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PROSPECTS OF AGRICULTURAL BIOTECHNOLOGY IN PAKISTAN

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Abstract

Agriculture is the livelihood of rural areas and plays a vital role for the economy of Pakistan. This paper reviews the mechanism governing the research and release of transgenic crops through various research institutions and regulatory authorities. There exists a large scope for genetic manipulations of crops and an effective extension of developed GM varieties from laboratory to farm is needed. The wide spread cultivation of Bt cotton since 2002 requires implementation of biosafety regulations and capacity building in management of GM crops.

INTRODUCTION

The economy of Pakistan is dependent upon agriculture. About 67% of the population is linked with agriculture and provides 24% of GDP as well as 48.5% of national exports [3]. Due to various factors, agricultural progress is not sufficient to account for national food security. During 2004-2010, average growth rate remained 3.75% per annum (Figure 1). The depletion of national resources necessitates a 5-6% increase in agricultural output to meet national food needs substantially.

The principle aim of this paper is to provide an overview of GM crops research in the country and various related policy and legislative issues which are essential to realize for agricultural sector of Pakistan. The direct effects of new agricultural technology on poverty reduction are the productivity benefits enjoyed by the farmers who actually adopt the technology. These benefits usually manifest themselves in the form of higher farm incomes.

MATERIAL AND METHODS

The current situation of development and adoption of transgenic crops is assessed by reviewing the already work done in Pakistan. A comprehensive literature on research infrastructure, regulations and approval mechanisms was analysed and discussed.

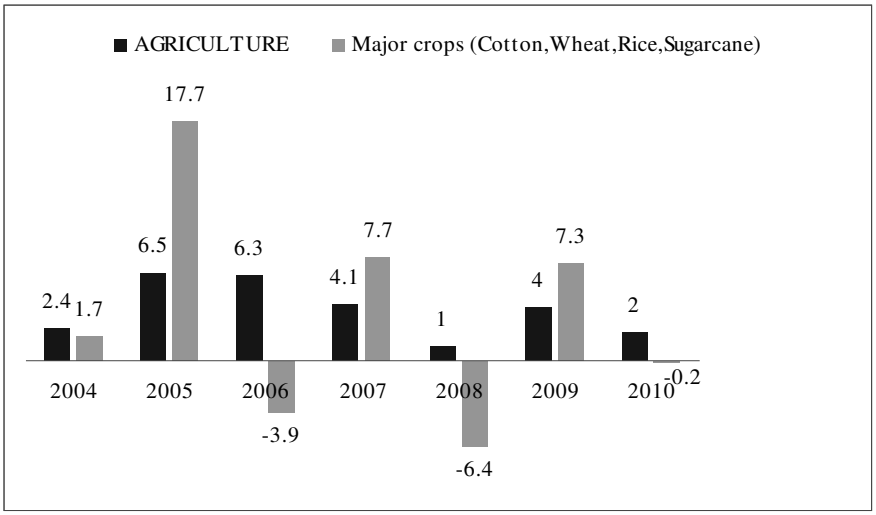


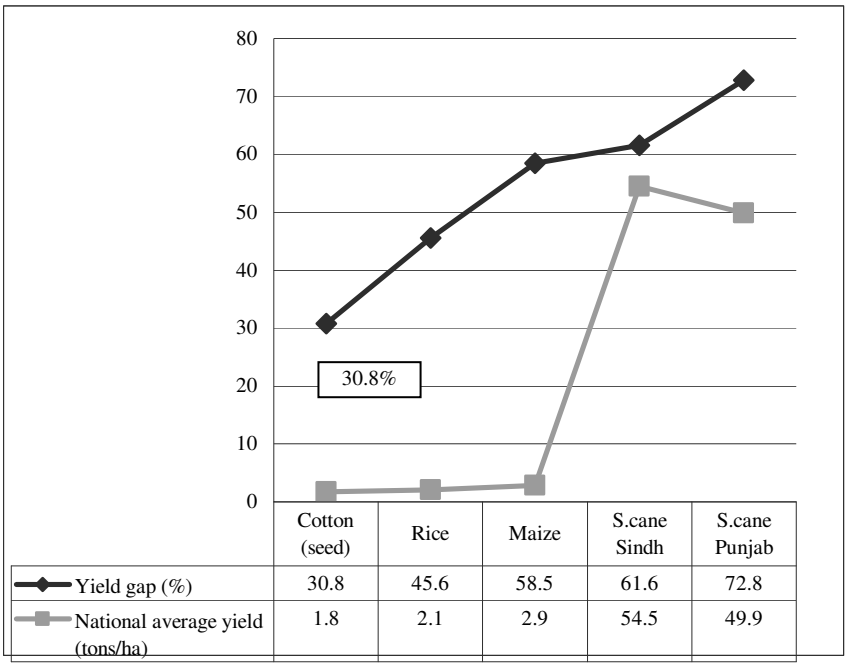
Fig. 1. Growth rates of agriculture and major crops

NEED OF AGRICULTURAL BIOTECHNOLOGY

Wheat, rice, cotton, sugarcane and maize are the major crops and they account for more than three-quarters of total crop output. Despite recent increase in agricultural output, the crop productivity is still very low as compared with the potential yield output (Figure 2). It is mainly due to biotic and abiotic stresses e.g. high price of agriculture inputs like seeds, fertilisers, pesticides, higher intensity of insects and pests attack, shortage of good quality and varieties of seeds, insufficient availability of water for irrigation.

