Acceptance and Use of Genetically Modified Rice in India

Ranjitsinh Mane

The views expressed in this book are those of the author and do not necessarily reflect the views or policies of to the John Templeton Foundation, University of Arkansas, and Division of Agriculture.

Acknowledgement

The John Templeton Foundation
300 Conshohocken State Road, Suite 500
West Conshohocken, PA 19428
USA

Department of Agricultural Economics and Agribusiness
217 Agriculture Building,
University of Arkansas, Fayetteville, AR 72701
USA

Policy Landscape of Genetically Modified Rice Acceptance and Use in India

Contents

Abbreviations

ABLE, Association of Biotechnology Led Enterprises
ACIAR, Australian Centre for International Agricultural Research
AIBA, All India Biotech Association
APC, Agricultural Price Commission
APCoAB, Asia Pacific Consortium on Agricultural Biotechnology
APEDA, Agricultural Processed Food Products and Export Development Authority
BCIL, Biotech Consortium India Limited
BKU, Bharatiya Kisan Union
BRAI, Biotechnology Regulatory Authority of India
CACP, Commission for Agricultural Costs and Prices
CCRI, Central Cotton Research Institute
CII, Confederation of Indian Industry
CPB, Cartagena Protocol on Biodiversity
CSIR, Council for Scientific Industrial Research
CV, Contingent Valuation
DAE, Department of Atomic Research
DBT, Department of Biotechnology
DCA, Department of Consumer Affairs
DFID, Department for International Development
DST, Department of Science and Technology
EPA, Environmental Protection Act
FBAE, Foundation for Biotech Awareness and Education
FCI, Food Corporation of India
FICCI, Federation of Indian Chamber of Commerce and Industry
FSSAI, Food Safety and Standard Authority of India
GDP, Gross Domestic Product
GEAC, Genetic Engineering Appraisal Committee
GHI, Global Hunger Index
GM, Genetically Modified
GOI, Government of India
IARI, Indian Agricultural Research Institute
IBSC, Institutional Bio-Safety Committee
ICAR, Indian Council of Agricultural Research
ICMR, Indian Council for Medical Research
ICRISAT, International Crops Research Institute for the Semi-Arid Tropics
ILSI, International Life Science Institute
IPR, Intellectual Property Right
KRRS, Karnataka Rajya Raitha Sangathana
MCA, Ministry of Commerce
MMB, Mahyco Monsanto Biotech
MoEF, Ministry of Forest and Environment
MSP, Minimum Support Price
MSSRF, M.S. Swaminathan Research Foundation
NAIP, National Agricultural Innovation Project
NATP, National Agricultural Technology Project
NBDB, National Bioresource Development Board
NBPGR, National Bureau of Plant Genetic Resources
NBS, Nutrient Based Subsidy
NCPGR, National Center for Plant Genome Research

NSAI, National Seed Association of India
NSS, National Sample Survey
PDS, Public Distribution System
PPV&FR, Protection of Plant Varieties and Farmers' Rights
PQO, Plant Quarantine Order
RCGM, Review Committee for Genetic Manipulation
SAU, State Agricultural Universities
TAAS, Trust for Advancement of Agricultural Sciences
TERI, Tata Energy Research Institute
TNAU, Tamil Nadu Agricultural University
TRIPS, Trade Related Intellectual Property Rights
UGC, University Grant Commission
USDA, United States Department of Agriculture
VAD, Vitamin A Deficiency
WGEP, Western Ghats Ecology Panel

A. Overview of Food and Agricultural Economy

India had an impressive average economic growth rate of 8.8 percent in the past decade with share of agricultural value added to Gross Domestic Product (GDP) stagnant at about 18 percent for the same period (World Bank, 2012). The growth rate of the agricultural sector has fluctuated from a high of 9 percent in 2003 to a low of 3 percent in 2011 resulting in an average of about 4.3 percent for the past decade. The growth rate in Indian agricultural sector has remained similar before and after the economic reforms of 1990s (Desai at el, 2011). In 2009, India witnessed food price inflation of around 18 to 19 percent (Dev and Rao, 2010). There were several reasons for the rise in food prices with low yields of food grains being one of them. The yields of rice and wheat from 1994/1995 to 2006/2007 had increased marginally by 0.86 percent and 0.52 percent, respectively (Dev and Rao, 2010). The implication of slow growth in agriculture has had serious consequences for food price inflation, increasing food insecurity and poverty (Desai at el, 2011). Higher food prices are a concern for poor households and their concerns of rising food prices is reflected at the ballot box every five years. Therefore the Government of India (GOI) has initiated the National Food Security Mission in 2007/2008 (www.nfsm.gov.in). The objective of the food security mission is to increase production of rice, wheat, and pulses by 10, 8, and 2 million metric tons (MMT), respectively by 2011-2012 (USDA, 2012). The overall contribution of the agricultural and allied sectors[1] to GDP (at constant prices) in 1970-71 was 44 percent over the next two decades the share of agriculture's contribution to GDP declined to 31.4 percent in 1990-91, reaching 14.6 percent in 2009-2010.(Sharma and Jain, 2011). The disaggregated statistics reveal that agriculture's contribution (excluding allied sectors) to GDP in 2009-2010 was 12.3 percent with forestry and logging at 1.5 percent and fisheries at 0.8 percent (CSO, 2011). Similarly, employment in agriculture, in 2004-2005 was about 52 percent of total national work force as compared to 70 percent in 1971 (Sharma and Jain, 2011). There is clear evidence that the role of agriculture in the Indian economy has been reduced both in terms of contribution to GDP and employment. The poverty[2]in India had decline from 45. 3 percent in 1994 to 29.8 percent in 2010 (World Bank).However, the decrease in poverty is not reflected in the Global Hunger Index[3] (GHI) of India, which is alarming and has remained stable at about 22 percent for the same period (IFPRI, 2012).

1. Food Production and Consumption Patterns

The trend of agricultural production of India has been increasing from 2004/2005 to 2010/2011 with the exception of 2009/2010. The decline in agricultural production in the latter was due to severe droughts in certain parts of the country (GOI, 2012).

[1] Agricultural and allied sectors include agriculture, forestry, logging, fisheries, and dairy.
[2] National poverty as a percentage of population
[3] GHI is a equal proportional combination of undernourished people, child underweight and child mortality as a percentage of population.

Table 1.Compound growth in Area, Production, and Yield of Selected Agricultural Commodities in percent.

	1980/81 to 1989/90			1990/91 to 1999/2000			2000/01 to 2011/12**		
	Area	Production	Yield	Area	Production	Yield	Area	Production	Yield
Rice	0.41	3.62	3.19	0.68	2.02	1.34	0.04	1.72	1.68
Wheat	0.46	3.57	3.10	1.72	3.57	1.83	1.22	2.37	1.14
Coarse Cereals*	-1.34	0.40	1.62	-2.12	-0.02	1.82	-0.75	3.01	4.39
Pulses	-0.09	1.52	1.61	-0.60	0.59	0.93	1.70	3.47	1.91
Sugarcane	1.44	2.70	1.24	-0.07	2.73	1.05	1.37	1.96	0.58
Oilseeds	1.51	5.20	2.43	-0.86	1.63	1.15	2.08	4.45	3.39
Total food grains	-0.23	2.85	2.74	-0.07	2.02	1.52	0.43	2.32	2.91

Source: Department of Agriculture and Cooperation, GOI , * Jowar, Bajra and Maize, ** Estimated

The compound growth rate in major food crops for past three decades is detailed in Table 1. Rice growth rate with respect to area and yield is on decline since past three decade. Rice production in India account for 40 percent of food grain production and is a major staple for 65 percent of population (USDA, 2012b). The main growing season in India is *kharif* (fall /early winter harvest) and *rabi*(winter planted / spring harvest). Rice is grown in almost all states of India; on area of 45 million ha with an average yield of 2.2 mt/ha (USDA, 2012b). Rice yields have remained stagnant for years and are among the lowest when compared to other countries.

The share of expenditure on individual food items to total food expenditure is outlined in table 2. The results indicate that the expenditure share of cereals has declinedfor urban and rural consumers; with increases in expenditure shares for pulses, milk, eggs, fish and meat, and vegetables (NSS, 66th Round). The consumption pattern at the household level clearly reveals that Indian consumers are shifting from cereals and pulses to fruits, edible oils and other processed products, which is largely due to economic growth that has contributed to their household income (Morisset and Kumar, 2008). In urban India the expenditure share of cereals on a per capita monthly basis of total food expenditure has declined from 36 percent in 1972-73 to 24 percent in 2005-2006 (Minten et al. 2009). The same trend was found for rural India when their expenditure share on cereals decreased from 56 percent in 1972 to 32 percent in 2005-2006 (Minten et al. 2009). In rural India the shift in consumption is largely attributed to better access to food due to improved infrastructure (Rao, 2000). Based on National Sample Survey (NSS) conducted by GOI there has been gradual decrease in consumption of rice as consumer shift to high value food (USDA, 2012b)

Table 2. Commodity wise share of household expenditure to total food expenditure

	Rural		Urban	
	1987-1988	2009-2010	1987-1988	2009-2010
Commodity				
Cereals	41.1	29.1	26.6	22.4
Pulses and Products	6.3	6.9	6.0	6.6
Milk and Products	13.4	16.0	16.8	19.2
Eggs, Fish and Meat	5.2	6.5	6.4	6.6
Vegetables	8.1	11.6	9.4	10.6
Sugar	4.5	4.5	4.3	3.7
Food total	100	100	100	100

Source: Reproduced from key indicators 2009 -10 National Sample Survey (NSS)

2. Role of Food and Agricultural Trade

Since the economic liberalization in the 1990s, agricultural imports have increased by 16 percent annually while exports have increased by 12 percent annually from 1990-2009 (ERS, 2012). Based on USDA estimates Indian agricultural imports were estimated to be $11.0 billion USD compared to $15.0 billion of exports in 2009/2010, making the country's balance of payment positive. Some of the major agricultural commodities that India imports regularly are edible oil, pulses (chickpeas, cowpeas, lentils, dry peas etc), raw cashew nuts, almonds, and apples. Likewise, wheat and sugar imports are intermittent to meet the shortfall in domestic production and meet food security stocks (ERS, 2012). Similarly, some of the major commodities that India exports are rice (basmati and non basmati), coffee, cotton, fruits and nuts, oil cakes, sugar, tobacco, and wheat (durum) (ERS, 2012). In general, the Indian economy remained closed from 1947 to early 1990 with government control on agricultural and non agricultural exports. However, since the 1990s, India liberalized its agricultural trade (both imports and exports) with tariffs on agricultural commodities imported being one of the highest in the world (Table 3 in Appendix). In the case of exports, India has removed most of the quantity restrictions but there is lack of coherent export policy. In 2008, India banned exports of rice, wheat and corn to curb inflation and limit the rise in domestic prices have caused build up of huge stocks. Since 2011 India has lifted ban on export of non basmati rice making it the largest exporter of rice in 2012 (USDA, 2012b).

Indian agriculture is under intense pressure to meet the needs of a liberalized economy since 1990s. There has been decreased investment in agricultural sectors, coupled with low productivity, increased consumer demand for diversified products from an existing production system (ERS, 2012). There has been a lack of reforms in Indian agriculture except on input subsidies and domestic support which have increased substantially in past few years. There is an undisputed role for technology to increase low yields in agriculture with the use of improved seeds and genetically modified crops .The environment for Indian agriculture and agricultural policy has changed significantly since the onset of rapid economic growth in the early 1990s. Rapid growth in incomes and urbanization are now strengthening and diversifying consumer demand and placing pressure on existing production systems, marketing institutions, and infrastructure (ERS, 2012).

