USDA Foreign Agricultural Service
GAIN Report
Global Agriculture Information Network

Template Version 2.08

Voluntary Report - public distribution

Date: 12/29/2003

GAIN Report Number: IN3125

India

Planting Seeds

Indian Seed Industry Under Transition

2003

Approved by:
Chad Russell
U.S. Embassy, FASNEWDELHI

Prepared by:
A. Govindan

Report Highlights:
The Indian seed industry is undergoing wide ranging transformations – which include an increasing role of private sector seed companies, rising presence of multinational seed companies with focus on biotechnology, and wide ranging changes in regulatory frameworks, which would affect seed research, marketing, and trade in coming years.

Includes PSD Changes: No
Includes Trade Matrix: No
Unscheduled Report
New Delhi [IN1]
[IN]

Structure of the Indian Seed Industry

- **Pubic Sector Seed Companies**
- **Private Sector Seed Companies**
- **Variety Development**
- **Public-Private Sector Cooperation**

Trade

Regulatory Environment

- **Industry Regulation and Quality Control**
    - **The Seed Act, 1966 and Seed Rules, 1968**
    - **Seed Control Order, 1983**
    - **New Seed Legislation, 2002**
- **Phytosanitary Regulations**
    - **The Destructive Insect and Pest Act, 1914, and**
    - **Plants, Fruits and Seeds (Regulation of Imports in India) Order, 1989**
- **Intellectual Property Rights**
    - **Plant Variety Protection and Farmers' Right Act, 2001, and Rules**
- **Other**
    - **Biodiversity Act, 2002**
    - **Rules for the manufacture, use, import, export, and storage of genetically engineered organisms**
    - **National Seed Policy**

Agricultural Biotechnology

Structure of the Indian Seed Industry

Although the Indian seed market is one of the largest, it is almost exclusively supplied by locally produced seeds. Farmers retain seed of major food crops (wheat, rice, sorghum, millet, corn, and pulses) and commercial crops for many years, and the largest volume of seed trade involves local exchanges of established self-pollinating varieties. The seed replacement rate in most crops is very low, with the exception of cotton and some vegetables. The use of hybrid seeds is mostly confined to cotton, and to some extent to corn, millet, sunflower, and few vegetables. However, awareness about the high yield and quality of produce from hybrid seeds, attracting farmers to switch over to hybrids, is growing.

The Indian seed industry used to be dominated by public sector seed companies. However, following the easing of government regulations and the implementation of a new seed policy in 1988, the private sector seed companies have started playing a major role in seed development and marketing. More recently, the government's decision to embrace biotechnology as a means of achieving food security has attracted several leading

biotechnology-focused multinational seed companies to India. The composition of the seed industry, by volume of turnover, has reportedly reached a ratio of 60:40 between the private and public sectors.

- **Public Sector Seeds Companies**

Public sector involvement in the seed industry on a national scale began at the beginning of the "green revolution" with the establishment of the National Seed Corporation (NSC) in 1963, which was charged with the responsibility of promoting seed industry development from production through processing, storage and marketing, and establishing a system of quality control. Before that, the Indian seed industry was little developed apart from a small number of private companies dealing with high value vegetable and flower seeds. In the initial years of operation, the NSC concerned itself mainly with foundation seed production and with seed certification after the enactment of Seed Act in 1966. The State Seed Corporations (SSC) were established later with support from the World Bank, initially in nine states, and later expanded to cover 13 states, for production and handling of seed in their respective states.

The role of public sector seed companies is now mostly confined to certified seeds of high volume, low value segment of high yielding varieties of cereals, pulses, and cotton with a limited presence in the high value hybrid sectors of cotton, cereals, and vegetables. Wheat and paddy seed constitutes a major share of the seeds handled by them. The NSC and SSCs work closely together to coordinate procurement and sales prices as well as variety demand and supply. Their presence is considered necessary by the government to ensure the availability of reasonably priced seeds of major crops throughout the country and to make sure that private sector seed companies do not enjoy and exploit unreasonable market power.

The public sector seed companies, however, lag behind in research; they are mostly dependent on public research institutions, under the aegis of Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs) for their breeder seed requirements. Based on feed back from dealers and end-users, the public sector seed companies/state governments forecast seed demand for various crops three years in advance and a requirement for breeder seeds is placed with the GOI's Ministry of Agriculture. Using the breeder seeds supplied by government research institutes, the public sector seed companies produce foundation seeds on government farms or reliable, well-trained contract farms. These are further multiplied in contract farmers' fields next year as certified seeds for commercial distribution. If for some reasons (drought or other weather calamities) the supply of certified seeds falls short of requirements, the public sector seed companies source commercial grain from the market, upgrade the quality, and after proper testing distribute it as quality seeds.