Biotechnology can help revolutionize farm efficiency through genetic modifications of local cultivars for various characteristics such as insect resistance, herbicide, salinity and drought tolerance and development of varieties capable of growing in waterlogged soils. Similarly soil desertification must be minimised by adoption of transgenic crops with low tillage characteristics to promote soil structure.

An adoption of GM crops increased crop yields significantly in other South Asian countries. Biotechnology has played an important role in the social welfare and uplift of economies there. GM cotton was introduced in India in 2002 and today the cotton yield has increased more than double i.e. 17 millions in 2001 to about 38 million bales in 2009[2].



	Cotton (seed)	Rice	Maize	S.cane Sindh	S.cane Punjab
Yield gap (%)	30.8	45.6	58.5	61.6	72.8
National average yield (tons/ha)	1.8	2.1	2.9	54.5	49.9

Fig. 2. Yield gap of major crops

In Pakistan, due to a lack of effective collaboration among institutes and government departments, the adoption of technologies has been very slow. Identification of priority areas of research, facilitations to plant breeders and field extension services need management.

RESEARCH INFRASTRUCTURE

Pakistan has a pro-biotech govt. and public where research and introduction of transgenic crops are emphasized. Biotechnology is recognized as priority area of research. In total there are 29 centres conducting biotech research at various levels. There are a number of new transgenic technologies being worked on relevant to major crops, in addition to insect and herbicide tolerant technologies. Most are output traits but there are also some new input traits for disease control and RNA mutations.

Several ministries and departments are responsible for biotechnology research, policy and regulation. These include the Ministry of Food, Agriculture & Livestock, the Ministry of Science & Technology Research, Higher Education Commission, and National Commission on Biotechnology, Pakistan Council of Science and Technology, and the Pakistan Atomic Energy. Biosafety aspects are the responsibility of the Ministry of Environment, Local Bodies and Rural Affairs.

Although the infrastructure is not well organized a general layout can be drawn as follows:

The Pakistan Council for science and technology (PCST) is the country's central body responsible for formulating policies and projects in support of national development. It works in close consultation with the federal ministries and provincial departments, major R&D organizations, universities and private sector. Its plans are reviewed by the Executive Committee of the National Commission on Science and Technology (ECNCST) before approval from National Commission on Science and Technology (NCST).

Pakistan Agricultural Research Council (PARC), part of the ministry of food and agriculture was established in 1981 to conduct, support, and coordinate and promote agricultural research. Under its management, a number of Biotech Institutions conduct agricultural research in various agro-ecological zones. The largest of these is National Agricultural Research Centre (NARC). NARC tests and disseminates germplasm for various food grains, vegetables and fruit crops. The research activities are organized into 11 institutes which conduct research on more than130 crops with a focus on national problems.

The Ministry of Food and Agriculture (MINFA) deals with the production and release of GM crops. It has developed several Standard Operating Procedures (SOPs) for handling of cases of improvement, approval and release of GM products. The secretary of the Ministry of Environment heads the NBC (National Biosafety Committee) and is responsible for oversight of all laboratory work and field trials as well as authorizing the commercial release of GM products. National Biosafety Committee (NBC), Technical Advisory Committee (TAC) and Institutional Biosafety Committee (IBC) administer the enforcement of National Biosafety Guidelines, awarding exemptions for laboratory and field work related with bioengineered products.

National Commission on Biotechnology composed of renowned scientists in the field of biotechnology was set up in 2001. This commission advises Govt. on specific measures for the development of biotechnology and it works for collaboration between the Govt. and the private sector in the development of high yielding disease resistant varieties.

The Pakistan Biotechnology Information Centre has been established at Latif Ebrahim Jamal National Science Information Centre, University of Karachi under the patronage of International Service for Acquisition of Agri-Biotech Applications (ISAAA) and National Commission on Biotechnology which serves as a hub to disseminate information, to support the collaborative efforts and to develop a network of institutions and individuals working in this field.

REGULATION AND RELEASE OF TRANSGENIC VARIETIES

Pakistan is very vigilant about introduction of transgenic varieties into the environment and risk assessment needs extensive information on a wide range of potential adverse effects. All GM crops are considered to be new organisms and risks of releasing GMOs into the environment are assessed during the same criteria as the risks of releasing any new species of plant, animal or microbe. The release cannot be granted if new variety might displace native species or damage natural habitats.