3. Rice Trade and India

Rice exports from India have increased dramatically in past two years largely in response to huge accumulation of stocks since 2008. Some of the leading export destinations for Indian rice are United Arab Emirates, Saudi Arabia, Iran, Kuwait, Yemen, United Kingdom, South Africa and United States (USDA 2012b). Rice exports from India are not consistent for past two decades (see fig 1) as exports are on residual basis only after meeting the domestic demand. The rice exports are predominately of basmati and low quality long grain rice. The exports of basmati rice from India are a major source of valuable foreign exchange for Indian economy. In India the basmati rice production was estimated to be 5.8 million ton from an area of 1.8 million ha in 2012(USDA, 2012b).

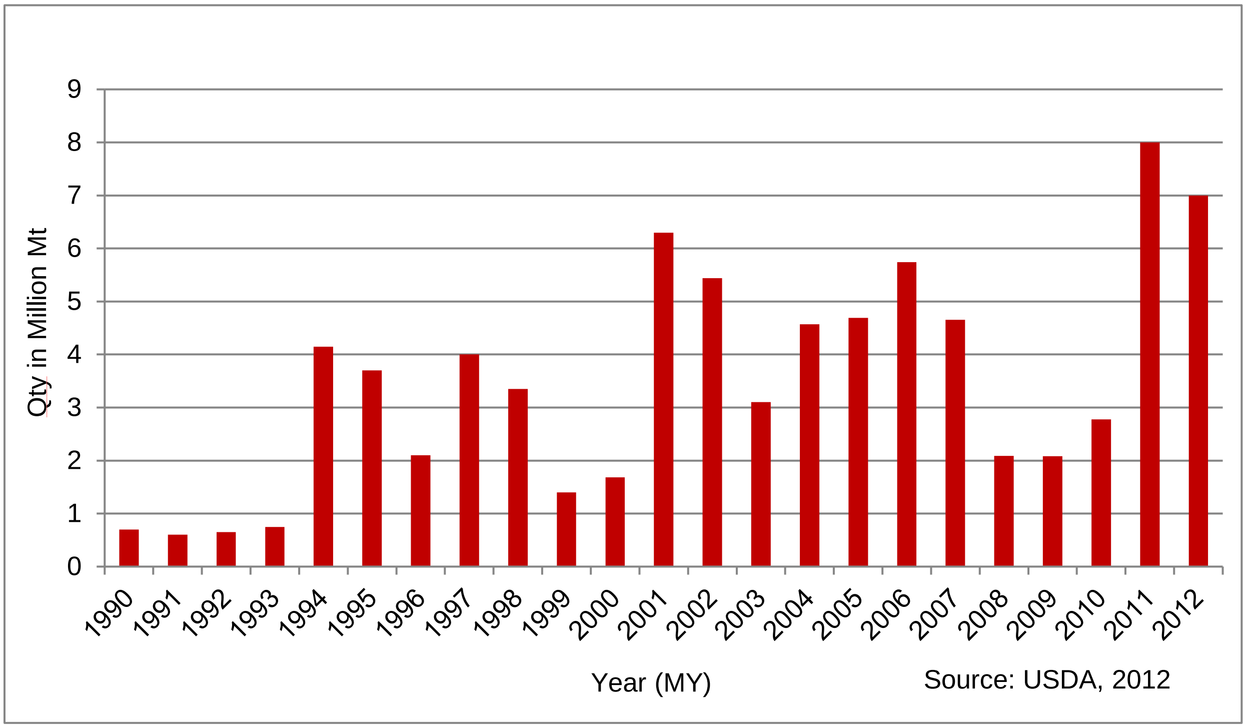


Figure 1, Indian Rice Exports (1990-2012)

4. Overview of Biotechnology Sector in India

The biotechnology sector of India is estimated to be 3.6 billion USD in 2011 and is forecasted to reach 11.6 billion USD by 2017 (IBEF, 2011). Since 1985, the Government of India has increased its public funding for research and development with 100 percent Foreign Direct Investment (FDI) in biotech sector. A brief overview of Indian biotech sector is illustrated in Chart 1. The sector wise revenue breakup of Indian biotechnology market reveals that the bio-pharmaceutical sector accounts for 61.7 percent of market revenue followed by bio-services at 18.8 percent and ag-biotech sector (Includes hybrid seeds) at 14.4 percent (ABLE Spectrum, 2011).

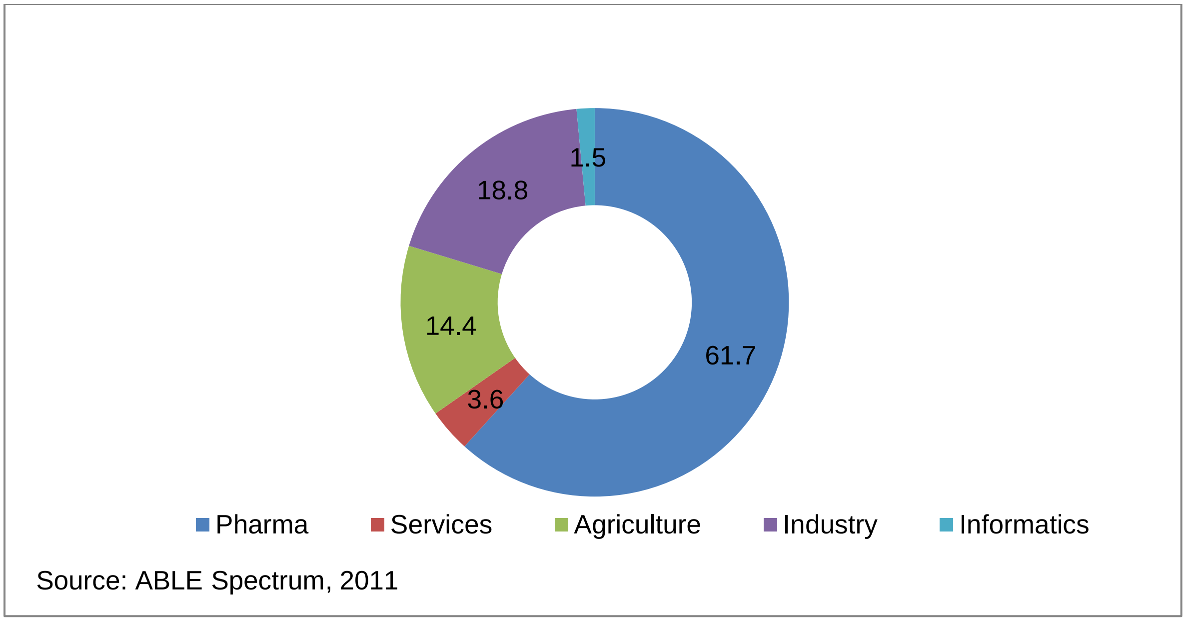
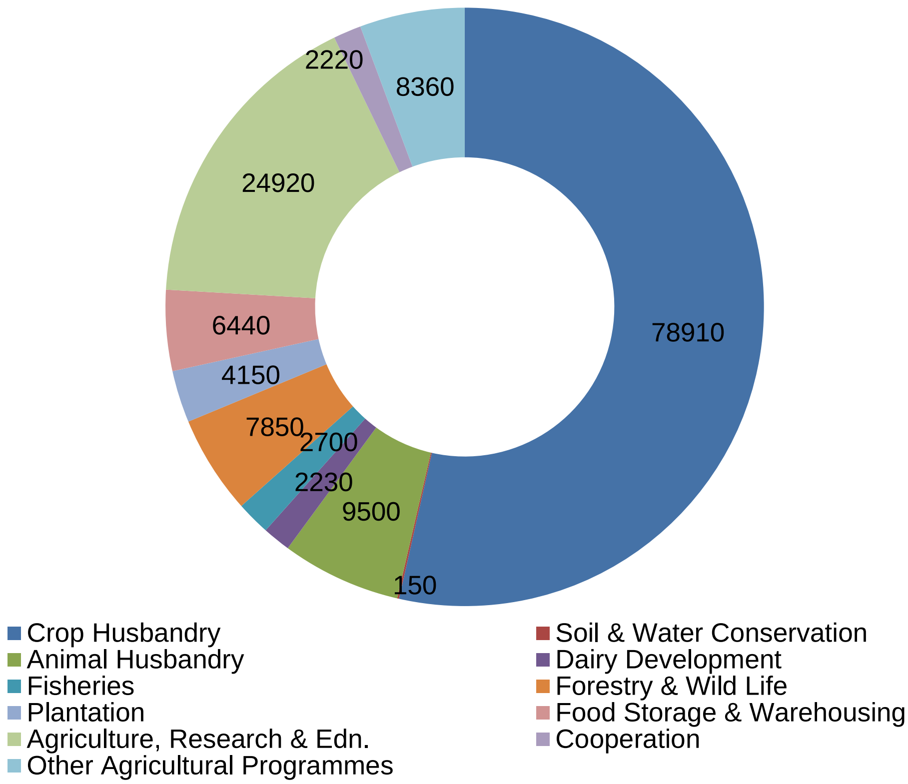


Figure 2, Indian Biotech Sectors wise Revenue in Percent for FY 2011

There are numerous public agencies responsible for biotech research under the Department of Biotechnology (DBT), Council for Scientific Industrial Research (CSIR), Indian Council for Medical Research (ICMR), and Indian Council of Agricultural Research (ICAR).The total public spending of Indian government on research and development in agriculture has increased from 0.9 billion USD[4] in 1996 to 2.3 billion USD in 2009 (Stads and Rahija, 2012). There is remarkable increase in public spending on research and development activity in Indian Agriculture. The majority of research and development spending of Indian agriculture is funded by central government set up under ICAR. The ICAR in turns distributes the funds to State Agricultural Universities (SAU) and regional research stations for crop research. Likewise, World Bank loans have funded two recent projects. First, National Agricultural Technology Project (NATP) and National Agricultural Innovation Project (NAIP). Likewise, In India, the Department of Science and Technology, and the DBT along with international donor agencies like Australian Centre for International Agricultural Research (ACIAR), Department for International Development (DFID) fund research and development activity in agricultural biotechnology. In India, based on research focus of scientist according to the crop, rice is the most researched crop (15%) followed by fruits (9%) and vegetables (6%) (Stads and Rahija, 2012).

The central government expenditure on agricultural research as a share of the total budget allocated to agriculture and allied sector has increased from 10 percent in 2002-2003 to 17 percent (about 25 billion Indian Rupees) in 2011-2012 (GOI, 2012). The DBT has supported different research institutes at national and state levels with public funds on research and development of biotech crops in India. In India, at state level there are about 47 State Agricultural Universities (SAU) working on genetically modified crops and training of human resources in the field of agricultural biotechnology (Choudhary and Gaur, 2011).

[4]USD measured in Purchasing Power Parity (PPP) at 2005 constant dollar.



Source: Expenditure Budget Vol. 1 State Plan Division, Planning Commission, Government of India,

Figure 3, Central Government Expenditure on Agriculture and Allied Sectors in Million Rs 2011-2012

Source: Expenditure Budget Vol. 1 State Plan Division, Planning Commission, Government of India,

5. Biotechnology Research in Rice

In India rice yields had remained stagnant for decades. Therefore, the GOI started rice hybrid research in 1989 under the ICAR. Since its inception, the Indian hybrid program faced several challenges, such as limited germplasm, poor grain quality, low level of tolerance to abiotic stress and low level of acceptance by consumers (Janaiah 2002,Janaiah and Hossain 2003). While poor quality of grain and lower price for hybrid rice were some of the reasons for lack of adoption of hybrid, the main constraints are the high cost of seeds, higher cost of cultivation, and lack of awareness (Spielman, Kolady and Cavalieri, 2011). Based on the National Food Security Mission's target the Government of Indian had plans to increase rice area under hybrid cultivation by 3 million hectares by 2011-2012. Unfortunately, the current hybrid area is only 1.5 million hectares (USDA 2012b). Despite of the above mentioned challenges in hybrid adoption the GOI is committed to improve rice yields and has approved GM rice field trials in India (see table 3). However, reaching approval for commercialization of GM rice in India is time consuming due to various regulatory, political, and socio-economic challenges discussed later.