All seed grown by contract growers for seed corporations meeting the specified standards attract a premium price over and above the commercial grain price for that crop. The premium can vary between 25 percent for cereals to over 100 percent for hybrids. In the public sector, NSC is usually the retail price setter with the SSCs following NSC prices in determining their own for similar or substitute varieties. For self-pollinated field crops, an accepted basis is to add a margin of 15 to 25 percent on production costs. For hybrid seeds of cereals and vegetables, prices to some degree reflect market trends. However, there is government intervention in the pricing of seeds produced by public sector corporations with the degree of intervention varying from state to state. Some states are now thinking of giving greater autonomy to their seed corporations to make them financially viable by allowing them to market private branded seeds, domestically produced or imported. An advantage to the government seed companies is that they have a vast distribution network

and trusted brand image. The reason why they are losing market share is because seeds by private companies often outperform the publicly available varieties. Some SSCs have started their own research to evolve superior propriety hybrids.

The following table shows breeder seeds supplied and the production and distribution of foundation, and certified seeds, mostly by government seed companies in metric ton.

Type of Seeds	1998/99	1999/00	2000/01	2001/02	2002/03(E)
Breeder seed	3,899	5,064	4,269	4,702	6,292
Foundation seeds	67,500	46,600	59,100	54,400	56,800
Certifies/quality seeds	849,700	879,800	862,700	910,000	950,000

E : Estimated

Source: Annual Report 2002-03, Ministry of Agriculture

- **Private Sector Seed Companies**

Easing of government regulations in the late 1980s spurred enormous development within the seed industry by attracting several foreign seed companies to India. While some of them (like Cargill) entered through joint venture partnerships with Indian seed companies, some others already had a presence in India through affiliate companies (like Hindustan Lever). They identified potential crops for hybridization and started research and development activities. Typically they concentrated on hybrids, mainly corn, cotton, sunflower, vegetables, and flowers (more recently on rice), and they now account for a major share of commercial production of these seeds in India. The basic reason for the private sector's focus on these crops is that it involves low production volume and higher margins. Concomitantly, they had little interest in developing self-pollinated crops, which involve high volume and low margin and are more prone to piracy in the absence of an effective Plant Variety Protection regime in India. Furthermore, there is no significant government intervention in the pricing of these hybrids, and the Indian seed regulations permit marketing of truthfully labeled seeds. Currently, some 500 hybrids of field crops and vegetables are being marketed, as truthfully labeled seeds, mostly by private seed companies.

The private seed sector now comprises some twenty or so large players (with sales turnover exceeding rs. 200 million), several medium companies (sales turn over between rs. 200 million and 20 million), and a large number of small, unorganized players (sales turnover less than rs. 20 million) with local presence.

The private seed industry is now undergoing a transition following the Indian government's focus on biotechnology research, as a means of increasing agricultural production and also driven by trends in the domestic and world seed market. Intensifying international competition, increasing R&D costs, and the complexity of biotechnology have lead to increased consolidation of the Indian seed industry with several of the large and medium companies merging or being taken over by multinational seed companies. Most large multinational seed companies now have their presence in India (either as a joint venture or with 100 percent equity) with their main focus on biotechnology. These include Monsanto, Bayer CropScience, Syngenta, Advanta, Hicks-Muse-Tate, Emergent Genetics, Dow Agro, Bioseed Genetics International Inc., Tokita Seed Co, and Nunhems Zaden BV.

Another factor attracting international seed companies to India is the country's varied agro-climatic conditions and abundant skilled and unskilled labor, as seed production, particularly hybrid seed production, is highly labor intensive. Private seed production is largely centered around Bangalore for vegetable crops and Hyderabad for field crops, particularly cottonseeds.

The emergence of these two seed production centers is due to ideal climatic conditions, better infrastructure, the technology and research leadership, and the expertise of the two regions' seed farmers in manipulating crops for perfectly synchronized flowering.

The initial focus of many of these companies has been cottonseed, for which genetically modified (Bt) hybrids have already been approved by the Indian government for commercial cultivation, with other bio-engineered crops in the pipeline. Most of these companies have licensing agreement with Monsanto for the Bt gene; some are trying to develop their own Bt technology, legally or illegally.

