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Role of Bio-Technology in the Development of Agriculture Sector in India

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Abstract

Biotechnology is not a single technology. It can be broadly defined as "using organisms or their products for commercial purposes." Modern biotechnology has offered opportunities to produce more nutritious and better tasting foods, higher crop yields and plants that are naturally protected from disease and insects. Modern biotechnology allows for the transfer of only one or a few desirable genes, thereby permitting scientists to develop crops with specific beneficial traits and reduce undesirable traits. Benefits can also be seen in the environment, where insect-protected biotech crops reduce the need for chemical pesticide use. Insect-protected crops allow for less potential exposure of farmers and groundwater to chemical residues, while providing farmers with season-long control. Also by reducing the need for pest control, impacts and resources spent on the land are less, thereby preserving the topsoil. Governments also rely on scientific research because they are responsible for setting health and safety standards regarding new developments. National governments and international organizations support food biotechnology as a means to avoid global food shortages. Many policy making bodies are also trying to balance support of the food biotechnology industry with public calls for their regulation. Such regulations are necessary to protect public health and safety, to promote international trade, conserve natural resources, and account for ethical issues. This paper studies the performance of Biotechnology in the development of Agriculture sector in the various forms.

Keywords: Modern Biotechnology, Development of Agriculture, National Government Policies, and Potential Crops.

Introduction:

Broadly speaking, biotechnology is a technique that uses living organisms or substances. From these organisms it makes or modify a product for a practical purpose. Biotechnology can be applied to all classes of organism - from viruses and bacteria to plants and animals - and it is becoming a major feature of modern agriculture . Modern agricultural biotechnology includes a range of tools that scientists employ to understand and manipulate the genetic make-up of organisms for use in the production or processing of agricultural products. Biotechnology is being used to address problems in all areas of agricultural production and processing. This includes plant breeding to raise and stabilize yields; to improve resistance to pests, diseases and abiotic stresses such as drought and cold; and to enhance the nutritional content of foods. Biotechnology is being used to develop low-cost disease-free planting materials for crops such as cassava, banana and potato and is creating new tools for the diagnosis and treatment of plant and animal diseases and for the measurement and conservation of genetic resources. Biotechnology is being used to speed up breeding programmes for plants, livestock and fish and to extend the range of traits that can be addressed. Animal feeds and feeding practices are being changed by biotechnology to improve animal nutrition and to reduce environmental waste. Biotechnology is used in disease diagnostics and for the production of vaccines against animal diseases.

Methodology:

The study is largely based on secondary data obtained through scanning of available literature on the subject from various libraries and institutes. Various magazines, newspapers, journals etc. were consulted. Interviews and group discussions with knowledgeable people in this field. The relevant data from various sources has been collected and the updated report has been compiled.

1. Objectives:

The major objectives of this work are.

1) To study the performance of Modern Biotechnology in Agriculture sector in the various forms.
2) To reveal the Government policies to implement Biotechnology policy in Agriculture sector in India
3) To examine the development of Agriculture farming in the context of using Biotechnology.
4) To know the impact of Biotechnology in Agriculture sector.

2. Modern Biotechnology in Agriculture:

Modern biotechnology holds considerable promise to meet challenges in agricultural production. It makes use of life sciences, chemical sciences and engineering sciences in achieving and improving the technological applications of the capabilities of the living organism of their derivates to make products of value to man and society.

A) Several branches of biotechnology in Agriculture are:

- **Blue Biology**: It is a term that has been used to describe the marine and aquatic applications of biotechnology, but its use is relatively rare.
- **Green Biology**: It is a biotechnology applied to agricultural processes. The example is the designing of transgenic plants to grow under specific environments in the presence (or absence) of chemicals. One hope is that green biotechnology products are ultimately more environmentally friendly.