Table 3. Current GM Rice Testing Site in India by Public and Private Organization

Company	Trait	Site in India
BASF India Limited	Yield enhancement	TNAU, Coimbatore, Tamilnadu
Bayer Biosciences Pvt. Ltd.	Insect resistance, Herbicide tolerant	Patancheru, Andhra Pradesh, Davangree, Karnataka
Bose Institute	Iron enhancement	Calcutta ,West Bengal,
E.I. DuPont India Pvt. Ltd	Insect resistance, Male sterile female inbred rice lines, Herbicide tolerant	Medak, Andhra Pradesh , Raipur, Chhattisgarh, Hubli Bangalore,
Delhi University , South Campus	Insect resistance	New Delhi
Indian Agricultural Research Institute	Insect resistance	Shillong, Meghalaya
Maharashtra Hybrid Seeds Co. Ltd. (Mahyco)	Insect resistance	Nizamabad, Andhra Pradesh
Metahelix Life Sciences Pvt. Ltd.	Insect resistance	Ranga Reddy, Andhra Pradesh
Tamilnadu Agricultural University (TAU)	Insect resistance	Coimbatore, Tamilnadu
University of Calcutta	Stress tolerant (abiotech)	Chin surah, West Bengal

Source: http://igmoris.nic.in, 2012

The GM rice research in India has different objectives. The most common research objectives are to increase yield, reduce pesticide use, increase nutrient availability, or address climate change challenges such as drought or increased salinity (see table 3)

B. Overview of the Political Economy and Policy Environment in India

1. Structure of Agricultural and Food Policy Environment

Food security at national and household level is the priority of Indian agriculture policy. The three main pillars of food security policy are government procurement at Minimum Support Price (MSP), Buffer Stocks, and Pubic Distribution System (PDS). The MSP has met its objective by providing rice and wheat farmers a margin of around 20 percent over total cost of production (Dev and Rao, 2010). Buffer stocks are maintained by the Food Corporation of India[5] (FCI), which is also responsible for procurement of food grains at MSP. At the farm level, the majority of farm inputs such as electricity and fertilizer are partly or fully subsidized by state or central governments in different proportion. Such policies have resulted in increased used of inorganic fertilizers. There has been a steady growth in the use of fertilizer from 111.8 Kg per ha in 2006-2007 to 144.14 kg per ha in 2010-2011 (Department of Fertilizer, GOI, 2012). Domestic production of urea is about 80 percent with large amount of other fertilizers (potassium and phosphorus) imported. The Nutrient Based Subsidy (NBS) program of 2010 sets a fixed subsidy for fertilizers every year, with farmers only paying 50 percent of the cost of delivery for potassium and phosphorus fertilizer (Economic Survey, 2011-2012).

The FCI and Agricultural Price Commission[6] (APC) or Commission for Agricultural Costs and Prices (CACP) were instituted in 1965 to meet consumer demand of low food prices (Gulati et al. 2007). However, two consecutives droughts from 1965-66 to 1966-67 led to emergency food aid imports and the expansion in scope of FCI. The food grain policy of allowing FCI the monopolistic role in procurement and distribution of food grain served its purpose during the 1960's,1970's and 1980's, but since 1990's these

[5]State Trading Agency
[6]APC since 1985 is Commission for Agricultural Costs and Prices (CACP)

policies are ineffective since the share of government expenditure on food subsidies as percent of GDP has doubled over the past decade (Gulati et al. 2007). The monopoly of FCI has led to inefficiencies and diminished investment in the food grain system. The stimulus to production due to MSP, the maintenance of excessive buffer stocks, and the banning of exports of major staple commodities have successfully protected Indian consumers from higher food prices.

The agricultural policy with respect to rice production in India is currently focused on two major issues. First, the issue of wide variation in rice productivity among different states. The GOI has initiated special technologies for eastern India to increase rice productivity in rainfed conditions (USDA, 2012b). Second, in northern states the continued cropping pattern of rice -wheat or rice - rice has lead to depletion of ground water and decline in soil fertility. However, GOI has not advocated any change in cropping pattern because first there are no better alternatives crops for rotation, and second the northern states area major source for central procurement of wheat and rice stocks. Other environmental challenges in rice production that agricultural policy has failed to address are raising sea level in coastal regions, melting of glaciers and erratic monsoon patterns, which would seriously undermine rice production in India. The environmental challenge needs to be addressed with multiple tools and use of biotechnology in rice production is one of them.

2. Regulatory Institutions in India

The Department of Biotechnology (DBT) was established in 1986 under the Ministry of Science and Technology and the Ministry of Forest and Environment (MoEF). The DBT has two subdivisions: a) National Center for Plant Genome Research (NCPGR) and b) National Bioresource Development Board (NBDB). In order to coordinate the working of allthe relevant stakeholders, DBT constituted the Biotech Consortium India Limited (BCIL) in 1990. All issues related to preserving biodiversity, monitoring of bio-safety of biotech crops, and implementation of the Cartagena Protocol on Biodiversity (CPB) are under the Ministry of Environment and Forests (MoEF).

Figure 3 Regulatory Framework for Approval of Genetically Modified Crops in India

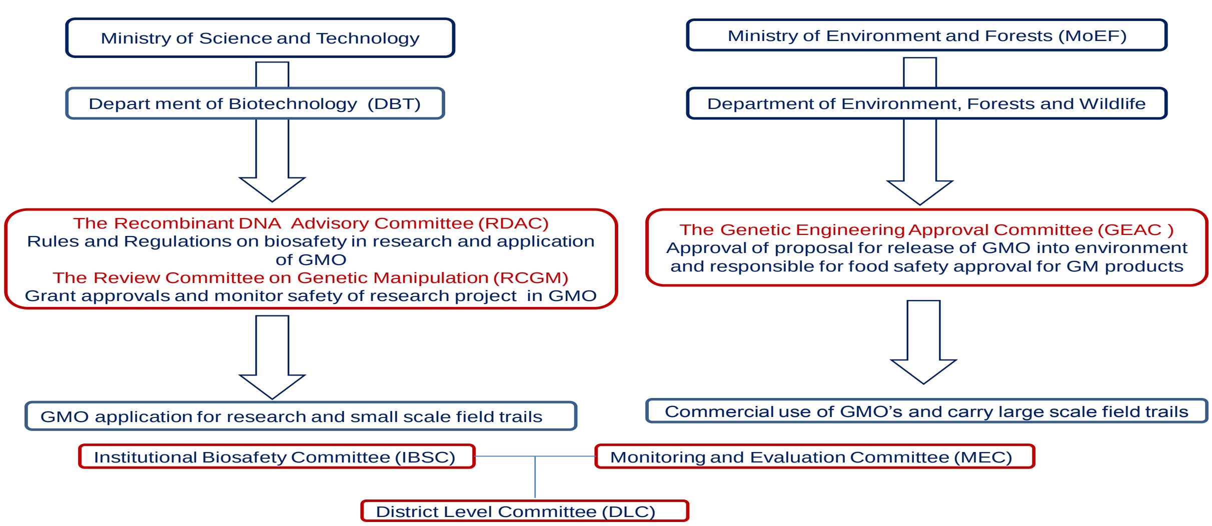


Figure 4, Regulatory Framework for Approval of Genetically Modified Crops in India
Source: Department of Biotechnology, GOI

In brief, the Institutional Bio-Safety Committee (IBSC) is responsible for experiments conducted within approved laboratories and contained greenhouses. Second, the Review Committee for Genetic Manipulation (RCGM) is responsible for approving experiments involving import of transgenic material (tissue, DNA, seeds, any other plant parts), limited field trials, biosafety and toxicity studies. Third, the Genetic Engineering Appraisal Committee (GEAC) is responsible for large scale field trials, and commercial approval of transgenic crops. A detailed schematics of the regulatory framework for approval of genetically modified crops is illustrated in chart 3. Likewise, a brief description of regulatory authority and their function is outlined in table 5 (for more details see table 3 in appendix).The DBT has five testing protocols for food derived from GM crops: 1. Oral use of GM crops by testing in rats; 2. Use of rodents for long term study; 3. Check the stability of protein in the transgenic plants; 4. Digestibility of Pepsin; and 5. Finally studies of GM crops by feeding GM crops to livestock (ABLE, 2012).

Table 5. A brief overview of the Regulatory Authorities and their Role

Name of Authority	Role
Institutional Biosafety Committee (IBSC)	To approve category I and II experiments. Recommend and seek approval of RCGM for category III experiment
Review Committee on Genetic Manipulation (RCGM)	To recommend and seek approval of RCGM for category III experiments
Genetic Engineering Appraisal Committee (GEAC)	To approve large scale use, open release to environment. Inform decision to administrative ministry and applicants/investigators to follow PVP/Seeds Act
Indian Council of Agricultural Research (ICAR)	Gather agronomic information or data on transgenic
State Biotechnology Coordination Committee and District Level Committee	To visit trials site, analyze data, inspect facilities, and recommend safe and agronomic viable transgenic practices.
Category I: Experiments that involves non-pathogenic and non-infectious viral, bacterial or fungal DNA. Category II: Experiments that involves infectious or pathogenic organisms that are not potentially dangerous or infectious. Category III: Experiments that involving whole organisms that are potentially harmful, pathogenic and infectious to humans and the environment	

Source: Association of Biotechnology Led Enterprise, 2012

The Cartagena Biosafety Protocol is an international agreement that advocates and ensures safe use of living modified organism by taking into consideration the risks associated with human health and limits the negative effects of modern biotechnology on biodiversity. As of 2003, India is obligatory to the Cartagena Biosafety Protocol. The safety guidelines on assessment of food derived from genetically modified crop in India meets international standards.

3. Challenges in Commercialization of Bt Brinjal (Egg Plant)

The first food crop to reach the approval stage for commercialization in India was bt brinjal. The crop development started in 2000 followed by approval application from RCGM for small and GEAC for large field trials in 2004 and 2007, respectively (CEE, 2010). The development of bt brinjal was a public private[7] partnership of national and international organizations. Based on concerns raised by different stakeholders, extensive consultation of two expert sub committees was instituted by GOI in 2007 and 2009. The second expert subcommittee had submitted its report to GEAC which approved the release of bt brinjal on 14 Oct 2009. However, there was a strong concern on the biosafety of bt brinjal raised by different stakeholder for and against the release of bt brinjal for commercial cultivation. Therefore, the MoEF has initiated a nationwide consultation of stakeholders in early 2010 and has kept the final decision pending (CEE, 2010). The bt brinjal has taken about 9 years for product development and approval process, and 3 years out of 9 years in getting approved by regulatory authorities for commercial cultivation.

A brief timeline on the development of GM rice in India is outlined in table 6. The initial genetic engineering lab trials in rice were initiated by national public and private organizations later lead by international private organizations.