The seed industry is represented at the national level by two associations " The Seed Association of India" based in New Delhi and the "Association of Seed Industries" based in Mumbai. Recently, a third association called All India Crop Biotechnology Association (AICBA), was formed with members from mostly hybrid seed producers and multinationals like Monsanto and Dow Chemicals.

Variety Development

Variety development (especially for self-pollinated crops) is predominantly carried out in the public sector, although in recent years there is growing private sector involvement, which focuses mainly on hybrid cereals, cotton, sunflower, vegetables, and flowers. The private sector is also actively involved in developing bio-engineered crops of cotton, oilseeds, and other crops. The ICAR, operating through 30 All India Coordinated Crop Improvement Projects (AICCIPs), five Crop Directorates, and seven National Research Centers coordinates public sector plant breeding. Basic genetic material from which new varieties are developed is available from the institutions' own resources and from the National Bureau of Plant Genetic Resources (NBPGR), through which India has established a working relationship with international agricultural research centers. ICAR's own institutes and several SAUs at research centers located in different parts of the country and focusing on various agro-climatic zones carry out the AICCIPs.

The present arrangement in India for variety development, testing, evaluation, and release are as follows:

- New varieties are developed by SAUs, ICAR institutes, and private seed companies.
- Varieties that show some promise are entered into the All India Coordinated Trials (AICT) operated by SAUs, ICAR institutes, and State Agricultural Departments under the auspices of ICAR.
- Results of the AICT are presented at the respective Annual Workshops of participating scientists working on the particular crop, where recommendations are formulated for submission to the Variety Release Sub-Committee of the Central Seed Committee who makes final recommendations to the Agriculture Ministry on which varieties should be released and notified.

Public-Private Sector Cooperation

Cooperation between private sector seed companies and public research institutes under ICAR, SAUs, and the International Crop Research Institute for Semi-Arid Tropics (ICRISAT), supported by the Consultative Group on International Agricultural Research (CGIAR), is growing. Public sector breeder seeds are available free of charge to private seed companies with no strings attached. The AICT annual workshops provide venues to private sector seed companies to assess what is available with public research institutes. Under the

"consortium" model with ICRISAT, private companies can jointly fund research that results in publicly available parental lines, which they often cross with in-house genetics to produce proprietary hybrids. ICRISAT recently introduced a live-in campus for private sector researchers to use the institutions' facilities and expertise. ICRISAT is focusing more on private sector partnerships for funding reasons and also because of private companies' effectiveness in getting the research result out to farmers. ICRISAT is currently reviewing its policy of keeping all research in the public domain and is considering licensing/royalties/exclusive rights. Private companies can also fully fund research at SAUs for exclusive rights on the results and/or hire professors as consultants, although the degree of cooperation varies from state to state.

Trade

The New Policy on Seed Development, 1988 eased the regulations on imports and exports of seeds. Nonetheless, importing and exporting of seeds is not easy in India. Although export restrictions on seeds have been mostly removed, restrictions still apply on exports of seeds of jute, onion, cotton, castor, fodder, etc., as well as wild plant germplasm for biodiversity reasons. Exports of seeds of the restricted category are allowed on a case-by-case basis under license issued by the Director General of Foreign Trade, on recommendations from the Department of Agriculture and Cooperation of the Government of India (GOI). Some companies report difficulty in obtaining phytosanitary certificates for exports. There are restrictions on taking germplasm out of India. Custom grown hybrid vegetable and corn seeds and wheat seeds form a major component of India's exports and exports are shifting to high value products. Exports in Indian Fiscal Year (IFY) 2001/02 were valued at $28 million (including $14.5 million wheat and corn seeds).

Under the New Policy on Seeds, imports of vegetable and flower seeds are permitted, while other crops are subject to a license requirement. All seed consignments must be accompanied by an import permit and a Phytosanitary Certificate with additional declarations as the case may be. Permits are issued to those importers who are registered with the NSC. Getting imported seed through Plant Protection and Quarantine offices can be difficult and companies say it all depends on the officer in charge. Seed could be retained for thirty days or more for inspection and clearance, but in practice this has become a minimum period. For imports of germplasm, NBPGR is authorized to issue permits. However, they retain samples of all imported seed material to enrich their germplasm collection. Imports consist of mainly vegetables, flowers, mostly from USA, Korea, Japan, and Europe. Imports in IFY 2002/03 were valued at $14.3 million.

Regulatory Environment

Industry Regulation and Quality Control

The Ministry of Agriculture within the following legislative framework determines overall policy with regard to the seed industry.

