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GM Crop Technologies: Food and Nutritional Security

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Review

Agriculture is a way of life for more than 60% of India's populations. The cultivation of land not only sustains their livelihood but also provides a social milieu for their day–to–day living. Agricultural production in India got a major boost with the introduction of dwarf varieties of wheat and rice in 1997s which in ensured food security and self–sufficiency. However, in the last 10 years the yields of cereal crops have been stagnating. The productive agricultural areas and encountering serious problems of water depletion, deficiency of micronutrients in the soil. Agricultural production is becoming dependent on agrochemicals, thereby increasing input costs and causing significant damage to the environment and human health. While there is self-sufficiency in cereal grains at present, the yields and productivity of dry land crops, mostly grain legumes and oil seeds remain low and no major breakthroughs in productivity enhancement and yield stabilization have been achieved. India's population is expected to rich approximately 1.5 billion by 2050. It is estimated that around 300 million (roughly 30%) of India's population suffers from malnutrition. Nutritional security for everyone would require more extensive availability of grain legumes, edible oils, fruits and vegetables. The challenges of malnutrition, enhanced productivity and crop diversification can be met by better resource management and by breeding more productive, more nutritious and at the same time less input-demanding crops.

Advances in modern biology, especially biotechnology, offer many advantages when applied in conjunction with the traditional techniques of plant breeding. The scientific and technological advances in these areas have progressed at a remarkable pace during the last decade at the global level. The most compelling case for the intervention of biotechnology is its capability to contribute to : i) increasing crop productivity, and thus contribute to global food, feed and fibre security, ii) lowering production costs , iii) conserving biodiversity, as a land-saving technology capable of higher productivity, iv) more efficient use of external inputs, for a more sustainable agriculture and environment, v) increasing stability of production to lessen suffering during famines due to abiotic and biotic stresses and vi) to the improvement of economic and social benefits and the alleviation of poverty.

With the advent of techniques of genetic engineering in the early seventies, the natural barrier to gene exchange and transfer has been removed. The genomes of rice, *Arabidopsis, Medicago,* sorghum, tobacco, potato, tomato, linseed, chickpea, pigeon pea etc. have been unraveled which will provide better opportunities in future to manipulate crops for desirable traits. Achievements, to date, in agricultural biotechnology have surpassed all previous expectations and with the development of high throughput technologies, the future is even more promising.

Development of transgenic crops expressing a variety of novel traits such as insect resistance, disease resistance, herbicide tolerance, hybrid production, improved oil quality etc. have led to large scale cultivation of GM (genetically modified) crops which currently occupied 170million hectares on a global scale in 2012. Substantial social, economic and environmental benefits have been realized worldwide by cultivating GM crops.

Government of India as approved commercial cultivation of 3 Bt cotton hybrids in 2002. Subsequently, the other Bt cotton event viz., "Bollgard II", "GFM-Cry 1 a" "Event-1", "BNLA601" and "Event 9124" were also subjected to the biosafety tests, proved to be safe and approved for cultivation. As of now, about 1000 Bt cotton hybrids are available for cultivation. In the year 2011-12, Bt cotton was cultivated in more then 10.0 million hectares and with a record production 33 million bales of cotton was realized, which is a testimony to the power of GM cotton. This success needs to be replicated in food, fruit and vegetable crops, to ensure long-lasting food security. In near future we may expect many GM crops, which have been modified for better availability of vitamins, iron, micronutrients quality proteins and oils, which would ensure nutritional security to the masses.

Table1. A list of field trials of GM crops being conducted by public research institutions

Sl.No	Crops	Year	Institute	Traits
1	Brinjal	2006	IARI, New Delhi	Insect resistance
2	Castor	2006	Directorate of Oil Seeds Research, Hyd	Insect resistance
3	Groundnut	2006	ICRISAT, Hyderabad	Virus resistance
4	Potato	2006	Central Potato Research Institute, Shimla	Fungal resistance
5	Rice	2006	IARI, New Delhi	Insect resistance
6	Rice	2006	TNAU, Coimbatore	Disease resistance
7	Tomato	2006	IARI, New Delhi	Virus resistance
8	Brinjal	2007	UAS, Bangalore	Insect resistance
9	Brinjal	2007	TNAU, Coimbatore	Insect resistance
10	Potato	2009	Central Potato Research Institute, Shimla	Tuber sweetening
11	Chickpea	2009	ICRISAT, Hyderabad	Abiotic stress tolerance
12	Sorghum	2009	National research Centre for Sorghum, Hyderabad	Insect resistance
13	Watermelon	2010	Indian Institute of Horticulture Research	Virus resistance
14	Tomato	2010	Indian Institute of Horticulture Research	Virus resistance
15	Tomato	2010	IIVR, Varanasi	Insect resistance
16	Tomato	2010	NRCPB, New Delhi	Fruit ripening
17	Papaya	2010	Indian Institute of Horticulture Research	Virus resistance
18	Sugarcane	2010	Sugarcane breeding Institute	Insect resistance
19	Sorghum	2010	Central research Institute for dry land Agriculture	Abiotic stress tolerance
20	Groundnut	2010	University of Agricultural Sciences, Bangalore	Abiotic stress tolerance
21	Mustard	2010	NRCPB, New Delhi	Abiotic stress tolerance

