plant, the resulting plant is considered to be genetically modified and the new characteristic coded by that gene is inherited by subsequent generations.

Genetic engineering/modification involves artificial transfer of genes or gene fragments from one organism to another to produce novel traits in the recipient living organism. The steps involved in the development of a GM plant are as follows:

a. Identification of a gene(s) giving a desired trait
b. Designing genes for insertion
c. Transfer to plant tissue
d. Selection and regeneration of plants
e. Lab analysis and safety testing
f. Greenhouse and field trials
g. Approval by Government agencies
h. Commercialization
i. Monitoring of efficacy and safety

The first step is to identify a particular characteristic from any organism (plant, animal or microorganism) and find out which gene or genes in the organism are responsible for producing that characteristic. Once a gene has been isolated, a gene construct is prepared consisting of a promoter sequence, a termination sequence and a marker gene for successful integration and expression in the plant genome. The next step is the plant transformation i.e. uptake and establishment of introduced DNA. There are two main methods for transformation of plants i.e. the *Agrobacterium* mediated method and the gene gun method *(Figure 2).*

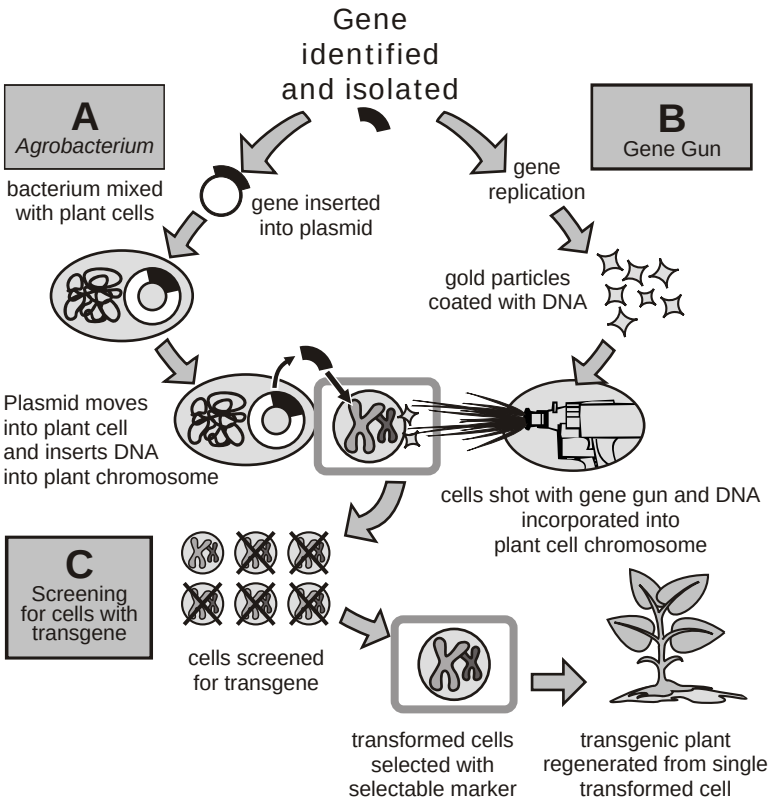

Figure 2: Genetic Modification Process

There are a number of ways through which genetic modifications of plants are accomplished. Essentially, the process has five main steps:

1. Isolation of the genes of interest
2. Insertion of the genes into a transfer vector
3. Transfer of the vector to the organism to be modified
4. Transformation of the cells of the organism
5. Selection of the genetically modified organism (GMO) from those that have been successfully modified

Following the gene insertion process, plant tissues are transferred to a selective medium containing an antibiotic or herbicide, depending on which selectable marker was used. Only plants expressing the selectable marker gene will survive and it is assumed that these plants will also possess the transgene of interest. Thus, subsequent steps in the process use these surviving plants.