- **The Seed Act, 1966 and Seed Rules, 1968**

The Seed Act enacted in 1966, the Seed Rules framed under this Act and notified in 1968, and amendments from time to time provide the basic regulatory structure to ensure seed quality control. The Act provides for compulsory quality control of seed of any notified kind and variety; voluntary certification of seed of any notified kind or variety; and truthfully labeling of seeds. The Act specifies the function of various regulatory bodies associated with the industry as well as rules for notification of new varieties, specifications of minimum limits

of germination and purity, regulation of sale of seeds, certification, labeling, etc. The full text of the Seed Act and Seed Rules are available at:

http://agricoop.nic.in/seedsact.htm
http://agricoop.nic.in/seedsrules.htm

- **Seed (Control) Order, 1983**

A Seeds (Control) Order was issued in 1983 under the Essential Commodities Act of 1955, which required seed dealers to obtain a license valid for three years in order to operate, grants the Controller powers to regulate the sale and distribution of seed and provide additional power to the seed inspectors. The full text of the Order is available at:

http://agricoop.nic.in/seedsconord.htm

- **New Seed Legislation, 2002**

The GOI is in the process of formulating a new seed legislation, which would ultimately replace the existing Seed Act, Rules, and Seeds (Control) Order, 1983. This legislation is aimed at regulating the quality of seeds for sale, imports, and exports. Various stakeholders are currently reviewing the draft bill. The salient features of the proposed legislation are:

- Compulsory registration of all varieties being offered for sale by National Seed Board (NSB), to be constituted by the government
- Registration to be valid for fifteen years for annual and biennial crops and 18 years for long duration perennial crops
- Registration of genetically engineered crops subject to clearance under the Environmental (Protection) Act, 1986
- Selling, bartering, importing/exporting of seed of any transgenic kind/variety subject to declaration to this effect
- Non-registration of a kind/variety of seeds containing any technology (including genetic use restriction technology and terminator technology), which is harmful, or potentially harmful
- Registration of existing varieties on the basis of three years of agronomic performance data to be submitted by the applicant
- Registration of new/exotic varieties only provisionally for two years
- Registration of all seed producers and seed processing
- Declaration of information on adaptability and expected agronomic performance by the breeder
- NSB to decide the seed standards, to appoint private/public seed certification agencies and to formulate rules for compensation to farmers in the event of a crop failure due to defective seeds
- Exemption of farmers' seed from the Seed Act and allowing them to save their own seeds and market it without branding.

Phytosanitary Regulations

- **The Destructive Insects and Pests Act, 1914 & Plants, Fruits and Seeds (Regulation of Import in India) Order, 1989**

This Act and Order regulate the import into India of agricultural products including plants and seeds. Salient features are:

- Prohibit import of seeds for sowing and planting materials without a valid permit
- Clearance of consignments subject to inspection, fumigation, disinfection, and disinfestations as the case may be under official supervision
- Imports not permitted unless accompanied by an official Phytosanitary Certificate

The full text of the Act, Order and Amendments are available at:

http://agricoop.nic.in/dtpact.htm
http://agricoop.nic.in/pfs.htm
http://agricoop.nic.in/pfsorder.htm

Intellectual Property Rights

- **Plant Variety Protection and Farmers' Rights Act, 2001 & Rules**

To address concerns about the lack of effective intellectual property rights in the seed industry, the GOI enacted legislation in August 2001 named, "Plant Variety Protection and Farmers' Rights Act, 2001." This legislation provides for the establishment of a "Protection of Plant Varieties and Farmers' Right Authority" to implement the Act. Under the new legislation, farmers will continue to enjoy their traditional rights to save, use, exchange, share, and sell the produce of the protected variety with the only restriction that the farmer will not be able to sell branded seed of the protected variety for commercial purpose. The legislation contains several of the contentious issues such as the compulsory acquisition of parental material of a variety and granting production license to a third party to produce proprietary variety when there is a shortage of such seeds. The GOI recently published the rules under this legislation, which are available at:

http://agricoop.nic.in/seeds/farmersact2001.htm

Other

- **Biodiversity Act, 2002**

Being a signatory to the United Nations' Convention on Biological Diversity, India enacted a Biodiversity Act in 2002. The Act provides for the establishment of a National Biodiversity Authority (NBA) and State Authorities. The full text of the Act is available at:
http://envfor.nic.in:80/divisions/biodiv/act/bio_div_act.htm

The provisions of the Act, which will have a bearing on seed trade, are:

- Person(s) who are not citizens of India would be required to take permission of NBA before obtaining any biological resource occurring in India. Foreign companies, and even Indian companies having foreign equity are included in the list of such persons.