Table 6. Chronology on the Development (lab and field trials) of GM Rice in India

Year	Targeted Trait	Organization
2006	Insect Resistance Iron Enhancement	Mahyco, Indian Agricultural Research Institute (IARI), Tamilnadu Agricultural University (TNAU)
2007	Insect Resistance	Mahyco
2008	Insect Resistance	Bayer Bioscience Pvt Ltd
2009	Insect Resistance	Bayer Bioscience Pvt Ltd
2010	Insect Resistance, Herbicide tolerant Insect Resistance, Yield Enhancement	Bayer Bioscience Pvt Ltd Metahelix Life Sciences Pvt. Ltd.BASF India Ltd.
2011	Insect Resistance	E.I. Dupont India Pvt. Ltd
2012	Herbicide Tolerant Salt Tolerant	E.I. Dupont India Pvt. Ltd Monsanto

Source: IGMORIS, GEAC

4. Non-Governmental Organizations

Civil groups or NGO's have been on the offense on the use as well as adoption of GM crops without understanding the positive agronomic and economic effects. Some of the leading organization that are vocal about GM crop at national level are Gene Campaign, Research Foundation for Science, Technology and Ecology[8],M.S Swaminathan Research Foundation (MSSRF), Tata Energy Research Institute (TERI).Greenpeace India is an umbrella organization under the Greenpeace actively involved in disseminating information on anti GM activities (reports, seminar, and publications). The organization has a strong presence in India since 1995. Likewise, other international organizations like Ford Foundation, Oxfam, Action Aid and Christian Aid have no position on GM crops. As far as farmers organizations are concern some of the most anti GM organization at regional and national levels are Karnataka RajyaRaithaSangathana (KRRS) in Karnataka,and BharatiyaKisan Union (BKU) respectively. Shetkari

[7]Agricultural Biotechnology Support from Cornell, Bt Technology from Maharashtra Hybrid Seed Company Ltd, and Field Trials support from Tamil Nadu Agricultural University, Coimbatore, University of Agricultural Science, Dharwad, and Indian Institute of Vegetable Research, Varanasi

[8] Organization led by Dr.Vandana Shiva one of the leading opponent of GM technology (http://www.vandanashiva.org)

Sangathana in Maharashtra is one of the farmers organization that favors use of GM technology in agriculture. At national level different government organizations have voice their opinion to reflect the opinion of their stakeholders. The opinions are based on institutes vested interested in GM crops. Agricultural Processed Food Products and Export Development Authority (APEDA) under the Ministry of Commerce (GOI) has no official position on the GM technology; however, the organization is concerned about its changing role in promoting Indian agricultural exports overseas where there is no acceptance of GM crops. The organization promotes both organic and inorganic agricultural products (processed and raw) overseas but with wide adoption of GM crops in India there will be legal and phytosanitary challenges in promoting Indian agricultural exports.

There are about 22 public institutes of which 11 are actively involved in GM testing. In India, some of the most active trade organizations that can actively lobbying for promoting agricultural biotechnology are Confederation of Indian Industry (CII) and Federation of Indian Chamber of Commerce and Industry (FICCI). However, these organizations are focused on the pharmaceutical sector of biotechnology rather than on agricultural biotechnology. The two important organizations that are active in promoting of biotechnology are Association of Biotechnology Led Enterprises (ABLE) and All India Biotech Association(AIBA). The ABLE was established in April 2003 as a nonprofit organization that representing 270 members from agricultural biotechnology, pharmaceutical, banking, academic and others sectors of biotech industry. The organization objectives is to promote biotechnology through advocacy for optimal policies and regulation of biotech research, promote entrepreneurship, network industry professional and promote Indian biotechnology at national and international trade shows and conferences. Similarly, AIBA was established in 1994 as a non-government organization to promote biotechnology in India. The main objective of AIBA is to promote and safeguard interest of its member and promote biotechnology in every aspect of Indian society. Likewise, Biotech Information Center (BIC) promotes collaborative conferences on agricultural biotechnology. Furthermore, other organization that promotes crop biotechnology in India are the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), The Energy and Resources Institute (TERI), International Life Science Institute (ILSI), the Foundation for Biotech Awareness and Education (FBAE), Barwale Foundation, the National Seed Association of India (NSAI), Asia Pacific Consortium on Agricultural Biotechnology (APCoAB) and the Trust for Advancement of Agricultural Sciences (TAAS).

C. History and Development of Current Biotechnology and GM Policy

The sixth 5 year plan (1980-1985) initiated the policy formulation for biotechnology development in India with Council for Scientific Industrial Research (CSIR) responsible for coordinating different agencies. Based on the five year plan the National Biotechnology Board (NBTB) was set up for development of biotechnology in India with a member of the planning commission being the chair and other members from the Department of Science and Technology (DST), CSIR, ICAR, Indian Council of Medical Research (ICMR), Department of Atomic Research (DAE), and the University Grant Commission (UGC), (Maria et al. 2002). The objectives of NBTB were too broad, ranging from food security to employment and international trade (Maria et al. 2002). In 1986 the NBTB was replaced by a new government body, the Department of Biotechnology (DBT), under the Ministry of Science and Technology. The current role of DBT centers on the development of human resources, the promotion of biotechnology (e.g., by setting up biotech park) and regulate other aspects related to biotechnology such as IPR, trade, and investment).Two biotech sectors in India have received lots of attention from domestic and international media. They are agricultural biotechnology and health care biotechnology largely due to its complex research which attracts investment in research and development and potential for wide application that can benefit Indian society (Maria et al. 2002). At present there are numerous public and private organization working on genetically modified crops in India. However, private organizations are in the lead for commercialization of the GM technology with respect to product innovation and their ultimate marketing. Based on Randhawa and Chhabra (2009) assessment, from 1997 to 2008 there have been about 79 imports of transgenic research material, of which private companies account for about 85 percent. Monsanto, Bayer, Mahyco, and Syngenta were the major importers of transgenic material. In the case of rice, there were 13 private and 7 public imports of transgenic material (Randhawa and Chhabra, 2009). As of April, 2012 the GEAC has permitted Bayer Bioscience Pvt Ltd to conduct selection trials[9] for different rice events at three different agro climatic zones (GEAC, 2012). Likewise, salt tolerant GM rice event selection trials are currently conducted by Monsanto and other event trials are conducted by Metahelix Life Sciences (GEAC, 2012).

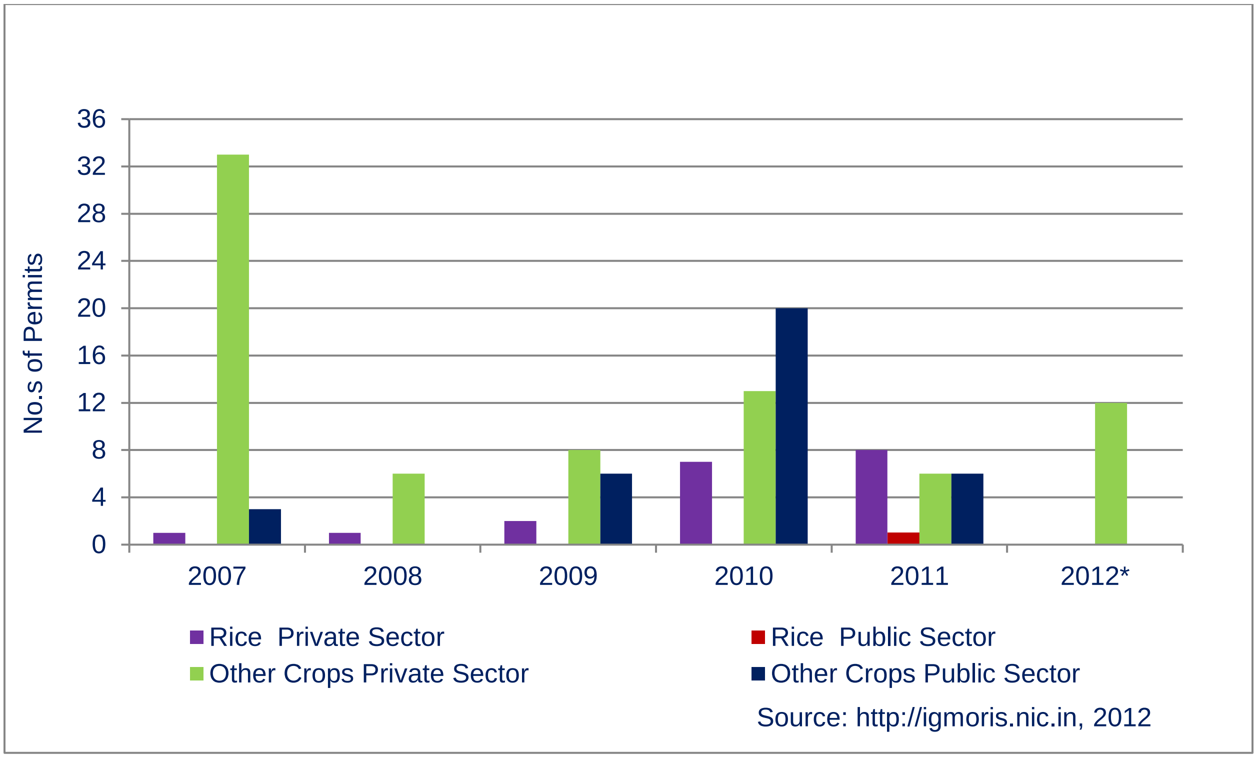


Figure 5. Approved Field Trials of GM Crops based on Permits Issued by GEAC from 2007-2012

The figure 5 depicts the frequency of GM crops field trials by source of permits. The statistics clearly revels that the private sector has a comparative advantage over public sector in conducting field trials and possible commercialization of GM technology. Likewise, there has been a gradual increase in permit approvals to conduct field trials starting with one field trial in 2007 and reaching 9 field trials in 2011.

1. The Status of Intellectual Property Rights

The Patent Act of 1970 does not allow patenting in the agricultural sector, but in order to comply with the Trade-Related Intellectual Property Rights (TRIPS) agreement, India has made changes to its law (Speilman et al., 2011). Based on the 2001 Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, there is legal protection offered to registered seed varieties developed by a breeder or farmer but there are no specifics on offering of any patent rights.

[9]Event Selection

2. The Status of Seed Policy

The seed policy has evolved from the Seed Act of 1966, which regulates the quality of certified seeds, to the Seed Control Order of 1983, which regulates and licenses the sale of seeds, including transgenic seed (USDA, 2012). The seed policy in India is developed by the Ministry of Agriculture. As per the seed policy, The Environmental Protection Act (EPA) of 1986 has mandatory testing guidelines and regulations for environmental and bio-safety of all biotech crops before their commercial release. Similarly, all imported biotech seeds are reviewed and approved for research purposes as well as tested for agronomic potential by two federal agencies the National Bureau of Plant Genetic Resources (NBPGR) and ICAR respectively (USDA, 2012). The new 2004 seed bill known as the Seed Act[10] was introduced in the parliament in December, 2004 with final parliamentary approval still pending. One of the identified hurdles in commercialization of biotech crops was the price of the technology or price of seed. There is no policy mechanism to regulate the price of seed or technology (USDA, 2012). Therefore, seed companies and technology providers are free to charge whatever price they feel is appropriate for their seed or technology. However, individual state governments[11] have argued in case of bt cotton that technology fees are too high and there should be fair pricing structure for farmers. The legal battle between state and seed companies has reached the Supreme Court and the decision of intervening the seed market is still pending. The GOI is committed to promote the development of seed industry for instance, by giving attractive conditions to encourage FDI (Economic Survey, 2012). In case of rice, based on government data and firm level surveys conducted by Pray and Nagarajan (2012) the new seed cultivar[12] of rice in India have doubled from 1990 to 2010. To add further the survey concluded that private investment on seed and plant biotechnology sector grew more than 10 times from 1990 to 2009.

Table 7. Change in Number of Notified Rice Varieties[13] from 1980 to 2012

Number of Notified Varieties and Hybrids by Decade				
Crop	1980-1989	1990-1999	2000-2010	2011-2012
Rice	198	188	303	41

Source: Pray and Natrajan, 2012, Diwakar and Arvindkumar, 2012

The Table 7 outlines the number of notified cultivar release every year in India; there is increase in number of notified varieties registered with GOI. The commitment of GOI to regulate rice seed production and distribution with respect to seed quality is revealed by the numbers in table 7. At same time GOI is making a genuine attempt to counter bio-piracy in rice seed market.

3. Regulation on Food derived from genetically modified organisms

Based on the Food Safety and Standards Act of 2006, the GOI has unified the food law to regulate food products derived from genetically modified organisms under a single authority called as the Food Safety and Standard Authority of India (FSSAI) (USDA, 2012a). The FSSAI will be responsible for implementing and formulating science based international standards (The Cartagena Protocol on Biosafety) on biosafety (USDA, 2012a)

4. Labeling of GM food

Labeling regulations of GM foods is yet to be finalized, although the Department of Consumer Affairs (DCA), under the Ministry of Consumer Affairs, Food and Public Distribution has unilaterally introduced regulation on labeling of all packages containing genetically modified food with the word GM (USDA,

[10]For more details refer http://agricoop.nic.in/seeds/seeds_bill.htm

[11]In January, 2006 Government of Andhra Pradesh argued against biotech firms by filing a complaint under Monopolies and Restrictive Trade Practices Commission (MRTPC) that technology fees were exorbitant.