To obtain whole plants from transgenic tissues such as immature embryos, they are grown under controlled environmental conditions in a series of media containing nutrients and hormones by tissue culture. Once whole plants are generated and they produce seeds, evaluation of the progeny begins.

To verify whether the inserted gene has been stably incorporated without detrimental effects to other plant functions, product quality, or the intended agroecosystem, initial evaluation includes attention to activity of the introduced gene, stable inheritance of the gene and unintended effects on plant growth, yield, and quality.

The plant is then crossed with improved varieties of the crop because only a few varieties of a given crop can be efficiently transformed, and these generally do not possess all the producer and consumer qualities required of modern cultivars. The initial cross with the improved variety must be followed by several cycles of repeated crosses to the improved parent, a process known as backcrossing. The goal is to recover as much of the improved parent's genome as possible, with the addition of the transgene from the transformed parent. The next step in the process is multi-location and multi-year evaluation trials in greenhouse and field environments to test the effects of the transgene and overall performance. This phase also includes evaluation of environmental effects and food safety.

How was the Bt Brinjal developed?

Bt Brinjal is the first Genetically Modified food crop in India that has reached the approval stage for commercialization.Bt Brinjal has been developed by inserting a gene *cry1Ac* from a soil bacterium called *Bacillus thuringiensis* through an *Agrobacterium*-mediated gene transfer. It is a genetically modified brinjal developed by the Maharashtra Hybrid Seed Company Ltd. (Mahyco), a leading Indian seed company. Bt Brinjal event EE1 has been developed in a Public Private Partnership mode under the aegis of the Agriculture Biotechnology Support Project from Cornell University where the Bt technology available with M/s Mahyco has been transferred (free of cost) to Tamil Nadu Agriculture University, Coimbatore, University of Agricultural Sciences, Dharwad and the Indian Institute of Vegetable Research, Varanasi.

Bt brinjal contains three foreign genes which have been inserted namely:

1. The *cry1Ac* gene which encodes an insecticidal protein Cry1Ac, is derived from common soil bacterium *Bacillus thuringiensis* (Bt) subsp. *kurstaki* to produce the insecticidal protein. The *cry1Ac* gene is driven by a viral promoter, the cauliflower mosaic virus (CaMV) 35S promoter.
2. The *nptII* gene for an antibiotic resistance marker, neomycin phosphotransferase-II.
3. The *aad* gene for another marker 3” (9) O-aminoglycoside adenyl transferase.

It has been indicated that the expression of the *cry1Ac* genes would provide an effective built-in control in brinjal for fruit and shoot borer to reduce pests-linked damages.

The Mahyco has developed a new DNA construct, which contains a gene sequence, by encoding insecticidal protein in all parts of brinjal plant which will last through its lifetime. The *cry1Ac* gene along with two other supporting genes namely *nptII* and *aad* genes are put together in such a way that they work in tandem to produce insecticidal protein that is toxic to the targeted insect, in this case the fruit and shoot borer.

How is the Bt Brinjal effective against pests like the fruit and shoot borer?

When fruit and shoot borer larvae feed on Bt brinjal plants, they ingest the Bt protein Cry1Ac along with plant tissue. In the insect gut which is alkaline with a pH >9.5, the protein is

solubilized and activated by gut proteases crystallizing into fine needle-like shards that pierce the insect gut lining making holes in it. This leads to disruption of digestive processes, paralysis and subsequent death of the fruit and shoot borer larvae.

What is the history of the development of Bt brinjal in India?