At present various ministries are handling issues of WTO (ministry of commerce), geographical indications (ministry of commerce), TRIPS (Pakistan Patent Office), copyrights (Ministry of Education), Biosafety guidelines, Cartagena Protocols (Ministry of Environment) and Plant Breeding Rights (Ministry of Food, Agriculture and Livestock). Many NGOs (Action Aid, Oxfam STIP, SUNGI etc.) are also actively involved inraising several issues related to biotechnology,GM crops and globalization. Safety protocols are required during development of GM crops and all such protocols are regulated under Standard Operating Procedures (SOPs). The Ministry Of Food and Agriculture (MINFA) deals with issues of development and approval of transgenic products. All field work with GM plants must proceed according to basic standards appropriate to the particular plant. Effects on the ecology in the open environment are studied for potential of cross hybridization and gene flow. But all conventionally-bred varieties are considered harmless and approved as such without further environmental assessment studies [1].

Pakistan has ratified the Cartagena Protocol on Biosafety (CPB) and WTO. Plant variety protection is regulated by the Plant Breeders Rights Ordinance (2000) which still needs enactment. Amendments to the Patent and Designs Act (1911) and Patent Ordinance (2000) to cover biotechnological innovations are also pending enactment. The Intellectual Property (IPR) Law does not cover live material and the Environment Protection Act does not cover GMOs.

Although Bt cotton has been in cultivation since 2002 in Sindh and Punjab, formal approval was granted in 2010 when 8 Bt cotton varieties, produced by Nuclear Institute of Biotechnology and Genetic Engineering (NIBGE) were released for general cultivation. In January 2011, 3 more Bt cotton varieties, developed by Centre of Excellence in Molecular Biology (CEMB) were approved for next growing season. Research work on other crops is mainly in experimental and field evaluation stages (Table 1).

Biofertilizers have been developed by NIBGE for almost all major crops and are being marketed under the commercial name "BioPower". Research work is being conducted to further improve the product and develop specific biofertilizer for each crop variety. Biofertilizers are based on living microbes (plant growth promoting

rhizobacteria) with beneficial traits like nitrogen-fixation, phosphate solubilization, phytohormone production and bio-control activity.

Table 1

Development of GM Crops in Pakistan

GM Crop	Genetically Engineered Traits	Stage
Cotton	Diamond back moth resistance with Bt genes, virus (ClCuV) resistance with Tr AC gene, virus (ClCuV) resistance with RNA interference RNAi, salinity tolerance, fibre modification, drought, herbicide tolerance	8 varieties approved for commercial release in 2010 and 3 varieties in 2011, Field Trials
Rice	Bacterial blight resistance with Xa21 gene, salt tolerance with yeast and Arabidopsis Na+/H+ antiporter genes, Insect resistance with Cry1Ac & Cry2A genes	Field trials, ready for release
Maize	Drought, herbicide and insect resistance	Experimental
Potato	Virus and insect resistance, salt tolerance	Experimental
Sugarcane	Insect resistance with Cry gene	Experimental
Chickpea	Insect (Bt gene) and virus resistance, Drought and salt tolerance with yeast, Arabidopsis Na+/H+ antiporter genes	Experimental
Sunflower	Drought and herbicide resistance	Experimental
Chillies	Virus resistance	Experimental
Tomato	Virus (TLCV) resistance through RNAi, Male sterility through RNAi male sterility, salinity tolerance	Experimental
Cucurbits	Virus resistance	Experimental
Tobacco	Insect (Helicoverpa armigera and Heliothis vericens) resistance with a novel synthetic spider venom gene, Salt tolerance with Yeast and Arabidopsis Na+/H+ antiporter genes, Salt tolerance with ArDH, chloroplast transformation	Experimental
Groundnut	Fungal resistance, herbicide tolerance	Experimental
Brassica	Male sterility through RNAi	Experimental

Reasons for delay in adopting transgenic crops include a long delay to develop and approve Biosafety Rules and Guidelines by the Ministry of Environment.Plant Variety Protection Act has still not been enacted and amendment Seed Act 1976 is still pending for approval.The delay in seed and plant breeder legislation, and poor implementation of Intellectual Property Laws are perceived as a major impediment to investment in Pakistan by multinational seed companies. Reluctance in finalizing this legislation is due, in part; to the desire of Pakistan's research communities to remain autonomous.

CONCLUSION

1. Biological innovations, or bio-innovations can only be realized when policy and governance mechanisms are in place so that the benefits of the new technologies outweigh the risks. Illegal import and multiplication of Bt cotton seed in Sindh and Punjab created havoc at farmers' field. Absence of biosafety guidelines and awareness at the farm level complicated the issue. To mitigate the issue in future, following recommendations may be considered.
2. Identification of sources for import of elite germplasm.
3. Reliable information must be extended to regulators, farmers and producers to help them make decisions based on up-to-date information and knowledge.
4. Proper legislation on variety patenting is needed. Overall, Pakistan needs to strengthen its legal, institutional, scientific and technical capacity. These can be achieved through training, study or exchange visits, workshops, public awareness and education and public-private partnerships.

REFERENCES

1. ***Government of Pakistan, National Medium-Term Priority Framework (NMTPF) 2007-2010, 2006.
2. ***International Food Policy Research Institute And Pakistan Agricultural Research Council, Agricultural Research and Development in Pakistan: Policy, Investments, and Institutional Profile, 2007.
3. ***MINFA, Agriculture Statistics of Pakistan, 2009-10.