[12]Cultivar is a product of Intentional Breeding Program

[13] The Seed Act states that only certified seeds are notified varieties .A statutory function of the Central government to regulate the quality of seed during sale under the Seed Act.

2012). However there was no consultation between DCA and other government agencies/stakeholders. As of January 2013, all GM food products are subject to mandatory labeling under the order of Ministry of Commerce (MCA).

5. Trade Policy in GM crops

In 2006, MoEF published procedure guidelines for GEAC on imports of GM products where as Ministry of Commerce and Industries notified that all GM imports must be approved by GEAC. The delegation of authority to GEAC regarding approval of GM crops for imports streamlined the process (USDA, 2012). As a result of which in 2007 the GEAC permanently approved import of soybean oil derived from glyphosate tolerant soybeans for consumption in India (USDA, 2012). However, no other GM food product (grain processed or unprocessed) is allowed for imports in India. India has imported a large amount of corn from GM corn producing countries to meet its poultry feed requirement. However, the GOI and consumers are unaware whether any of the imported corn was GM as India does not have GM crop testing facilities at the port of entry (Deodhar et al. 2008). Imports of plant genetic material, seed or any germplasm of genetically modified for research purpose is regulated by the National Bureau of Plant Genetic Resources (NBPGR) under the Plant Quarantine Order (PQO) of 2004 (USDA, 2012).

D. Identification of the Political, Legal, Regulatory and Socio-Economic Barriers to the Acceptance and Use of GM Rice.

1. The political landscape

The political parties' position on GM technology and their representation in coalition government are two important elements that can help us understand acceptance and use of biotechnology in the Indian society. Similarly, delegation of power between state and central government need to be assessed in order to understand who is in charge of making rules and regulations with respect to GM technology. The state governments in India have gain reasonable authority with respect to decision making in recent years and have performed differently on their commitment to use and adoption of biotechnology. As of June 2013, GEAC has granted permission to Bayer Bioscience Limited to conduct open field trails all over India but permission to conduct field trials at individual state level are still pending (Sethi, 2013). The GEAC has approved Bayer Bioscience Limited to conduct 45 transgenic rice events trial that include testing insecticidal protein (Cry1Ab and Cry1Ca) against stem borer(Kurmanath, 2013).

All major political parties lack coherent support to pro poor agenda except the (Left parties) and get electoral support based on religion and caste politics but they wisely use populist item such as free or subsidized electricity to farmers, writing off debt of the farmers to get elected. The Left parties[14] in India for past few decades account for 15 percent of the national assembly. They support food and agricultural input subsidies and not against agricultural technology but are skeptical about innovations in plant biotechnology products sold by private and multinationals (Ramaswami, 2007). There is a decline in the ratio agricultural output to amount spending in agricultural research and no political parties has agricultural research spending as its priority (Ramawami, 2007). The historical context in adoption of bt cotton in India can develop our understanding regarding the position of political parties with respect to bt technology. Political parties in India have remained neutral about bt technology and all debates and decision making happened in courts, regulatory offices, and respective ministries[15] (Ramaswami, 2007). Based on the experience of bt cotton, bt mustard and bt brinjal all battles between proponents and opponents of agricultural biotechnology fought with the regulatory agencies. Based on Ramaswami's

[14] Is lead by Communist Party of India (Marxist),Community Party of India and other regional parties that have common socialist objectives and pro poor agenda.
[15] Department of Biotechnology, Agriculture and Environment

(2007) assessment of bt cotton the DBT was supportive, while Ministry of Agriculture was defensive on the use of GM technology. In case of biofortification, Indian health officials, nutritionists, scientists that are members of different commissions and committees are strong allies in favor of it (Ramaswami, 2007). But it is still unclear if these allies would favor golden rice or bt rice in India.

The political discourse used by epistemic brokers against bt cotton narrative is very powerful as it alleged Monsanto of being a powerful multinational corporation exploiting small Indian farmers with a technology that is unnatural and exploitative (Herring, 2009). The argument of Dr. Shiva[16] and her associates have systematically persuaded the general public about potential dangers of bt technology or biotechnology application in agriculture by linking the technology and the concept of Intellectual Property Right (IPR) to neo colonial threat to national food security. In order to address public concerns over the terminator technology[17] or terminator gene within bt cotton, the Government of India , DBT had banned use of any such technology in India (Herring, 2009). However, something unexpected had happened in absence of proper regulation with respect to bio-safety. Illegal seeds or prototype of bt cotton developed by MahycoMonsanto Biotech (MMB) had worked its miracle with Indian farmers, and the area under legal and illegal cotton expanded rapidly (Herring, 2009). Based on DrKranthi's limited sample survey at Central Cotton Research Institute (CCRI), on average 28 percent of illegal bt cotton seed does not have bt gene, with only 26 percent of bt cotton is first generation true hybrid and 46 percent of the sample was contaminated with non bt cotton (Herring and Khadilkar, Herring, 2009). The bottom line is most of bt seeds in the Indian cotton seed market are not bt or partly have some traits of bt cotton. There are two main reason to the above problem first, lack of monitoring and enforcement of intellectual property right. Second, high cost of legal bt seeds creates market for illegal seeds which are cheap and affordable for small and marginal farmers of India. The fallout of above problem is that illegal seeds are the major cause for failure of bt cotton seeds among many other agronomic and economic problems. The enforcement of proper intellectual property rights in most of the developing countries is practically impossible due to high transaction cost, politics and law (Herring, 2009).

2. Legal Challenges

In 2012, the GOI has drafted a bill to establish the Biotechnology Regulatory Authority of India (BRAI), an autonomous and statutory agency responsible for regulating research, transport, import, manufacturing and use of organisms and products of modern biotechnology (PIB, 2012). The BRAI will address shortfall in current regulatory system of multiple ministries and committees and will streamline the regulatory process under a single authority without altering the power of state governments (Chaturvedi et al. 2012). The structure of the proposed BRAI will have a chairperson, two fulltime and two part-time members who are subject matter specialist in Agriculture, Health Sciences, Environment and Biology (PIB, 2012). The other two major supporting institutes of BRAI will be Inter-ministerial Governing Board and National Biotechnology Advisory Council to administer the performance of BRAI and review use of biotech products in society respectively. The BRAI will have provision for public to express their views/concerns to authorities on a biotech product before the approval (Rao, 2012, Chaturvediet al.2012). As mentioned earlier the rules and regulations on the safety of biotech products for state may be different from the central government. So, there is possibility that GM products approved by central government may not be approved for cultivation in a particular state based on the individual states concern regarding safety of biotech products (Rao, 2012).

[16]Dr Shiva's Research Foundation for Science, Technology and Ecology promotesbiodiversity conservation, support local farmers, and create awareness on the hazards of genetic engineering.
[17]Terminator gene is a technology which makes genetically modified seeds sterile after being planted once.

3. Regulatory Challenges

Based on the review of current regulatory system for approval of GM crops, there are two major regulatory barriers. First; there is a high cost as well as time involved in the approval process. Second, there is clearly lack of enforcement of IPR (Spielman et al, 2011). The above assessment of regulatory hurdles is based on experiences in the approval of bt cotton, bt mustard, and bt brinjal.

To be specific, the estimated cost incurred by MMB for bt cotton from 2001 to 2003 at the pre-approval regulatory stage was about 1.8 million USD (Pray, Bengali and Ramaswami,2005). In 2002-2003, about 4 to 5 million USD were spent by Pro-Agro and PGS for its product, the herbicide tolerant mustard for advanced regulatory process with 0.1 million USD additional in 2005 for testing at the request of GEAC (Spielman et al.2011). To address concerns of major agricultural biotech firms even if we assume that strict testing for genetically modified crops until it is approved for commercialization is an expensive. But, if there is uncertainty regarding getting the product approved for commercial cultivation even after following strict testing protocol creates risk for in investing in development of GM technology. . Based on Spielman et al. (2011) personal interviews of agbiotech industry leaders, an argument was made by the industry representatives that the regulatory uncertainty will have a negative impact on firms willingness to participate in Indian agbiotech market.

4. Socio- economic barriers

The impact of GM rice on human health, and environment need to be understood and assessed using protocols that are grounded in both theory and practical application. In response to the ongoing debate on adoption of bt brinjal socio economic barriers need to be considered. Based on their own scientific and socio economic assessment, central and state governments had different opinion on adoption of bt brinjal (Chaturvedi et al. 2012). There was lack of a mutually-agreed single method to assess the long term impact of GM crops on human health and environment and the economic benefits of GM crops is assessed largely by evaluating agronomic performances. The revised guidelines for research on GM crops and for toxicity and allergenicity evaluation of transgenic seeds, plants and plant parts should be generate information on economic advantages (GOI). Although there is environmental objective but most of the provision in guidelines are on the evaluation of agricultural production, trade and commerce (Chaturvedi et al. 2012).

In the proposed BRAI bill of 2012, the Socio-Economic Consideration (SEC) of the biotech products will be handled by individual ministries/authorities (Chaturvedi et al. 2012). Although, delegating the regulatory power to a single authority can have advantages with respect reducing the time for approval of GM crops. However, based on Chaturvedi et al. (2012) assessment BRAI should not be making both policy making and regulations as the field of biotechnology is very diverse where in Ministry of Agriculture is the competent authority to make SEC assessment of agricultural biotechnology and Ministry of Fishery is ideal for SEC assessment of Marine Biotechnology.

5. Golden Rice in India

India has one of the largest numbers[18] of children suffering from Vitamin A Deficiency (VAD). In 2009, India had about 44 percent of children under age 5 underweight, 48 percent stunted and 20 percent wasted (ADB, 2012). The use of golden rice is often recommended by researchers as a cost effective tool to address VAD. Stein et al. (2006) conducted and analysis of alternative ways of addressing VAD in India, and concluded that one of the most effective solutions was the inclusion of golden rice in the diet.

[18] In India about 330,000 children die due to VAD every year (WHO)

6. Bt Cotton in India and learning experiences

The DBT first approved Mahyco Monsanto Biotech (MMB) to conduct research on bt cotton in India in 1998. Later in 2002, GEAC approved the commercial cultivation of btcotton throughout the country. Inspite of numerous regulatory challenges and negative publicity of bt cotton acceptance/adoption, it is a success in India in every aspect of socio-economic analysis. Kathage and Qaim (2012) study of bt cotton farmers states that farmers who adopted bt cotton increased their per acre yield by 24 percent and profits by 50 percent. In 2013, Qaim and Kouser analysis concluded that bt cotton farmers experienced 15 to 20 percent decrease in food in security.

Based on Herring's (2009, 2010) construct the epistemic brokers in India have systematically used various stories such as multinational biotech companies having monopoly over Indian seed market, high costs and low yields and debt ridden Indian farmers due to use of bt cotton, end of biodiversity due to genetic contamination of bt cotton cultivation and many more stories to generate negative perception of bt technology in general public. However, farmers in India had started cultivation of bt cotton using Navbarath 151[19] before the official approval of MMB by the GOI. There was no initial government as well as civil society intervention to stop the spread of illegal bt cotton seeds in the Indian market (Herring, 2009). The laws regulating transgenic organisms were violated and none of the epistemic broker paid detailed attention to the event.

The supply side benefits of the GM technology are represented by studies of Stein et al. (2006) and Neilsen and Anderson (2000). The Neilsen and Anderson (2000) estimated that with the introduction of GM rice varieties in India there would be an overall benefit of 1.18 billion USD per year at 1995 dollars. However there are few studies that focus on the demand side of GM food and GM rice. The Contingent Valuation (CV) study of Deodhar et al. (2008) concluded that price was an important factor for acceptance of GM foods. The same study indicated that consumers were willing to pay a premium of 19.5 percent extra for GM rice in a sample of population that had extremely low understanding of GM technology. Likewise based on Bansal et al. (2010) study on GM foods the more information consumers have on GM food the more likelythey have an anti GM view. Furthermore, consumers were willing to pay premium for GM wheat when no information was provided to them regarding its positive and negative effects (Anand et al. 2007).