- Prohibits transfer of material or research occurring in India or obtained from India unless the research is collaborative and there are agreements to this effect before the Act was commenced

- Does not allow application for IPRs without permission of NBA in case the biological resource from India has been used for development of such a product

- Provides for imposition of charges by way of royalty subject to terms and conditions

- **Rules for the manufacture, use, import, export, and storage of hazardous microorganisms genetically engineered organisms or cells under the Environment (Protection) Act, 1986**

All genetically engineered crops/varieties will be tested for environment and bio-safety before their commercial release. Bio-safety guidelines and regulations are formulated by the Department of Biotechnology (DBT) in exercise of powers conferred to it through "**Rules for the manufacture, use, import, export, and storage of hazardous microorganisms genetically engineered organisms or cells"** formulated under the Environment (Protection) Act, 1986 and issued by the Ministry of Environment and Forests in 1989. Imports and exports of bio-engineered products are also governed by these rules. The full text of the Rules is available at:

http://envfor.nic.in/legis/hsm/hsm3.html

- **National Seed Policy, 2002**

The National Seed Policy, 2002, is expected to lay the foundation for comprehensive reforms in the seed sector. This will entail significant changes to the existing legislative framework in order to stimulate varietal development in line with market trends and to introduce advanced scientific knowledge (including biotechnology) to meet farmers' needs. The full text of the National Seed Policy, 2002 is available at:

