*International Journal of Bio-resource and Stress Management* 2012, 3(1):116-118

# Agricultural Biotechnology for Sustainable Agriculture and Rural Development

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**Article History**

Manuscript No. 224
Received in 14th November, 2011
Received in revised form 10th January, 2012
Accepted in final form 4th March, 2012

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***Keywords***

Biotechnology, Genetic engineering, biodiversity, conventional technologies

**Abstract**

Technology application that uses biological systems living organizing or their derivatives to make or modify products or processes for specific uses is known as Biotechnology. Agricultural biotechnology is a collection of scientific techniques, including genetic engineering that is used to modify and improve plants, animals and microorganisms for human benefit. The present shady explores the roles biotechnology may play in contributing to sustainable agriculture and rural development with particular concerns for bio safety and bio-diversity. Plant biotechnology research is applied to well define social or economic objectives, such as improving the food staples of the poor. An objective of biotechnology is now dependent on private investment not on the Government level. Long – term public sector investment in agricultural research is essential to address the needs of poorer farmers. Increased participation by farmers in sustainable agriculture and rural development process is of vital concern. Many actions in several fields need to be developed by Governments to make sure that the pro-poor potentialities of agricultural biotechnologies are realized.

## 1. Introduction

Biotechnology is defined in article 2 of the Convention on Biological Diversity as any technological application that uses biological systems, living organisms or derivatives thereof to make or modify products or processes for specific uses. Agricultural biotechnology is a collection of scientific techniques, including genetic engineering, that are used to modify and improve plants, animals and microorganisms for human benefit. It is not a substitute for conventional plant and animal breeding but can be a powerful complement. The present report explores what roles biotechnology may play in contributing to sustainable agriculture and rural development, with particular concerns for bio-safety and biodiversity. It focuses on several major policy issues, presenting biological diversity as a source of raw product for crop and animal improvement, including the use of biotechnology. And it considers bio-safety as a major domain for addressing the impact of biotechnologies on health and the environment. The report suggests policy issues that will need to be resolved by Governments if biotechnology is to contribute effectively to the food and livelihood security of developing countries in the next millennium.

## 2. Role of Bioverisity

This paper in based on the report, a simple descriptive and an explorative methodology is followed.

### *2.1. Agricultural biodiversity*

Agricultural biodiversity encompasses the variety and variability of animals (including aquatic animals), plants, forestry and micro-organisms - at the genetic, species and ecosystem levels - necessary to sustain the key functions of the agro- ecosystem and its structure, as well as processes for and in support of agricultural production and food security. The biological resources contained within agricultural biodiversity are of direct and vital importance to the food security and socioeconomic development of all countries.

FAO and the Conference of Parties to the Convention have continually promoted the development of national plans and strategies for the conservation and sustainable use of agricultural biodiversity. Because modern agricultural biotechnologies offer ways to improve and expand the sustainable use of genetic resources, they should be considered in any national planning regarding the sustainable use of agricultural biological resources in order to meet sustainable agriculture and rural development objectives.

### *2.2. Scope of Biotechnology for sustainable agriculture and rural development*

Agricultural biotechnologies have major potential for facilitating and promoting sustainable agriculture and rural development. They could also generate environmental benefits, especially where renewable genetic inputs can be effectively used to substitute for dependency on externally provided agrochemical inputs. The fact that genes or genotypes (e.g., varieties, breeds) can constitute locally renewable resources is of profound significance to the further development of sustainable agriculture and rural development However, the power of modern biotechnologies to generate useful genotypes has not yet been harnessed for poorer farmers.

Nevertheless, the extent to which modern biotechnology will contribute to the achievement of food security for all is still an open question. Science alone is unlikely to provide a complete solution to the problems of rural development. There are many processes, factors and socio-economic structures underlying poverty in rural areas, such as lack of access to land and other productive resources, low purchasing power, political powerlessness, fragile environments and distance from markets. Agricultural (or indeed plant biotechnology) research is but one factor which could impact on rural poverty; it is not a panacea for sustainable agriculture and rural development.

Comparative reviews of the state of agricultural biotechnologies in some developing countries have been carried out by the International Service for National Agricultural Research - Intermediary Biotechnology Service, a Consultative Group on International Agricultural Research (CGIAR) centre, and the Organization for Economic Cooperation and Development (OECD), which concluded that the majority of developing countries have limited practical access to the tools and germplasm necessary to apply more sophisticated biotechnology research to their national needs. The barriers to such access are many and include lack of financial, scientific and infra structural resources.

Biotechnology research has not been closely integrated with the problems and constraints confronting low-income farmers in the agricultural sector of developing countries. Biotechnology needs to be focused on some key problems within sustainable agriculture and rural development that historically have not been effectively addressed by conventional technologies.

Governments, scientists, non-governmental organizations, donors and CGIAR will have to consider the development of innovative mechanisms for the transfer of biotechnologies in developing country agriculture. Long-term public-sector funding will be necessary if the dissemination of agricultural biotechnology research is to benefit the poorer strata of society.