E. Critical Assessment of Barriers to the Acceptance and Use of GM Rice

1. Agronomic Challenges

In order to meet challenges of climate change such as water scarcity and droughts there is development of drought resistant GM rice at present but there is no product in pipeline (Gaudin et al. 2012). As testing of GM rice under different agronomic condition requires large number of open field trails (Mittler, 2006) which are currently restricted to private sector. The public sector organizations lack biosafety regulations and finance to carry open field trials (Gaudinet al.2012). In India, there is clearly lack of large scale field trials due to delay in the regulatory process for approval.

Similarly,based on recommendation of the task force on agricultural biotechnology under the supervision of Dr M.S Swaminathan it was concluded that "important centers of origin, and diversity should be protected so as conserving precious agro-biodiversity in their pristine purity". Furthermore, the report clearly state that cultivation of GM crops in agro-biodiversity sanctuaries (wildlife sanctuaries and national parks) should be prohibited (Chaturvedi, et al. 2012). As rice is cultivated in almost every state of

[19]Navbharath 151 was stealth/biopirated seed developed by Navbharath Seeds in Gujarat Ahmadabad India, using Cry1Ac illegally derived from Monsanto (Roy et al, 2007).

India the above recommendation would be a hurdle for GM rice cultivation as there is agro biodiversity in every corner of the country.

2. Yield and Per Capita Land Availability

Since 2011, bt cotton in India is cultivated on 26 million acres by 7 million farmers accounting for 90 percent of total cotton area (Kathage and Qaim, 2012). The results of bt technology adoption in cotton with respect to time are evident, in a period of about 9 years the technology is adopted by large number of farmers. Based on Kathage and Qaim (2012) study bt cotton in India increased the per acre yield by 24 percent and delivered profit of 50 percent to small land holders[20]. There is a concern of GM crops that they do not deliver the expected output at farmers' level especially in developing countries like India where the average land holding is 1.06 ha[21].

The success of bt cotton in India is commendable but it remains to be assessed whether similar success can be achieved in adoption of bt rice. The average land holding of rice farmers is less than cotton farmers therefore, both increase in yield and profitability with use of GM rice in India needs to be investigated.

3. Regulatory Authority

The decision made by the government of India with respect to ban on commercial cultivation of bt brinjal in response to public protest was a big setback to plant biotechnology research and development. The reason stated by the government panel investigating concerns on commercialization of bt brinjal in response to public comments stated that there are better options to increase food production than GM technology (Jayaram and Jia, 2012). There is no economic and scientific study to challenge or argue on the decisions made by the GOI with respect to ban on bt brinjal cultivation. Likewise, the process and duration of getting approval from states to conduct field trails in their respective jurisdiction is time consuming, slowing the process of GM research (Jayaram and Jia, 2012). As mentioned earlier, uncertainty in getting a product approved for commercial cultivation would limit investment of biotech companies. Furthermore, based on the article by Chandrasekar (2012), the Western Ghat Ecology Panel (WGEP) in 2011 issued a report that GM crops are a threat to India's plant genetic biodiversity. Based on those reports the GOI, GEAC made no comments on the use of GM technology in food crops. However, as of June 2011 the GEAC has made it mandatory that agricultural companies must have permission from the states to conduct research trials, as a result of which so far 24 states have said no to such trials. The role of regulatory authority (GEAC) is crucial in commercialization of GM rice and other GM products, and it is strategic in balancing concerns of different stakeholders. The political leadership is expected to be silent on the issue of GM rice. However, the bureaucracy will take the same stand as it took for bt cotton and bt brinjal by advocating multiple test until there is less resistance to commercialization of GM rice.

4. Biosafety

The central government of India is the only authority responsible for approval of GM crops in India and state government has their individual right whether to allow fields trials in their jurisdiction. There is a clear guideline set by the GOI on procedures and regulations on approval of GMcrops at every stage of research trials to their final commercialization. The state governments have historically taken proactive position on bt cotton cultivation to favor farmers before the actual approval of central government. To be specific the state government of Gujarat and Maharashtra had approved cultivation of bt cotton before the government of India. In early years of 2003, some of the most successful bt cultivars on the market were

[20] The average land holding of cotton grower in India is 3 to 4 acre and farmer with land holding of less than 15 acres are considered as smallholder farmers

[21] Average Land Holding based on National Sample Survey (NSS) of 2002-2003.

developed illegally from the Monsanto's Cry1Ac technology (Roy et al.2007). The stealth seeds were already in market three years before the actual approval of bt cotton (Herring,2009). The Cry1Ac bt gene developed by Monsanto was found in NB151 (illegal cotton hybrid developed with Monsanto bt gene) the state government was reluctant to stop the spread of illegal bt cotton seed (Ramaswami, 2007). The state government will be strategic in their decision making on the acceptance and use of GM rice as long as it is in the vested interest of the state and will possibly use regulatory loopholes either to make excuse or favor GM rice cultivation.

5. Technology Pricing and Illegal Seeds

Based on the biopiracy experiences with respect to bt cotton in the state of Gujarat, it is crucial to understand the rice seed market to improve the odds of a successful diffusion of GM technology. The regulatory agency in India can stop the spread of illegal seeds in two ways. First, it can enforce strict rules and regulations on public and private agencies responsible for conducting field trials. Second, streamline the approval process of GM products already developed to stop the spread of illegal seeds. Currently, there are a large number of GM rice field trials (Chart 2), which is a recipe to start illegal GM rice seed industry. As mentioned earlier illegal GM rice seeds will be cheaper and readily accepted by farmers as witnessed in bt cotton. The theft of GM rice germ plasma and its subsequent replication for illegal seeds is very difficult to counteract due to lack of strict biosafety and intellectual property right. Indian farmers need cheaper GM seeds it does not matter if they are legal or illegal. The national and state political leadership is less likely to intervene into the seed market to make legal seeds cheaply available or stop spread of illegal seeds if the GM technology increases rice yields and revenue to farmers. The government intervention (central or state) in GM rice seed market on behalf of the farmers can either by carried out by having a partnership with private sector or licensing the GM rice technology from private sector. As witnessed in collective action taken by state government of Andhra Pradesh against MMB regarding fixingthe cost of bt cotton seed that is affordable to farmers.

6. Epistemic Broker

The epistemic brokers in India have systematically used high information cost on the knowledge of genetic engineering, lack of authoritative knowledge on verifiable facts on negative impacts of bt cotton to their advantage (Herring, 2009).The opponents of biotechnology are grounded into facts that monopoly and control of seed market by multinationals (Herring, 2009). The organizations led by Dr Shiva have 3000 native species of rice to preserves biodiversity. Dr Shiva is expected to be the biggest critics of GM rice and has argued in favor of the biodiversity and use of indigenous knowledge. However, her strongest opposition to golden rice (GM rice)is interpreted in her essay "Golden Rice" Hoax–When Public Relations Replaces Science". The epistemic brokers in India will systematically exploit work of multinationals in GM rice to their advantage by use of neo colonial invasion of rice seed market. The idea of neo colonialism will be exploited using the historical context of Bengal famine when British colonist exploited Indian rice farmers.

7. Cost of Golden Rice

There is enormous potential for golden rice. However, there are two major problems with respect to its adoption and acceptance. First, as there is no commercial production of golden rice in India, little is known about its actual production, consumption, storage, cooking and availability of vitamin A from golden rice (Dawe and Unnevehr, 2007). Second, based on Steins (2006) estimates the disaggregated cost of commercialization of golden rice in India would be as follows; cost of development in India $ 4.1 to $ 8.7 million, regulatory cost $ 2.2 -2.5 millions, and promotion and marketing of golden rice $15.6 – 30.7 millions. There is a huge cost involved in bringing golden rice from laboratory to field. The most important question is who will pay for the commercialization of the technology.

8. Technology Communication Challenges

The Department of Biotechnology and Ministry of Environment and Forests (MoEF) were unsuccessful in communicating the information of biotech crops with respect to their safety in production and consumption (Choudhary and Gaur, 2011). A comprehensive public relation campaign is a must for adoption of GM rice.The MSSRF, based on their surveys in Indian villages, found that people in rural communities have less understanding of GM crops in India and advocate the need for public education on GM crops. The organization is actively promoting breeding programs on biofortification of rice with iron and is pragmatic about its approach towards use of biotechnology applications in agriculture as long as it meets the organization objectives (MSSRF, 2012).

9. Public Interested Litigation (PIL) by Non Government Organisations (NGO)

The Indian legal system has played a dual role of regulating biotechnology research and development in India. The court system in India supervises state institution's responsible for regulating biotech research and permits public participation in policymaking process related to genetically modified crops.

The PIL is a writ petition that can be submitted to the Judge of APEX court (Supreme Court in most cases) by an individual who may be directly or indirectly affected by any social or personal issues such as human right violations or environmental issues. The PIL has been pursued by NGO's in India to petition against environment pollution, disturbance of ecological balance, and other issues of public importance (Supreme Court of India, 2003). The simplicity of the PIL process has been used by anti gm activist like Vandana Shiva, Suman Sahai, Aruna Rodrigues, Prashant Bhushan and Kavitha Kuruganti to place a moratorium on release of bt brinjal and restrictions on the recommendation made by the parliamentary standing committee and the Supreme Court-appointed technical expert committee (Times of India, 2014).

As mentioned earlier some of the most notable PIL with respect to the genetically modified crops are presented chronologically as follows in the next section. In 1999 Dr. Vandana Shiva, founder of the Researcher Foundation for Science, Technology and Ecology filed a PIL in the Supreme Court of India in order to protect ecological and economic security of farmers. The litigation argued that the regulatory regime under the RCGM did not have authority to authorize field trials of genetically modified crops under the bio-saftey rule of 1989 and any such trial of gm crop would be treated as unintentional release and violation of national biosaftey law (Damodaran, 2005). Later in 2004,and 2006 the Gene Campaign filed a PIL with respect to regulatory structure and deregulation of processed food that contained gm ingredients respectively (Freeman et al. 2004).

The most landmark PIL was filed by Aruna Rodrigues before the Supreme Court of India in 2005, in which she argued that field trials should be carried out after a comprehensive rigorous scientific, biosafety assessment of GE crops. In 2006, Suman Sahai and Gene Campaign filed a PIL seeking for more moratoriums on GE technologies (Freeman et al.2004). As a result of their PIL a halt was placed on release of new crops till 2008. However, in 2008 again Aruna Rodrigues filed a new PIL based on precautionary principle arguing that biosafety test are need to be carried out to protect citizens from major health hazards. As per her PIL, GE seeds had a potential to cause harmful effects. The PIL with respect to biotechnology regulatory system more robust are genuine when we look at the case of unregulated gm cotton seeds in India. The Indian regulatory system has struggled with the legitimacy of the system and its inability to restrict the spread of unregulated genetically modified seed (Freeman et al. 2011).

As per Dembrowski (2001), the PIL aspect of Indian legal system has actually undermined the benefits the system offers and has resulted paralysing the Indian legal system in three ways: first majority of stakeholders, who are rural, marginalized and non-english speakers do not have access to PIL system. Second, the entire process of administration of PIL is slow and burdensome. Third, there are challenges in actual enforcement of court rulings with respect to PIL. To conclude the PIL has shaped Indian biotechnology regime by changing composition of GEAC committee but it has also created delay in conducting field trial as well as approval of gm crops in India (Freeman et al. 2011). The PIL system has been used by selected members of civil society using judiciary to insert them in the decision making process but concerns regarding the marginal farmers are not represented as they may have no issues with acceptance and use of gm crops in India. It is not clear if the above mentioned small groups may or may not represent the opinion of the Indian society regarding acceptance and use of genetically modified crops. As per Rajamani (2007) it seems like PIL has been used by a small group of unelected urban people to shape agenda in policymaking debate with respect to genetically modified crops

F. Conclusions

The GM rice policy in India is at a crossroad given the increasing involvement of different agencies that have complicated the actual approval procedure for GM crops. GM rice is still restricted to small and large scale field trials in different parts of the country. The lessons from bt brinjal, bt cotton and bt mustard would definitely mean that commercialization of GM rice will be time consuming under the current regulatory framework. However, if the current biotech policy is revised and the approval process streamlined there would be chance for early commercialization of GM rice.