Table-2: A list of field trails of GM food crops being conducted by private companies /research institutions

Sl. No	Crops	Year	Institute	Traits
1	Brinjal	2006	Sungro Seeds, New Delhi	Insect resistance
2	Brinjal	2006	Mahyco, Mumbai	Insect resistance
3	Cabbage	2006	M/s Nunhems, Gurgaon	Insect resistance
4	Cauliflower	2006	Sungro Seeds, New Delhi	Insect resistance
5	Cauliflower	2006	M/s Nunhems, Gurgaon	Insect resistance
6	Corn	2006	Monsanto, Mumbai	Insect resistance
7	Okra	2006	Mahyco, Mumbai	Insect resistance
8	Rice	2006	Mahyco, Mumbai	Insect resistance
9	Tomato	2006	Mahyco, Mumbai	Insect resistance
10	Okra	2007	Mahyco, Mumbai	Insect resistance
11	Rice	2008	Bayer Bioscience Pvt. Ltd.	Insect resistance
12	Tomato	2008	Avesthagen Limited	Nutritional quality
13	Corn	2008	Monsato India Limited	Insect resistance, Herbicide tolerance
14	Brinjal	2009	Bego Sheetal Seeds, Jalna	Insect resistance
15	Corn	2009	Pioneer Overseas Corporation	Insect resistance, Herbicide tolerance
16	Corn	2009	Dow Argo.	Insect resistance
17	Rice	2009	Bayer Bioscience	Insect resistance
18	Rice	2009	Mahyco, Jalna	Insect resistance, Herbicide tolerance
19	Rice	2010	E.I. DuPont	Heterosis
20	Rice	2010	Bayer Bioscience	Insect resistance
21	Rice	2010	Metahelics Life science	Insect resistance
22	Rice	2010	BASF India Limited	Insect resistance
23	Maize	2010	Pioneer Overseas Corporation	Insect resistance, Herbicide and Tolerance
24	Corn	2010	Dow Agro Sciences	Insect resistance
25	Corn	2010	Syngenta Biosciences	Insect resistance
26	Maize	2012	Honduras	Herbicide and Tolerance
27	Soybean	2014	Monsanto	Insect resistance

Efforts are being made in Indian public research institutions since early eighties to develop transgenic crops. The government of India has been very supportive of the effort to develop transgenic crop and invested liberally through the department of biotechnology, department of science and technology and Indian council of agricultural research. Many research groups have embarked upon transgenic programmes in recent years. Commensurate with this, significant effort were made to isolate useful genes from various organism. Many transgenic crops are currently being developed and tested at various public and private institutions (table 1 and 2). Between 1996 and 2011, the total surface area of land cultivated with GM crops had increased by a factor of 94, from 17000 square kilometers (4,200,000 acres) to 1,600,000 km2 (395 million acres). 10% of the world's crop lands were planted with GM crops in 2010. In 2012, GM crops were planted in 28 countries; 20 were developing countries and 8 were developed countries, 2012 was the first year in which developing countries grew a majority (52%) of the total GM harvest. 17.3 million farmers grew GM crops; around 90% were small holding farmers in developing countries(ISAAA, 2012). 2014 was the nineteenth year of widespread cultivation of crops containing genetically modified (GM) traits, with the global planted area of GM-traited crops having reached over 175 million hectares. The commercialization of GM crops has continued to occur at a rapid rate since the mid 1990s, with important changes in both the overall level of adoption and impact occurring in 2014. During this nearly 20-year period, there have been many attempts to assess the farm level economic impacts associated with the adoption of this technology.

The earlier analysis into the global economic impact of GM crops since their commercial introduction in 1996 by integrating data and analysis for 2014. Previous analysis by Brookes and Barfoot has been published in various journals, including Agbio Forum 12 (Brookes and Barfoot 2009) , the International Journal of Biotechnology (Brookes and Barfoot 2011), and GM Crops (Brookes and Brafoot 2012), GM Crops (Brookes and Barfoot 2013) GM Crops (Brookes and Barfoot 2014) and GM Crops (Brookes and Barfoot 2015). The methodology and analytical procedures are unchanged to allow a direct comparison of the new with earlier data. It is to note that some data presented in this paper are not directly comparable with data presented in previous analysis because the current paper takes into account the availability of new data and analysis .

Very significant net economic benefits at the farm level amounting to $17.7 billion in 2014 and $150.3billion from 1990 to 2013.The technology has made important contribution to increasing global production levels of the 4 main crops (of soybeans, corn, cotton and canola), having, for example, 158 million tones and 322 million tons respectively to the global production of soybean and maize since the introduction of the technology in the mid 1990s Brookes G, Barfoot (Brookes and Barfoot,2015).

References

Brookes, G. and Barfoot, P.2009. Global impact of biotech crops: socio-economic effects 1996–2007. *J. Agro. Biotechnol. Manage Econ. Agbioforum*.,12(2): 184-208.

