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GM crops in India: Products in the pipeline as of 2012:

{I am T. M. Manjunath, a Ph.D. in agricultural entomology with over four decades of research and executive experience, both in public and private sectors. My areas of interest include biological pest control, insect resistant transgenic crops and integrated pest management. I was a key member of the Monsanto-Mahyco team that was responsible for introducing the Bt-cotton technology into India, right from the early stage till its regulatory approval in March 2002 and thereafter. I am presently an independent technical consultant and also serving in several expert committees of Govt of India and others}.

I have prepared the following note keeping the present theme of the e-email conference in mind. *Bt-cotton* is the first and continues to be the only GM or GE crop approved in India for commercial cultivation since March 2002. Its adoption rate (about 95% of the total cotton area) and success are phenomenal. This has generated enormous interest in crop biotechnology, and work on various traits and crops are in progress. The names of private and public sector organizations involved in such product development are separately indicated below in alphabetical order with serial numbers for easy reference. The various traits and crops, the year(s) in which the trials were approved by Genetic Engineering Appraisal Committee (GEAC), and also the names of product developers indicated by their respective serial numbers in parenthesis, are listed in the table below.

GM crops in India at various stages of regulatory field evaluation as of 2012

(8 traits; 17 crops; 32 institutions)

Traits	Crops, Year(s) of trial approval and Product Developers* <i>(see the names of product developers by looking at the nos. in parenthesis)</i>
Insect resistance	Brinjal/Eggplant - 2006,2007 to 2010 (4,9,14,21,23,28,30) Cabbage - 2006, 2009 (12,14) Castor - 2006, 2011 (19) Cauliflower - 2006, 2008 (12,14) Chickpea - 2009 (25) Corn /Maize - 2006, 2010 (10,15) Cotton - 2008 to 2012 (3,5,7,8,11,16) Okra - 2006,2007(9) Rice- 2006,2007 to 2011 (3,6,9,11,21,28) Sorghum - 2009,2011 (20) Sugarcane - 2010 (27) Tomato - 2006,2010 (9,23)
Virus resistance	Groundnut - 2006, 2009-2010 (24) Papaya - 2010 (22) Potato - 2006, 2009 (17) Tomato - 2006,2010 (21,22) Watermelon - 2010 (22)

Herbicide tolerance	Corn/Maize - 2012 (10) Cotton - 2010, 2012 (3, 9)
Herbicide tolerance & Insect resistance stacked	Corn/Maize - 2008 to 2011 (10,13,15) Cotton - 2008-2009, 2011-2012 (3,9,10,13,15) Rice - 2010 (3)
Drought tolerance	Chickpea - 2009 (24) Groundnut - 2009 to 2012 (24) Mustard - 2010 (25) Rice - 2011 (32) Sorghum - 2010 (18)
Yield enhancement	Rice - 2011 (2)
Delayed ripening	Tomato - 2006,2008,2010 (1,21,25)
Male sterile, female inbred lines	Mustard - 2010-2011 (31) Rice - 2010-2011 (6)
*PRODUCT DEVELOPERS	
Private companies:	
1. Avesthagen Ltd, 2. BASF India Ltd., 3. Bayer Bioscience Pvt Ltd., 4. BejoSheetal Seeds, 5. Dow Agrosciences India Pvt Ltd., 6. E. I. Dupont India Pvt. Ltd., 7. J. K. Agri Genetics, 8. Krishidhan Seeds, 9. Maharashtra Hybrid Seed Co. Ltd (MAHYCO), 10. Monsanto India Ltd., 11. Metahelix Life Sciences Pvt Ltd., 12. Nunhems India Pvt Ltd., 13. Pioneer Overseas Corporation, 14. Sungro Seeds Pvt Ltd., 15. Syngenta Biosciences Pvt Ltd.,	
Public Institutions:	
16. Central Institute for Cotton Research, Nagpur; 17. Central Potato Research Institute, Shimla; 18. Central Research Institute for Dryland Agriculture, Hyderabad; 19. Directorate of Oil Seeds Research, Hyderabad; 20. Directorate of Sorghum Research, Hyderabad; 21. Indian Agricultural Research Institute, New Delhi; 22. Indian Institute of Horticultural Research, Bengaluru; 23. Indian Institute of Vegetable Research, Varanasi; 24. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad; 25. National Research Center for Plant Biotechnology, New Delhi; 26. Rubber Research Institute of India, Kottayam; 27. Sugarcane Breeding Institute, Coimbatore; 28. Tamil Nadu Agricultural University, Coimbatore; 29. University of Agricultural Sciences, Bangalore; 30. University of Agricultural Sciences, Dharwad, 31. University of Delhi - South Campus, New Delhi; 32. University of Calcutta, Kolkata.	
<i>Compiled by: Manjunath (2012);</i>	
<i>Data source: http://igmoris.nic.in/field_trials.asp (for details on genes/events, please refer this website)</i>	

Products in pipeline:

Of the 17 crops listed in the table, only brinjal or eggplant (*Solanum melongena*) incorporated with the lepidopteron specific *Bt* gene, *cry1Ac*, for controlling the Fruit-and-Shoot Borer, *Leucinodes orbonalis*, has undergone all the biosafety and agronomic tests between 2000 and 2008 as originally prescribed by the regulatory committees. The *Bt* gene was introduced into brinjal hybrids by Mahyco and into local varieties by Tamil Nadu Agricultural University and University of Agricultural Sciences (Dharwad) and these were recommended by GEAC as safe and beneficial for commercial approval in 2009. However, the then Minister of Environment & Forests, after the controversial public consultations and apparently under tremendous pressure from certain activist groups, announced a moratorium in February 2010, saying it has to undergo some more safety tests without specifying them. As of now, the moratorium is

still in force. Thus, *Bt*-brinjal is foremost among the crops awaiting final approval. While *Bt*-rice and *Bt*-okra, both developed by Mahyco, have undergone Multi-Location Research Trials (MLRT), all other crops with various traits are in the first or second year of Biosafety Research Level-1(BRL-1). The biosafety data of approved genes/events as well as of new genes/events under regulatory evaluation are available at:http://igmoris.nic.in/major_developments.asp. These are the products in pipeline, but considering the prevailing regulatory uncertainty in the country, it is difficult to forecast when these will be approved.

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