India has one of the largest area under rice cultivation, so the impact of GM rice technology on agro-biodiversity needs to be considered by conducting multi-location open field trials. There is no conceptual framework and methodology on how to evaluate the socio-economic impact of GM crops in India (Chaturvedi et al. 2012).Rice farming is primarily a subsistence activity, and the role of GM technology needs to be assessed by taking into consideration the socio economic impact of GM rice.

A systemic approach to address contentions with respect to GM technology on low information to farmers, and high information costs to consumers is need to counter epistemic brokers narratives on gm technology. The golden rice is identified by Stein (2006) as one time and cost-effective investment[22] to address VAD in India, but social and environmental groups are expected to be hostile toward any use of GM technology in biofortification (Ramaswami, 2007). Therefore, GM rice developed at public institutes supported by nonprofit organization may counter less resistance to technology adoption. A strict biosafety protocol is required to prevent spread of illegal seeds and protection of IPR.

[22] Provided there is no use of terminator technology

G. References

All India Biotech Association (AIBA), 2012. "Main Objectives of AIBA" http://www.aibaonline.com/objectives.html (Last accessed as of on 1/21/2012)

Anand, A., Mittelhammer, R. C., &McCluskey, J. J., 2007.Consumer response to information and second-generation genetically modified food in India. *Journal of Agricultural & Food Industrial Organization*, *5*(1).

Asian Development Bank (ADB), 2012. Food Security and Poverty in Asia and the Pacific Key Challenges and Policy Issues.Mandaluyong City, Mamila, Philippines

Association of Biotechnology Led Enterprise, 2012. Matters of Fact "GM crops and Food are Safe".

Bansal, S., Chakravarty, S., &Ramaswami, B. 2010. Weak Aversion to GM Foods: Experimental Evidence from India. *Centre for International Trade and Development Discussion Paper, Jawaharlal Nehru University*.

Central Statistical Organization (CSO) ,2011. Ministry of Statistics and Programme Implementation

Chaturvedi, S., Srinivas, K. R., Joseph, R. K., & Singh, P., 2012.Approval of GM Crops. *Economic & Political Weekly*, *47*(23), 53.

Choudhary, B and Gaur K., 2012.Communication Challenges and Convergence in Crop Biotechnology. International Service for the Acquisition of Agri-biotech Applications (ISAAA): Ithaca, New York and SEAMEO Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA): Los Baños, Philippines Editor Navarro, Mariechel J. and Randy A. Hautea.

Cohen, J. I. 2005. Poorer nations turn to publicly developed GM crops. *Nature biotechnology*, *23*(1), 27-33.

Damodaran, A (2005). Re-engineering biosaftey regulations in India: towards a critique of policy, law, and prescriptions. *Law Environment and Development Journal*, 1, 1-20.

Dawe, D., & Unnevehr, L., 2007. Crop Case Study: GMO Golden Rice in Asia with Enhanced Vitamin A Benefits for Consumers. *AgBioForum*, *10*(3), 154-160

Dembowski, Hans (2001). *Taking the State to Court:Public Interest Litigation and the Public Sphere.* Asia House,

Deodhar, S. Y., Ganesh, S., & Chern, W. S., 2008. Emerging markets for GM foods: an Indian perspective on consumer understanding and the willingness to pay. *International Journal of Biotechnology*, *10*(6), 570-587.

Dev, S. M., & Rao, N. C., 2010.Agricultural Price Policy, Farm Profitability and Food Security. *Economic and Political Weekly*, *40*(26), 174-182.

Diwakar.M.C, and Arvindkumar., 2012. Notified Rice Varieties in India during 1996-2012, Directorate of Rice Development, Government of India, Ministry of Agriculture, (Department of Agriculture and Co-operation) 250-A Patliputra Colony, Patna – 800013 Bihar.

Economic Research Service, 2012. “India Agricultural Policy” United States Department of Agriculture web-page http://www.ers.usda.gov/topics/international-markets-trade/countries-regions/india/policy.aspx (Accessed as of on Jan 5, 2013)

Freeman, J., Satterfield, T., & Kandlikar, M. 2011. Agricultural biotechnology and regulatory innovation in India. Science and Public Policy, 38(4), 319-331.

Gaudin, A. C., Henry, A., Sparks, A. H., & Slamet-Loedin, I. H., 2012.Taking transgenic rice drought screening to the field.*Journal of Experimental Botany*.

Herring, R. J., 2009. Global Rifts over Biotechnology: The VT Krishnamachari Memorial Lecture 2009, Institute of Economic Growth Distinguished Lecture Series, Delhi University, New Delhi, December.

Herring, R. J., 2010. Epistemic brokerage in the bio-property narrative: contributions to explaining opposition to transgenic technologies in agriculture.*New biotechnology*, 27(5), 614-622.

Higgins, H & Singh S. 2008. India Biotechnology Annual, Foreign Agricultural Services, GAIN Report No. IN1807.

IFPRI, 2012. Global Hunger Index (GHI) The Challenge of Hunger: EnsurIng Sustainable Food Security under Land, Water, and Energy Stresses

Indian Biotechnology Rules and Regulations, 2013.http://dbtbiosafety.nic.in/steps/steps_transgenics.htm

Indian GMO Research Information System (IGMORIS), 2012. Database on activities on GMO and Products http://igmoris.nic.in/commercial_approved.asp

Janaiah, A., & Hossain, M., 2003. Can Hybrid Rice Technology Help Productivity Growth in Asian Tropics? Farmers' Experiences. *Economic and Political Weekly*, 2492-2501

Janaiah, A., 2002. Hybrid rice for Indian farmers: Myths and realities.*Economic and Political Weekly*, 4319-4328.

Jayaraman, K., & Jia, H., 2012. GM phobia spreads in South Asia. *Nature Biotechnology*, *30*(11), 1017-1019

Kathage, J., & Qaim, M., 2012. Economic impacts and impact dynamics of Bt (Bacillus thuringiensis) cotton in India. *Proceedings of the National Academy of Sciences*, *109*(29), 11652-11656.

Kurmanath K, 2013. “Nod for field trials of 5 GM crops” Published in Hindu Business Line, June 19, http://www.thehindubusinessline.com/industry-and-economy/agri-biz/nod-for-field-trials-of-5-gm-crops/article4827421.ece?ref=wl_industry-and-economy (Accessed as of on June 19, 2013)

Maria, Augustin, JoëlRuet, and Marie - Hélène Zérah, 2002. Biotechnology in India.Research Report. New Delhi, Scientific department of the French Embassy in India and Paris, Cerna, Ecole des Mines de Paris: 247

Mittler, R., 2006. Abiotic stress, the field environment and stress combination. *Trends in plant science*, 11(1), 15-19.

MoEF, 2012. “Decisions taken in the 116th meeting of the Genetic Engineering Appraisal Committee (GEAC) held on 11.04.2012”. http://moef.nic.in/divisions/csurv/geac/information.html (Accessed as of on Dec 23, 2012)

Morisset, M., & Kumar, P., 2008. *Trends and pattern of consumption of value added foods in India*. Mimeo.

MSSRF, 2012. M. S. Swaminathan Research Foundation, Annual Report, 2011-2012

Pray, C. E., & Naseem, A. (2007). Supplying crop biotechnology to the poor: opportunities and constraints. *Journal of Development Studies*, *43*(1), 192-217.

Pray, Carl E. &Nagarajan, Latha, 2012. "Innovation and research by private agribusiness in India:," IFPRI discussion papers 1181, International Food Policy Research Institute (IFPRI).

Press Information Bureau (PIB), 2012. “Press Regulatory Authority to be Set Up on Bio-Technology” http://pib.nic.in/newsite/erelease.aspx?relid=84347 (Accessed as of on 1/19/2013)

Qaim M, and Kouser S, 2013. Genetically Modified Crops and Food Security. PLoS ONE 8(6): e64879. doi:10.1371/journal.pone.0064879

Rajamani, L.(2007). Public interest environmental litigation in India: exploring issues of access, participation,equity, effectiveness, and sustainability. *Journal of Environmental Law*, 19(3),293-321

Ramaswami, B. 2007. Biofortified crops and biotechnology: A political economy landscape for india. *AgBioForum*, *10*(3), 170-177. Available on the World Wide Web: http://www.agbioforum.org.

Scoones, I, 2008. Mobilizing against GM crops in India, South Africa and Brazil. *Journal of Agrarian Change*, *8*(2-3), 315-344.

Sethi N, 2013 “Environment Ministry ignores states opposition,approves GM trials” Published in Times of India, June 19 2013, http://timesofindia.indiatimes.com/home/environment/developmental-issues/Environment-ministry-ignores-states-opposition-approves-GM-trials/articleshow/20657469.cms (Accessed as of on June 19, 2013)

Sharma, V. P., & Jain, D., 2011. High-Value Agriculture in India: Past Trends and Future Prospects. W.P. No. 2011-07-02, Indian Institute of Management, Ahmedabad,July 2011.

Shiva, V. 2002. The “Golden Rice” Hoax–When Public Relations Replaces Science. *Genetically Modified Foods: Debating Biotechnology. Ed. Michael Ruse and David Castle. New York: Prometheus*.

Spielman, David J. & Kolady, Deepthi & Cavalieri, Anthony, 2012. "Public Expenditures, Private Incentives, and Farmer Adoption: The Economics of Hybrid Rice in South Asia," 2012 Conference, August 18-24, 2012, Foz do Iguacu, Brazil 125694, International Association of Agricultural Economists.

Spielman, David J., Kolady, Deepthi, Cavalieri, Anthony and Chandrasekhara Rao, N., (2011), The seed and agricultural biotechnology industries in India: An analysis of industry structure, competition, and policy options, No 1103, IFPRI discussion papers, International Food Policy Research Institute (IFPRI), http://EconPapers.repec.org/RePEc:fpr:ifprid:1103

Stads, G. J., & Rahija, M, 2012. Public agricultural R&D in South Asia Greater government commitment, yet underinvestment persists, International Food Policy Research Institute Washington DC and Agricultural Science and Technology Indicators, Rome Italy

Stein, A. J. 2006. *Micronutrient malnutrition and the impact of modern plant breeding on public health in India: How cost-effective is biofortification?*. Alexander J Stein.

Stein, A. J., Sachdev, H. P. S., & Qaim, M. 2006.Potential Impacts of Golden Rice on Public Health in India. In *2006 Annual Meeting, August 12-18, 2006, Queensland, Australia* (No. 25381).International Association of Agricultural Economists.

Supreme Court of India (2003). Compilation of Guidelines to be followed for entering letters / petitions receivedin this court as Public Interest Litigation (PIL).