Brookes, G. and Barfoot, P.2011. The income and production effects of biotech crops globally 1996–2009. *Int. J. Biotechnol*., 2011; 12(1/2): 1-49; http://dx.doi.org/10.1504/ IJBT.2011.042680

Brookes, G. and Barfoot, P.2012. The income and production effects of biotech crops globally 1996–2010. GM Crops, 3(4):265-73.

Brookes, G. and Barfoot, P.2013. The income and production effects of biotech crops globally 1996–2011. *GM Crops*, 4(1):1-10; http://dx.doi.org/10.4161/ gmcr.22748.

Brookes, G. and Barfoot, P.2014. Economic impact of GM crops: the global income and production effects 1996–2012. *GM Crops*, 5(1):65-75; PMID:24637520; http://dx. doi.org/10.4161/gmcr.28278.

Brookes, G. and Barfoot, P.2015. Global income and production impacts of using GM crop technology 1996–2014. *GM Crops*, 6: 13-46

Cohen, J.I. and Paarlberg, R.2004. Unlocking crop biotechnology in developing countries- a report from the field. *World Dev*., 32(9):1563-77.

FAO. 2001. The state of food insecurity in the world FAO.

Falck Zepeda, J., Sanders, A., Trabanino, R., Medina, O., Batallas-Huacon, R.2009. Small 'resource poor' countries taking advantage of the new bio-economy and innovation: the case of insect protected and herbicide tolerant corn in Honduras. Paper presented to the 13th ICABR conference, Ravello, Italy, June.

Falck Zepeda, J., Sanders, A., Trabanino, R., Medina, O., Batallas-Huacon, R.2012. Caught between Scylla and Charybdis: impact estimation issues from the early adoption of GM maize in Honduras. *Agbio forum*,15 (2):138-51.

Galveo, A.2012. Farm survey findings of impact of GM crops in Brazil. Brazil: Celeres; 2012. Available from: www. celeres.co.br.

Galveo, A.2014. Farm survey findings of impact of GM crops in Brazil. Brazil: Celeres; Available from: www. celeres.co.br

Huang, J. and Rozell, S., Pray, C. and Wang, Q.2002. Plant biotechnology in China. *Science*, 295: 674-7.

ISAAA, 2012. Annual report Executive Summary.

Kouser, S. and Qaim, M.2014. Bt cotton, damage control and optimal levels of pesticide use in Pakistan. *Environment and Development Economics*,19(6):704-723.

Lesney, M.S.1999. The garden of Dr. Moreau: plant biotechnology as a chemical enterprise. Genetically modified foods are the fore-runners of designer chemical plants. Todays Chem Work, 1999:8(6):28-33.

Agro. M.B.2014. Intacta soybeans: An economic view of the benefits of adopting the new technology. 2014 report commissioned by Monsanto Brazil

Morris, M.L. and Hoisington, D.2000. Bringing the benefits of biotechnology to the poor: the role of the CGIAR centers. In Qaim M, Krattiger AF, von Braun J, editors. Agricultural Biotechnology in Developing countries: Towards Optimizing the benefits for the Poor. Boston, MA: Kluwer Academic Publishers,327-56.

Norsworthy, J.K., Ward. S.M., Shaw, D.R., Llewellyn, R.S., Nichols. R., Lebster, T.M., Bradley, K.W., Frisvold, G., Powles, S.B., Burgos, NR, et al.2012. reducing the risk of her- beside resistance: best management practices and

OPEN ACCESS

ISSN: 0946 - 4313 (Print

recommendations.Weed Science 60(Herbicide Resistant Weeds Special Issue): 31–62.

OECD (Organization for Economic Co-operation and Development),2003. Accessing agriculture biotechnology in emerging economics. Paris, France: OECD.

Thirtle, C., Beyers, L., Ismaeel, Y., Piesse, J.2003. Can GM-technologies help the poor? The impact of Bt cotton in the Makhathini flats of KwaZulu-Natal. *World Dev*.,31(4): 717-32.

United Nations, 1999. World Population Prospects: The 1998 Revision, New York.

Van der Weld ,W.2009. Final report on the adoption of GM maize in South Africa for the 2008/09 season. South African Maize Trust; 2009.

Vitale, J.2010. Impact of Bollgard II on the Socio Economic and Health Welfare of Smallholder Cotton Farmersin Burkina Faso: Results of the 2009 Field Survey. 14th ICABR conference, Ravello, Italy, June.

Vitale, J., Glick, H., Greenplate, J. and Traore, O.2008. The economic impact of 2nd generation Bt cotton in West Africa: empirical evidence from Burkina Faso. International Journal of Biotechnology 2008; 10(2/3):167-183; http://dx.doi.org/10.1504/IJBT.2008.018352.

Yorobe, J.2004. Economics impact of Bt corn in the Philippines. Paper presented to the 45th PAEDA Convention, Quer- zon City, 2004.

Zambrano, P.2009. Insect resistant cotton in Colombia: impact on farmers. Paper presented to the 13th ICABR conference, Ravello, Italy, 2009.

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