http://agricoop.nic.in/seedpolicy.htm

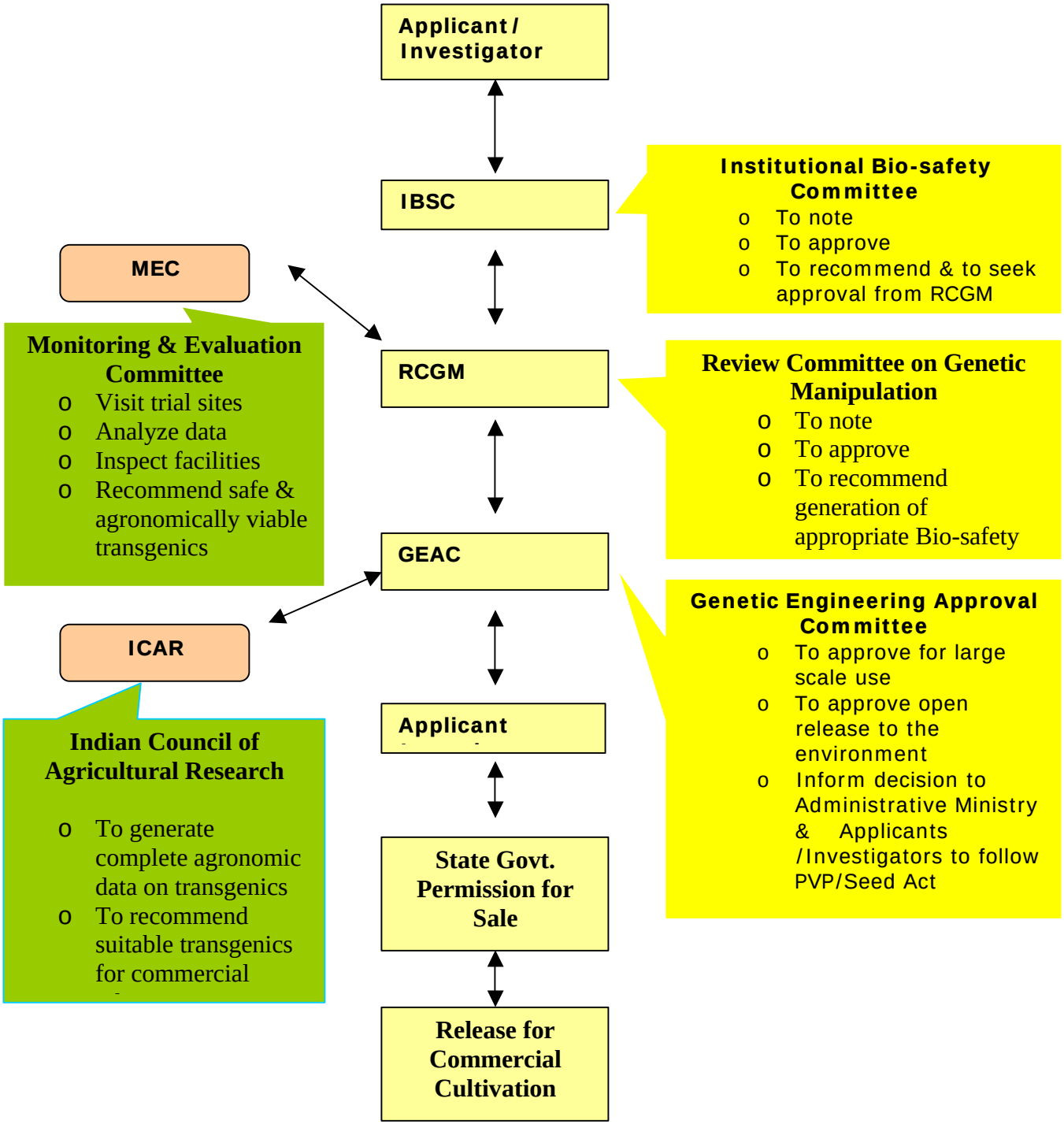
Agricultural Biotechnology

There is a general recognition within India's scientific community, and even within the government, that biotechnology offers the only realistic means to achieving food security. According to the GOI's National Seed Policy, 2002, "Biotechnology will play a vital role in the development of the agriculture sector. The technology can be used not only to develop new crops/varieties, which are tolerant to diseases, pests, and abiotic stresses, but also improve productivity and nutritional quality of food." Consequently, Indian seed industry is getting increasingly engaged with biotechnology issues in general and transgenic crop technologies in particular. As mentioned earlier, most large multinational seed companies with a focus on biotechnology have a presence in India. However, the country is approaching a crossroads where extensive investments in biotech crops, by both the private and public sectors, need to begin paying off if further investments are to be justified. There is growing frustration, especially among private companies, associated with the present regulatory structure and procedures, which have approved only one (non-food) technology after seven years of deliberations and review. Bio-engineered varieties of several crops are in various stages of

development and testing, both by pubic sector research institutes/universities and private seed companies. The Genetic Engineering Approval Committee (GEAC), indefinitely delayed the commercial release of a bio-engineered mustard hybrid, developed by Proagro Seed Company (a company of the Bayer CropScience Group), in an April 2003 decision.

What is constraining the growth of crop-biotechnology in India is a lack of formal policy on commercial release of biotech crops. There is no clear frame of reference for policy makers and hence the tendency is towards inaction rather than action. Although a substantial regulatory framework exists, it is non-transparent, lacks clarity, particularly in the later stages, and at times not perceived to be science based. A slack Intellectual Property Rights (IPR) regime, which fails to protect the genes developed by multinational companies, is also a limiting factor.

Procedures Involved in the Commercialization of Indigenously Developed Transgenic Crops



Timeline Summary for Regulatory Process Leading to Commercial Release of Bt Cotton in India

Year	Studies Undertaken	GOI Oversight Committees
1995-1996	Application and permit for importation of Bt cottonseed containing the Cry1Ac gene.	DBT
1996-2000	Greenhouse breeding for integration of Cry1Ac gene into Indian germplasm, seed purification, and stock increase Limited field studies for potential of pollen escape, aggressiveness, and persistence	DBT RCMG (DBT)
1998-2001	Biochemical and toxicological studies	RCMG (DBT) MEC
1998-2000	Multi-location field trials: agronomic and entomology performance of first generation Bt cotton hybrids, conducted by Mahyco and State agricultural universities.	RCMG (DBT) MEC
2000-2001	Soil rhizosphere evaluations and protein expression analyses from multi-location field trials	RCGM (DBT) GEAC
2001	Advanced stage multi-location field performance trials of first generation Bt cotton hybrids, conducted by ICAR	GEAC, ICAR DBT, MEC
2002	Submission of final bio-safety, environmental safety, gene efficacy and performance documentation to GEAC. Commercial release of first-generation Bt cotton hybrids by GEAC	GEAC
2002 - Ongoing	Continued field performance trials of second generation Bt cotton hybrids for regulatory approval	RCGM (DBT) GEAC, ICAR MEC
DBT – Department of Biotechnology GEAC – Genetic Engineering Approval Committee RCGM – Review Committee for Genetic Modification (Constituted by DBT) ICAR – Indian Council of Agricultural Research MEC – Monitoring & Evaluation Committees (Constituted by GEAC and RCGM)		