Times of India (2014). Agriculture activists slam IB report, say it's not intelligent, by Jayshree Nandi June 15, 2014. (Accessed as of on 15 July, 2014)

U.S.Department of Agriculture, 2012a. Foreign Agricultural Service, Global Agricultural Information Network "India, Agricultural Biotechnology Annual," GAIN Report Number IN2098, 2012,

U.S.Department of Agriculture, 2012b. Foreign Agricultural Service, Global Agricultural Information Network "Grain and Feed Annual," GAIN Report Number IN2026,

Appendix:

Table 1. Area, Production and Yield of Major Crops in India 5 Year Average (2005-06 to 2009-10)

Group of Crops	Crops	Season	Area Million Ha	Production Million Tonnes	Yield Kg./ Hectare
I. Food grains	Rice	Kharif	39.36	80.38	2042
		Rabi	4.41	13.64	3092
		Total	43.77	94.02	2148
	Wheat	Rabi	27.75	77.04	2777
	Jowar	Kharif	3.43	3.54	1034
		Rabi	4.62	3.79	820
		Total	8.05	7.33	911
	Bajra	Kharif	9.26	8.29	895
	Maize	Kharif	6.96	13.04	1875
		Rabi	1.05	4.00	3813
		Total	8.01	17.04	2128
	Total Coarse Cereals	Kharif	21.97	27.32	1244
		Rabi	6.31	9.14	1449
		Total	28.28	36.46	1290
	Tur	Kharif	3.54	2.57	726
	Gram	Rabi	7.61	6.44	847
	Total Pulses	Kharif	10.65	4.99	469
		Rabi	12.27	9.32	760
		Total	22.92	14.31	625
	Total Food grains	Kharif	71.97	112.70	1566
		Rabi	50.74	109.15	2151
		Total	122.71	221.85	1808
II .Oilseeds	Groundnut	Total	6.06	6.93	1144
	Rapeseed & Mustard	Rabi	6.36	7.04	1108
	Soy bean	Kharif	8.83	9.59	1086
	Sunflower	Total	1.94	1.23	632
	Nine Oilseeds	Total	26.92	26.92	1000
III . Other Cash Crops	Sugarcane	Total	4.60	312.44	67929
	Cotton @	Total	9.35	22.66	412
	Jute & Mesta$	Total	0.92	11.10	2172
@ : Production in million bales of 170 kg. each.					
$: Production in million bales of 180 kg. each.					

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation.

Table 2. Per capita Consumption of Different Commodities in India from 1993 - 2010

Commodities	Year	Qty. consumed in a month		Qty. consumed per Annum	
		Rural	Urban	Rural	Urban
Rice	1993-94	6.79	5.13	82.61	62.42
(Kg)	1999-00	6.59	5.10	80.18	62.05
	2004-05	6.38	4.71	77.62	57.31
	2009-10	6.14	4.66	74.70	56.64
Wheat/	1993-94	4.32	4.44	52.56	54.02
atta	1999-00	4.45	4.45	54.14	54.14
(Kg)	2004-05	4.19	4.36	50.98	53.05
	2009-10	4.36	4.34	53.03	52.82
Coarse cereals	1993-94	2.29	1.03	27.86	12.53
(Kg)	1999-00	1.68	0.87	20.44	10.59
	2004-05	1.55	0.87	18.86	10.59
	2009-10	0.85	0.38	10.34	4.60
All cereals	1993-94	13.40	10.60	163.03	128.97
(Kg)	1999-00	12.72	10.42	154.76	126.78
	2004-05	12.12	9.94	147.46	120.94
	2009-10	11.35	9.37	138.08	114.05
All pulses &	1993-94	0.76	0.86	9.25	10.46
pulse products	1999-00	0.84	1.00	10.22	12.17
(Kg)	2004-05	0.71	0.82	8.64	9.98
	2009-10	0.65	0.79	7.92	9.60
All edible oil	1993-94	0.37	0.56	4.50	6.81
(Kg)	1999-00	0.50	0.72	6.08	8.76
	2004-05	0.48	0.66	5.84	8.03
	2009-10	0.64	0.82	7.74	9.95
Banana	1993-94	2.20	4.48	26.77	54.51
(No.)	1999-00	2.48	5.00	30.17	60.83
	2004-05	2.37	4.14	28.84	50.37
	2009-10	3.86	6.65	46.96	80.91
Coconut	1993-94	0.32	0.46	3.89	5.60
(No.)	1999-00	0.37	0.51	4.50	6.21
	2004-05	0.35	0.47	4.26	5.72
	2009-10	0.46	0.63	5.55	7.64
mango	1993-94	0.06	0.12	0.73	1.46
(kg)	1999-00	0.10	0.16	1.22	1.95
	2004-05	0.09	0.11	1.10	1.34
	2009-10	0.11	0.16	1.31	1.92
Apple	1993-94	0.03	0.11	0.37	1.34
(kg)		1999-00	0.08	0.00	0.97
	2004-05	0.03	0.12	0.37	1.40
	2009-10	0.05	0.16	0.55	1.92
Groundnut	1993-94	0.03	0.04	0.37	0.49
(kg)	1999-00	0.05	0.06	0.61	0.73
	2004-05	0.05	0.08	0.61	0.97
	2009-10	0.05	0.07	0.61	0.82
Vegetables	1993-94	2.71	2.91	32.97	35.41

(Kg)	1999-00	3.30	3.49	40.15	42.46
	2004-05	2.92	3.17	35.53	38.57
	2009-10	4.04	4.12	49.14	50.11
Milk : liquid	1993-94	3.94	4.89	47.94	59.50
(litre)	1999-00	3.79	5.10	46.11	62.05
	2004-05	3.87	5.11	47.09	62.17
	2009-10	4.12	5.36	50.09	65.19
Eggs (No.)	1993-94	0.64	1.48	7.79	18.01
	1999-00	1.09	2.06	13.26	25.06
	2004-05	1.01	1.72	12.29	20.93
	2009-10	1.73	2.67	21.08	32.53
Fish (kg)	1993-94	0.18	0.20	2.19	2.43
	1999-00	0.21	0.22	2.56	2.68
	2004-05	0.20	0.21	2.45	2.51
	2009-10	0.27	0.24	3.27	2.90
Goat meat/	1993-94	0.06	0.11	0.73	1.34
mutton (kg)	1999-00	0.07	0.10	0.85	1.22
	2004-05	0.05	0.07	0.57	0.85
	2009-10	0.05	0.09	0.57	1.11
Chicken (kg)	1993-94	0.02	0.03	0.24	0.37
	1999-00	0.04	0.06	0.49	0.73
	2004-05	0.05	0.09	0.61	1.03
	2009-10	0.12	0.18	1.50	2.19

Source: National Sample Survey Organization (50, 55, 61 & 66 th round) GOI

Table 3. India's bound and Applied Agricultural Tariffs for Selected Commodities

	Bound Rate	2006	2007	2008	2009	2010
		Ad valorem tariff (%)				
Cereals and Pulses						
Wheat	100	50	0	0	0	0
Rice (milled)	70	70	70	0	0	0
Corn	70	50	70	0	50	50
Wheat flour	150	30	30	0	30	30
Pulses	100	10	0	0	0	0
Oilseeds	100	30	30	30	30	30
Oil cakes	100	15	15	15	15	15
Crude vegetable oils and sugar						
Palm	300	80	45	0	0	0
Rapeseed	70	75	75	0	0	0
Soybean	45	45	40	0	0	0
Sunflower Seed	300	75	40	0	0	0
Sugar	150	60	60	60	0	0
Dairy products						
Milk	100	30	30	30	30	30
Butter	40	40	40	40	30	30
Cheese	40	30	30	30	30	30
Milk powder	60	60	60	60	60	60
Poultry & fish						
Chicken leg	150	100	100	100	100	100
Whole chicken	100	30	30	30	30	30
Fish	Unbound	30	30	30	30	30
Fruit & vegetables						
Apples	50	50	50	50	50	50
Grapefruit	25	25	25	25	25	25
Strawberries	100	30	30	30	30	30
Pears	35	30	30	30	30	30
Oranges	40	30	30	30	30	30
Onions	100	5	5	5	5	5
Potato	150	30	30	30	30	30
Frozen vegetables	55	30	30	30	30	30

Source: Adapted from ERS (2012)

Table 4. Biotech Regulatory Authorities in India and there composition and functions:

Committee	Members	Functions
Genetic Engineering Appraisal Committee (GEAC)	Chairman- Additional Secretary, Ministry of Environment and Forests (MOEF) Co-Chairman - Nominee of Department of Biotechnology (DBT) Members from Ministry of Industrial Development, Department of Biotechnology, Department of Atomic Energy, Expert members: Director General-ICAR, Director General ICMR; Director General-CSIR; Director General of Health Services; Plant Protection Adviser Directorate of Plant Protection; Quarantine and storage; Chairman, Central Pollution Control Board Other experts in individual capacity Member Secretary MOEF	1.Review and recommend the use of bio-engineered products for commercial applications. 2. Approve activities involving large scale use of bio-engineered organisms and recombinants in research and industrial production from an environmental safety angle. 3. Consult RCGM on technical matters relating to clearance of bioengineered crops/products. 4.Approve imports of bio-engineered food/feed or processed product derived thereof. 5. Take punitive actions on those found violating GM rules under EPA, 1986
Review Committee on Genetic Manipulation (RCGM); function under Department of Biotechnology (DBT).	Member from Department of Biotechnology, Indian Council of Medical Research (ICMR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR) Other subject matter specialist	1. Develop guidelines for the regulatory process for research and use of bioengineered products from a bio-safety angle. 2.Monitor and review all ongoing GM research projects up to the multi location restricted field trial stage. 3.Undertake visits to trial sites to ensure adequate security measures. 4.Issue clearance for the import of raw materials needed in GM research projects. 5.Scrutinize applications made to the

		GEAC for the import of bioengineered products. 6.Form Monitoring and Evaluation Committee for biotech crop research projects. 7.Appoint sub-groups when required in topics of interest to the committee
Recombinant DNA Advisory Committee (RDAC); function under DBT	Scientists from DBT and other public sector research institutions	1.Take note of developments in biotechnology at the national and international level. 2.Prepare suitable guidelines for safety in research and applications of GMOs. 3.Prepare other guidelines as may be required by the GEAC.
Monitoring Cum Evaluation Committee (MEC)	Experts from ICAR institutes, State Agricultural Universities (SAUs) other agricultural/crop research institutions and representatives from DBT	1.Monitor and evaluates trial sites, analyze data, inspect facilities and recommend safe and agronomically viable transgenic crops/plants for approval to RCGM/GEAC
Institutional Biosafety Committee (IBC); functions at research institution/ Organization level.	Head of the Institution, Scientists engaged in biotech work, Medical Expert, and Nominee of the Department of Biotechnology	1.Develop a manual of guidelines for the regulatory process on bioengineered organisms in research, use and application to ensure environmental safety. 2.Authorize and monitor all ongoing biotech projects to the controlled multi location field stage. 3.Authorize imports of bio-engineered organisms/transgenic for research purposes. 4.Coordinate with

		district and state level biotechnology committees
State Biotechnology Coordination Committee (SBCC) functions under the state government where biotech research occurs.	Chief Secretary, State Government; Secretaries, Departmentsof Environment, Health, Agriculture, Commerce, Forests, Public Works, Public Health; Chairman, State Pollution Control Board; State microbiologists and pathologists; Other experts.	1.Periodically reviews the safety and control measures of institutions handling bio-engineered products. Inspect and take punitive action through the State Pollution Control Boards or the Directorate of Health in case of violations. Nodal agency at the state level to assess damage, if any, due to release of bio-engineered organisms and take on-site control measures.
District-Level Committee (DLC); functions under the district administration where biotech research occurs.	District Collector; Factory Inspector; Pollution Control Board Representative; Chief Medical Officer; District Agricultural Officer, Public Health Department Representative; District Microbiologists/Pathologists; Municipal Corporation Commissioner; other experts	1.Monitor safety regulations in research and production installations. Investigate compliance with rDNA guidelines and report violations to SBCC or GEAC. Nodal agency at district level to assess damage, if any, due to release of bio-engineered organisms and take on-site control measures.

Source: Department of Biotechnology (DBT) and Ministry of Environment and Forest (MOEF), GOI, Reproduced from USDA Foreign Agricultural Service, GAIN Report IN807, by Holly Higgins and Santosh K Singh 2008.

About Author:

Dr. Ranjitsinh Mane is Research Program Associate at the University of Arkansas, Rice Research and Extension Center, Stuttgart, Arkansas, USA

Recommended Citation format:

Mane, R. U. (2015) *Acceptance and Use of Genetically Modified Rice in India*.

Retrieved from URL