Chronology of the development and approval of Bt Brinjal

2000	Transformation and greenhouse breeding for integration of *cry1Ac* gene into brinjal hybrids and seed purification.
2001-2002	Preliminary greenhouse evaluation to study growth, development and efficacy of Bt brinjal.
2002-2004	Confined field trials to study pollen flow, germination, aggressiveness and weediness; biochemical, toxicity and allergenicity studies and backcrossing into the regular breeding programme.
2004	RCGM approves conducting multi-location research trials of seven Bt brinjal hybrids
2005	Through a MoU under the aegis of Agribiotechnology Support Programme II (ABSP II) of USAID Mahyco shares the technology with TNAU, DAU and IIVR to develop open pollinated varities of Bt Brinjal. Back crossing and integration of EE1 into 4 varities of TNAU, Coimbatore and 6 varities of UAS, Dharwad is done.
2004-05	Biosafety data on the effects of Bt brinjal on soil micro-flora, efficacy against fruit-shoot borer, pollen flow , germination, aggressiveness and weediness; toxicity and allergenicity studies, chemical composition etc submitted to the Review Committee on Genetic Modification (RCGM). RCGM recommends large scale trials to the GEAC.
2006	- Mahyco submits bio-safety data to Genetic Engineering Approval Committee (GEAC) and seeks permission for large scale trials.

	- GEAC posts the biosafety data on Bt brinjal on GEAC website - GEAC constitutes a sub committee to look into the concerns raised by civil society. - Supreme Court stops ongoing field trials of GM crops due to a PIL filed by civil society representatives.
2007	- The subcommittee [expert committee 1] submits its report, recommends that 7 more studies on bio-safety be repeated for reconfirmation of data generated during confined multi-location trials but gives a green signal for large scale trials. - Supreme Court lifts ban on GM crop field trials subject to conditions such as isolation distance etc. - GEAC approves large scale trial. - As per GEAC direction, Indian Institute of Vegetable Research [IIVR] takes up the responsibility of large scale trails of Mahyco's Bt Brinjal trials at 10 research institutions across the country in 2007 and 11 in 2008 .
2009	January- IIVR submits the results of the large scale trails. Due to concerns raised by several stakeholders including some national and international experts, GEAC constitutes a 2nd sub-committee [Expert committee 2 or EC2] to look into adequacy of biosafety data generated as well as the concerns raised by all stake holders.
2009 Oct.14th	The Subcommittee submits its report based on which GEAC approves the environmental release of Bt Brinjal containing the event EE1.
2009 Oct.15th	Responding to strong views expressed both for and against the release of the Bt Brinjal, the Minister of State for Environment and Forests (I/C) (to whom the GEAC reports) announces a nationwide consultation in January and February of 2010 pending a final decision on this issue.

Bt Brinjal Prospects and Concerns

What are some of the arguments for and against the release of Bt brinjal in India?

The development of Bt brinjal and the regulation process so far have caused a raging debate in the country on the relevance and need for a Bt brinjal. This debate has revolved and evolved around issues of its safety to human health, environment, farmers' seed rights, consumer choice etc. Industry promoters as well as public and private sector scientists consider Bt Brinjal a breakthrough in agricultural research and development in India. On the other hand opponents including scientists, civil society groups, farmers unions and even some political parties argue that the risks far exceed the benefits.

Arguments made in favour of Bt brinjal	Arguments made against Bt brinjal
Pest Management and Environmental Impacts	
● Brinjal cultivation involves usage of huge amounts of pesticide. 60% of plant protection cost is for controlling fruit and shoot borer. ● Small and marginal farmers use 25-80 sprays of pesticides in Brinjal cultivation. ● In spite of the extensive use of chemical pesticides, the pest is difficult to control by the application of pesticides as the	● Effective non-pesticide pest management and Integrated Pest Management exists and is being practised by farmers. ● The question of internal destruction of pests is dangerous to the health of the consumer. The integrated pest management systems, in combination with good farming practices, are the only healthy solution to good crops. A healthy farm ecosystem is the

larvae are often hidden in the fruit and do not come in contact with the insecticides. Further the application of pesticides has to be critically timed by farmers in such a way so as to kill the larvae before they bore into shoots and fruits.