Source: Maharashtra Hybrid Seed Company Ltd. (MAHYCO)

Bio-engineered Crops in the Pipeline

Crop	Inserted Event	Purpose of Bioengineering	Companies / Institutions Involved
Cotton	Cry 1 A(c) /1 /4	To generate resistance to lepidopteran pests	Raasi Seeds Limited, Attur Ankur Seeds Limited, Nagpur International Center for Genetic Engineering and Biotechnology, Delhi Maharashtra Hybrid Seeds Company, Mumbai
	Bt Toxin 2/	To generate resistance to lepidopteran pests	Central Institute for Cotton Research, Nagpur
	CP4EPSPS 1/	To generate weedicide resistant plant	Maharashtra Hybrid Seeds Company, Mumbai
	Vip -3 Gene 1/	To generate resistance to lepidopteran pests	Syngenta India Limited, Pune
	Cry 1 A(c) & Cry 2 A(b) 1/	To generate resistance to lepidopteran pests	Maharashtra Hybrid Seeds Company, Mumbai
Mustard / Rapeseed	Bar, Barnase& Barstar 2/	To develop herbicide tolerant plant	Delhi University, Delhi
	Bar, Barnase& Barstar 3/	To develop better hybrid cultivars	Proagro PGS (India) Limited, Delhi
	CP4EPSPS 2/	To generate weedicide resistant plant	Maharashtra Hybrid Seeds Company, Mumbai
	Ssu-maize Psy & Ssu-tpCtrl 2/	To generate plants containing high beta carotene	Tata Energy Research Institute (TERI), Delhi
	Choline Dehydrogenase gene 2/	To increase stress tolerance	Indian Agricultural Research Institute, Delhi
	Arabiodopsis annexin gene 2/	To increase stress tolerance	Indian Agricultural Research Institute, Delhi
Rice	Bt Toxin 2/	To generate resistance to lepidopteran pests	SPIC Foundation, Chennai Bose Institute, Kolkata IARI Sub-station, Shillong International Center for Genetic Engineering and Biotechnology, Delhi

	ADC & SAMDC 2/	To generate stress tolerance	Bose Institute, Kolkata
	Herbicide tolerant gene 2/	To generate herbicide tolerant plant	Center for Cellular and Molecular Biology, Hyderabad
	Bt and Xa 21 genes 2/	To develop plant resistant to lepidopteran pests and bacterial blight/ diseases	Central Rice Research Institute, Cuttack
	Pyruvate Decarboxylase and Alcohol Dehydrogenase gene 2/	To generate plants tolerant to flooding	Delhi University, Delhi
	Xa 21, Cry 1 A(b), BB and SB Resistant gene 1/	To generate plant resistant to lepidopteran pests, bacterial and fungal diseases	Directorate of Rice Research, Hyderabad
	Bt and Chitanase gene 1/	To generate plants resistant to lepidopteran pests	Indian Agricultural Research Institute, Delhi
	Gm2 gene 2/	To generate plants resistant to gall midge pest	International Center for Genetic Engineering and Biotechnology, Delhi
	Cry 1 A(c), Xa 21 & GNA genes 2/	To generate resistance to bacterial diseases, lepidopteran and sucking pests	Maharashtra Hybrid Seeds Company, Mumbai
	Chitinase, Beta - 1, 3-Glucanase and Osmotin Gene 2/	To develop plants resistant to fungal infection	Madurai Kamaraj University, Madurai
	Maize Transposable Element 2/	To generate plants tolerant to abiotic stresses	SPIC Foundation, Chennai
	Cry 1 A(b) 2/	To develop plant resistant to lepidopteran pests	Narendradev University of Agriculture, Faizabad
	GNA Gene 2/	To develop plants resistant to pests	Tamil Nadu Agricultural University, Coimbatore
Corn	Cry 1 A(b) 2/	To generate resistance to lepidopteran pests	Syngenta India Limited, Pune