Over the longer term, there is little doubt that some biotechnological approaches to agricultural improvement could generate social, economic and environmental benefits if specifically targeted at the specific needs of poorer groups. While a vast range of approaches for the biotechnological improvement of such agronomic traits are either under study or in early development phases, given the current lack of focused public sector support for pro-poor agricultural biotechnology it is unlikely that poorer farmers will have economic access to such improvements in the short term.

A search through the scientific literature on biotechnology reveals a range of agricultural biotechnological research that could impact favorably on all of the priority areas. However, the relevance of uncritically listing all biotechnology research which is under way and might meet sustainable agriculture and rural development objectives should be questioned. The development of a technology does not guarantee its widespread dissemination - especially to poorer social groups. When it comes to food security, it is the practical application of the research that matters, rather than the promise of the "pipeline" research orientation. The agricultural biotechnology research community lacks concrete examples of pro-poor applications of molecular level biotechnology being put to use in farmers fields on a scale necessary to have an impact on rural poverty.

Very few public-sector institutions or organizations are involved in the transfer of appropriate biotechnologies to the crops and farming systems of rural groups in developing countries, reflecting the current bias in agricultural biotechnology research to commercial markets. Internationally, there are only a handful of underfunded agricultural biotechnology initiatives (public or private sector) with an explicit focus on poorer farmers as their primary clients/markets. Some examples are the Center for the Application of Molecular Biology to International Agriculture; the FAO-facilitated Technical Cooperation Network on Plant Biotechnology for Latin America; the International Centre for Tropical Agriculture Cassava Biotechnology Network; and other biotechnology networks created and managed by the CGIAR international centres. Several national Governments of developing countries have good programmes on agricultural biotechnologies, such as Mexico, Argentina, Brazil, China, India and Egypt.

### *2.3. Assessing impacts of biotechnology on health and the environment*

There are concerns about potential risks posed by some aspects of biotechnology. These risks fall into two basic categories: the effects on human and animal health, and the environmental consequences. Caution must be exercised in order to reduce the risk of transferring toxins from one life form to another, of creating new toxins or of transferring allergenic compounds from one species to another that could result in unexpected allergic reactions. Risks to the environment include the possibility of out-crossing, leading, for example, to the development of more aggressive weeds or wild relatives with increased resistance to diseases or environmental stresses, upsetting ecosystem balance. There is also the potential loss of biodiversity, for example, resulting from the displacement of traditional cultivars by a small number of genetically modified cultivars, and the potential for increased crop vulnerability resulting from the possible widespread adoption of varieties with simple, monogenetic, disease resistance mechanisms. However, in principle, these latter effects are no different from those that may result from many conventional approaches to plant breeding.

Policy decisions taken in regard to bio-safety regulations will have long-term implications for the sustainability of agriculture and food security. Many genetic engineering approaches to crop improvement arise from a lack of suitable conventional approaches to dealing with a particular agronomic problem or need. It appears that long-term negative implications for agriculture and food security can arise equally from having bio-safety regulations that are either too lax or too stringent.

Genetic engineering approaches have considerably broadened the range of gene pools which are now accessible for crop improvement purposes. If countries expect to benefit from modern biotechnologies in their agriculture and food sectors, they will have to give serious consideration to the drafting of bio-safety regulations that are tailored to meet their socio-economic needs. Bio-safety regulations and standards for risk assessment need to be harmonized within eco-regions since environments are common across political boundaries.

In the context of biotechnology risk assessment, there is a widely held scientific consensus that risk is primarily a function of the characteristics of a product - whether it is a purified chemical or a living organism to be field tested - and is not per se a function of the method of genetic modification. However, the current legal definitions of genetically modified organisms upon which most bio-safety legislation is being constructed are largely process- rather than products-oriented. The scientific consensus emerging from the vast range of bio-safety studies of transgenic plants is that each case should be evaluated on its own merits and hazards. Hence, bio-safety decisions might differ according to the particular type of transgenic, crop, environment and end use involved.

There is no evidence to suggest that transgenic crops or biotechnology per se would either decrease or increase biodiversity in agricultural or in "natural" ecosystems. Within agricultural systems, plant biotechnology research could be applied to either increasing or decreasing genetic diversity, depending on research objectives. With modern biotechnological methods, the use of the genetic resources from wild crop relatives may actually increase. The selective advantage that a particular genetically modified organism will confer in the agro-ecological niche in which it is applied should be considered in risk assessment.

In general, any risks of transgenic crops to biodiversity should be assessed relative to other non transgenic options. Most risk assessment studies regarding genetically modified organisms fail to do comparative studies to assess each particular risk relative to the levels of risk to health and environment from other options.

## 3. Conclusion

At the governmental level, there are currently no policy instruments which promote this type of biotechnological research. Long term public-sector investment in agricultural research will be essential to address the needs of poorer farmers and consumers. Evaluation of newly engineered crops must consider biodiversity as a value; monitoring bio-indicators can help in reaching decisions about their environmental impacts. Many actions in several fields need to be developed by Governments and by international organizations to make sure that the pro-poor potentialities of agricultural biotechnologies are realized.