- None of the botanical pesticides are expected to perform well since the pest hides itself from the sprays while staying inside fruits/shoot. Further, botanical pesticides have limited efficacy against these pests.
- Genetic improvement by conventional plant breeding has not been successful due to the lack of resistance to fruit and shoot borer in brinjal germplasm.
- Bt brinjal would reduce the pesticide usage in cultivation by 80%.
- No difference has been noticed with respect to susceptibility to various pests and diseases by virtue of presence of *cry1Ac* gene in Bt brinjal.

key to pest management. This includes selection of good seeds, appropriate irrigation system and improving soil quality.

- The experiences with a few other GM crops released in India and other parts of the world, especially Bt cotton, shows that over a period of time the total pesticide usage in GM crops has gone up due to increased secondary pest attacks and in some cases due to tolerance developed by the target pest. The Nagpur case study of the pest attack on Bt cotton plants shows that Bt does not have a foolproof mechanism to remove pest threat.
- Controlling pests with single toxic molecules either produced in factory or plant cell is an unscientific way of managing pests. Pests should be managed, not killed.
- The studies on non-target pests at best were inadequate and inaccurate. The studies have been focused on a limited number of insects and for only a limited period of time.
- The studies were also done with a surrogate protein and not with the modified Cry1Ac used in Bt brinjal.
- As Bt brinjal is created to produce the Cry1Ac toxin in every cell, the 'pesticides' have actually moved from exterior to the interior of brinjal, and this cannot be removed by washing as in the case of the usual

	pesticide at present. ● The studies on soil microflora were for a very short period. The impact of the break down products of the protein Cry1Ac on soil micro flora has not been conducted.
Biodiversity	
● There is no threat to wild brinjal germplasm as brinjal *S. melongena*, the cultivated variety, does not cross naturally with any of the wild relatives to produce fertile offspring. ● Bt brinjal does not exhibit any different agronomic or morphological traits compared to non-Bt brinjal that may give it a competitive advantage over other species in the ecosystem.	● India is a centre of origin and diversity of brinjal which has been cultivated here for over 4000 years. There are about 2000 varieties grown across India. ● The transgene transfer to local and hybrid varieties of brinjal will effectively destroy our brinjal diversity. As a general rule GM crops should not be cultivated in the center of origin as it could lead to the loss of original varieties by transgenic cross poiiination.
Human Health and Biosafety	
● Bt brinjal has been found to be safe for human consumption and safe for the environment. ● Human health concerns due to pesticide use can be reduced with this transgenic brinjal and its in-built resistance to pests. ● Rigorous bio-safety tests have been done as required by the Indian regulatory system. This includes acute toxicity tests in laboratory rats, sub-chronic oral toxicity studies, allergenicity studies on rats and rabbits and feeding studies in fish, chicken, goats, and milking cows. ● No significant difference was noted between Bt brinjal and non-Bt brinjal in bio-safety tests	● Inadequacy of tests:No third party or independent tests have been conducted so far on the Bt impact on human health. ● The longest study has been a 90 day sub-chronic test on a healthy adult rat. This does not address the possible health impact on humans of Bt brinjal as brinjal is a regularly eaten vegetable. ● Significant chronic toxicity studies including carcinogenicity studies have not been conducted. ● Brinjal itself has an inherent property of allergenecity which may be enhanced further in the

like acute oral toxicity, sub-chronic oral toxicity in rats, allergenecity of protein to rats, germination, weediness and aggressiveness tests, soil micro-biota studies etc.

- It has been reported that 90-110 days of age (mating age) of rats is considered equivalent to 21-25 years age of humans hence the 90 day study can be considered adequate.
- Promoters say that tests have been done by a third party and approved by different levels of the regulatory system.
- The Cry1Ac endo-toxin is a protein which breaks down when cooked. It is active only in an alkaline medium and since humans consume brinjal only when cooked it will not interfere with digestion. Additionally as the stomach is acidic the digestive process will not be affected by the introduction of the Cry1Ac toxin. The toxin breaks down into common amino acids in the digestive system, which are part of the normal diet and are neither toxic nor allergic. The Cry1Ac endo-toxin would only damage the fruit and shoot borer gut which is alkaline.
- For consumer choice there is a need for a clear labeling and liability regime which will ensure a foolproof mechanism for differentiation between varieties.