	CP4EPSPS 2/	To generate herbicide tolerant plant	Monsanto Enterprises Limited, Mumbai
Sorghum	Cry 1A(c) 2/	To generate resistance to lepidopteran pests	Maharashtra Hybrid Seeds Company, Mumbai
Chickpea	Bean Alpha AI gene PGIP Gene 2/	To generate resistance to diseases	Assam Agricultural University, Jorhat, Assam
Pigeon pea	Protease Inhibitor and Lectin genes 2/	To develop resistance to boll worms and aphids	Indian Agricultural Research Institute, Delhi
	Gus gene 2/	For Transformation work	Maharashtra Hybrid Seeds Company, Mumbai
Pea	GFP gene 2/	Transformation Studies	Indian Institute of Horticultural Research, Bangalore
Black Gram	Coat Protein and Replicase gene 2/	To develop resistance against Yellow Mosaic Virus	Madurai Kamaraj University, Madurai
	Dianthin and Barnase gene 2/	Insect resistance and herbicide tolerance	Madurai Kamaraj University, Madurai
Peanut	IPCVcp:IPCV Replicase gene 2/	To generate resistance to Indian Peanut Clumpy Virus	International Crops Research Institute for Semi-Arid Topics - Hyderabad
Potato	Cry 1A(b) gene 1/	To generate resistance to lepidopteran pests	Central Potato Research Institute, Shimla
	Ama 1 gene 1/	To generate protein enriched potatoes	Jawaharlal University, Delhi
	ACC sunthase gene 2/	To generate stress tolerant plants	Indian Agricultural Research Institute, Delhi
Tobacco	Cry 1 A(b) & Cry 1 C 1/	To generate resistance to lepidopteran pests	Central Tobacco Research Institute, Rajahmundry
	ctx-B and tcp genes - Antigens of *Vibrio cholerae* 2/	Edible Vaccine Development	Delhi University, Delhi
	Chitinase, Glucanase and RIP gene 2/	To generate resistance to fungal attack	Indian Agricultural Research Institute, Delhi
	Bt Gene 2/	To generate resistance to lepidopteran pests	International Center for Genetic Engineering and Biotechnology, Delhi

Brinjal (Egg plant)	Cry 1 A(b) 1/	To generate resistance to lepidopteran pests	Indian Agricultural Research Institute, Delhi
	Cry 1 A(c) 1/	To generate plant resistance to fruit and shoot borer	Maharashtra Hybrid Seeds Company, Mumbai
	Chitinase, Glucanase and Thumatin genes 2/	To generate disease resistance	Delhi University, Delhi
Tomato	ctx-B and tcp genes - Antigens of *Vibrio cholerae* 2/	Edible Vaccine Development	Delhi University, Delhi
	Cry 1 A(b) 1/	To generate resistance to lepidopteran pests	Indian Agricultural Research Institute, Delhi
	ACC Synthase 2/	To increase stress tolerance	Indian Agricultural Research Institute, Delhi
	Chitinase & Glucanase genes 2/	To generate resistance to fungal and viral diseases	Indian Institute of Horticultural Research, Bangalore
	Reporter/Leaf Curl Virus gene 2/	To generate resistance to fungal and viral diseases	Indian Institute of Horticultural Research, Bangalore
	Alfalfa Gluconase and Leaf Curl Virus gene 2/	To generate resistance to fungal and viral diseases	Indo-American Hybrid Seeds, Bangalore
	OXDC gene 1/	To generate resistance to fungal diseases	Jawaharlal Nehru University, New Delhi
	Snowdrop Lectin gene 2/	To generate resistance to lepidopteran pests	Rallis India Limited, Bangalore
Cauliflower	Bt toxin gene 2/	To generate resistance to lepidopteran pests	Indian Agricultural Research Institute, Delhi
Cabbage	Bt toxin gene 2/	To generate resistance to lepidopteran pests	Indian Agricultural Research Institute, Delhi
Bell Pepper	Snow Drop Lectin gene 2/	To generate resistance to lepidopteran pests	Rallis India Limited, Bangalore
Chilli	Snow Drop Lectin gene 2/	To generate resistance to lepidopteran pests	Rallis India Limited, Bangalore
Banana	ACC Synthase 2/	To increase stress tolerance	Indian Agricultural Research Institute, Delhi
Muskmelon	Rabies glycoprotein 2/	To develop edible vaccines	Indian Institute of Horticultural Research,

			Bangalore
Watermelon	GUS & GFP genes 2/	Transformation studies	Indian Institute of Horticultural Research, Bangalore
Coffee	Chitinase, Beta - 1, 3-Glucanase and Osmotin genes 2/	To develop resistance to fungal diseases	Madurai Kamaraj University, Madurai

Source: Department of Biotechnology, GOI

1/ Approved for conducting contained limited field trials.
2/ Approved for conducting green house trials and transformation work.
3/ Awaiting final approval of the GEAC after completion of mandated tests and trials.
4/ Approved by the GEAC for commercial cultivation.