Bt variety.

- When pesticides were first introduced and promoted, they were said to be harmless to human health. However, tough lessons have been learnt since then about the actual effects of pesticides. Genetic Engineering will have huge and as yet unknown implications for human health
- Brinjal in India is often eaten lightly cooked.
- In traditional medicine brinjal is used in its raw form. In its raw form the Cry1Ac toxin in the Bt brinjal is active and extremely dangerous.
- The human digestive system is mildly acidic only in the stomach, where the food resides briefly before it passes to the duodenum. The medium then changes from mildly acidic to alkaline to aid the working of the digestive enzymes of tryptase, amylase and lipase. The rest of the human alimentary canal remains alkaline till the end. Hence if the Cry1Ac toxin is active in alkaline medium, there will be a high absorption of the toxin into the human system leading to high toxicity in the human body.
- While India at present lacks a labeling and liability regime, there are also concerns that it will not help even if we have a labeling law in place as only a miniscule quantity of Brinjal or, for that matter, any vegetable is packed and sold.
- Studies on the accumulation or wash-out time span on this

	specific endo-toxin in Bt. brinjal have not been done. Historically the absorption and accumulation of the endo-toxins can be carcinogenic to humans. ● The existing assessments have completely overlooked the impact of Bt brinjal on the Indian systems of medicine. Given that brinjal and related plants are used in Ayurveda, Siddha and so on this is a significant lapse. It is not clear, therefore, whether the entry of Bt brinjal could make Indian systems of medicine/practices ineffective or even toxic, with regard to use of brinjal. ● In Ayurveda around 14 varieties of the brinjal are being used for medicinal preparations. Each one differs in its medicinal properties. Any intrusion in the basic nature will alter the Rasa (Taste), Guna (Property), Veerya (Potency), Vipaka (End Taste) and Prabhava (Synergetic Property) of the drug. These properties are coded for each drug and according to these codes the physicians are able to select a particular drug for a specific ailment. Transgenic changes would alter these properties and create a new plant with unknown coding.
Livelihoods and Economic Considerations	
● Bt brinjal increases marketable yields thus resulting in higher incomes for farmers. ● During trials, average shoot and fruit damage in Bt brinjal hybrids was found to be less than in non-Bt brinjal hybrid counterparts.	● While doing agronomic studies Bt brinjal has not been compared with best agricultural practices like non- pesticide management or integrated pest management practices being successfully undertaken in the

- Farmers will be able to continue to save and re-use their seeds for the hybrids varieties.
- Farmers practising organic farming can do so by following established agronomic practices such as maintaining isolation distance, differences in flowering time etc. for preventing cross-contamination and ensuring identity preservation for organic produce. As the rates of cross-pollination from one field to the other are quite low, and the frequency of such occurrence decreases with increasing distance from pollen source. Presently, the percentage of organic brinjal growers/exporters is negligible in the total production of brinjal in the country.
- The pricing of the seeds will be based on a cost-recovery model, making it affordable for all farmers, whether the seed comes from the private sector or the public sector.
- Mahyco, the developer of the technology, says they have shared it with three Indian public sector research institutions, Indian Institute of Vegetable Research, Tamil Nadu Agricultural University and Dharwad Agricultural University, to create Open Pollinated Varieties (OPVs) which would help the small and marginal farmers benefit from the technology at a low price.

country.

- Majority of the farmers in India are small and marginal farmers, so the possibility for maintaining isolation distances is inexistent.
- There is no guarantee that the prices will actually go down. On the contrary increased input costs could increase the price of Bt brinjal. The Bt cotton example shows that the seed cost increases substantially with GM crops thereby increasing the input costs.
- Organic farmers would be at risk as there would be no mechanism by which contamination by the transgene could be stopped. This would lead them to lose their certification and markets. This is evident from the examples from what happened in the case of Bt cotton.
- While Mahyco shared the truncated gene *cry1Ac* construct they developed with the public sector research institutions, there are conditions in the MoU stopping these institutions from developing their own hybrids or having a free hand in marketing of the OPVs.
- None of the public sector products would reach the market for another two years as they are yet to complete their trials. By then Mahyco, who have their GM brinjal hybrids ready, would completely dominate the markets. Thus the technology sharing is just a Trojan horse to get their product

Glossary

Gene: A segment of DNA that either codes for the synthesis of a specific protein or has a specific regulatory function.

Genetic engineering: A technique involving transfer of a selected piece of genetic material from one organism to another capable of performing new functions.

Genetic marker: A sequence of DNA with a known location on a chromosome and is known to be associated with a particular gene or trait. They are also used as a reference point for mapping other genes.

Genetic modification (GM): Any process that alters the genetic material of living organism. This includes duplicating, deleting, silencing or inserting one or more new genes or altering the activities of an existing gene. It can be performed on microbes, plants or animals (humans included).

Genetically modified organism (GMO): An organism (plant, animal, bacteria, or virus) that has had its genetic material altered, through genetic engineering to perform a new function or produce a new substance.

Genome: An organism's complete set of genes is called genome. It contains all of the genetic information or hereditary characteristics possessed by an organism.

Proteins: Proteins are chemical substances which mediate the form and function of cells and organisms either by forming part of definite structures or by acting as biological catalysts in life processes. Proteins are chains of different amino acids, and the order of amino acids and length of the chain are unique for each kind of protein.

Vector: It is used as a vehicle for transfer of foreign genes to get introduced into and become a part of the host cell, e.g. a bacteriophage, plasmid, or other agent that transfers genetic material from one cell to another.

References

Biotechnology Online Glossary.

http://www.biotechnologyonline.gov.au/topitems/glossary.html Accessed on 7 January 2010,

Centre for Sustainable Agriculture (2006). Briefing Paper on Bt Brinjal. Centre for Sustainable Agriculture, Secunderabad. Available at: www.csa-india.org/downloads/GE/bt_brinjal_briefing_paper.pdf

Information on GM crops/foods and related issues in India. Accessed http://www.indiagminfo.org on 7 January 2010

Kapoor, L., D (1990). Handbook of ayurvedic medicinal plants. CRC Press LCC, Florida, USA. p 304 306.

Kavitha, K and G. V. Ramanjaneyulu (2008). Genetic Engineering in Indian Agriculture: An Introductory Handbook (For private circulation only). Centre for Sustainable Agriculture, Secunderabad.

Report of the Expert Committee (EC-II) on Bt Brinjal Event EE-1.: (2009) Developed by: M/s Maharashtra Hybrid Seeds Company Ltd. (Mahyco), Mumbai, University of Agricultural Sciences (UAS), Dharwad and Tamil Nadu Agricultural University (TNAU), Coimbatore. Genetic Engineering Approval Committee, Ministry of Environment and Forests, Government of India, New Delhi

Available at: http://moef.nic.in/downloads/public-information/Report%20on%20Bt%20brinjal.pdf

Sadashivappa, P and M. Qaim, (2009). Bt Cotton in India: Development of Benefits and the Role of Government Seed Price Interventions. AgBioForum, 12(2): 172-183.

Shukla, V and L.B. Naik (1993). Agro-techniques of solanaceous vegetables, In Advances in Horticulture', Vol. 5, Vegetable Crops, Part 1 (edited by K. L. Chadha and G. Kalloo). Malhotra Publishing House, New Delhi, p. 365 (sic).

Series of Crop Specific Biology Documents, Biology of Brinjal.

http://dbtbiosafety.nic.in/guidelines/brinjal.pdf Accessed on 7th January 2010,

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