1) Aim of agricultural and plant biotechnologies:

1) Rapid multiplication of useful micro-organisms.
2) Micro propagation of plants.
3) Production of diagnostic tools for the identification of plant disease and detection of contaminants.
4) More efficient system of plant germplasm.
5) Genetically engineer plants i.e., which have new characteristic to improve the efficiency of crop production.
6) More and better crops at lower cost and
7) The technologies used in agriculture and horticulture are DNA manipulation, Tissue Culture, Gene Transfer, Biofertilisers.

B) Uses of Modern Biotechnology in Agriculture:

a) Crop yield:

Current genetic engineering techniques work best for effects that are controlled by a single gene. Many of the genetic characteristics associated with yield (e.g., enhanced growth) are controlled by a large number of genes, each of which has a minimal effect on the overall yield. There is, therefore, much scientific work to be done in this area.

b) Reduced vulnerability of crops to environmental stresses:

Crops containing genes that will enable them to withstand biotic and abiotic stresses may be developed. For example, drought and excessively salty soil are two important limiting factors in crop productivity. Biotechnologists are studying plants that can cope with these extreme conditions in the hope of finding the genes that enable them to do so and eventually transferring these genes to the more desirable crops.

c) Increased nutritional qualities:

Proteins in foods may be modified to increase their nutritional qualities. Proteins in legumes and cereals may be transformed to provide the amino acids needed by human beings for a balanced diet.

d) Reduced dependence on fertilizers, pesticides and other agrochemicals:

Most of the current commercial applications of modern biotechnology in agriculture are on reducing the dependence of farmers on agrochemicals. For example, Bacillus thuringiensis (Bt) is a soil bacterium that produces a protein with insecticidal qualities.

C) Animal biotechnology:

In animals, biotechnology techniques are being used to improve genetics and for pharmaceutical or industrial applications. Molecular biology techniques can help drive breeding programs by directing selection of superior animals. Animal cloning, through somatic cell nuclear transfer (SCNT), allows for genetic replication of selected animals

D) Plant Biotechnology:

Plant biotechnologies an play a key role in the massive production of improved crop varieties (through in vitro

tissue culture followed by clonally propagation), as well as in their genetic improvement. They can also help in propagating plant species which contain useful and biologically active substances, eg., food additive, pigment, pharmaceuticals, bio pesticides, etc. Organ tissue and cell culture could be more efficient than conventional extraction

a) Tissue Culture:

It is the science of cultivating animal/ plant tissue in a prepared medium. The application of tissue culture are in the field of multiplying bamboos, mass multiplication, micro propagation etc. Multiplication of bamboos. In general, it takes a long period to flower in bamboos. It has been reported that bamboos can be induced to flower in tissue culture in relatively lesser time. This opens up vast possibilities of selective breeding of improved bamboo varieties and thus replacing the vegetative propagation by speed propagation. Mass multiplication is carried out with a number of ornamental and field crops which have shown that the use of this fully mechanized procedure of multiplication, distribution and transfer is suited to commercial micro propagation.

b) Transgenic plants:

Transgenic plants have been engineered to possess several desirable traits, such as resistance to pests, herbicides, or harsh environmental conditions, improved product shelf life, and increased nutritional value.

c) Cisgenic plants:

Cisgenesis, sometimes also called intragenesis, is a product designation for a category of genetically engineered plants. A variety of classification schemes have been proposed that order genetically modified organisms based on the nature of introduced genotypic changes rather than the process of genetic engineering.

5. Animal husbandry:

Animal husbandry is improving productive efficiency, defined as milk output per feed resource input, is a critical factor in reducing the environmental impact and natural resource utilization by the dairy industry.

6. Biotechnology in Fisheries

In India, experimental transgenic *rohu*, *zebra fish* and *singhi* have been produced recently. At present, there is well-trained but very limited human capacity available for transgenic fish research and production. Genes, promoters and vectors of indigenous origin are available only for two species (*rohu* and *singhi*) for engineering growth. Though protocols are available for transformation of a few fish species, infrastructure for transgenic fish production is highly limited and biosafety testing procedures, specific to aquatic animals, are not in place.

7. Genetically Engineering in Agriculture:

a) Genetically Engineered Plants: Many plants have been commercialized in Agriculture, including tomatoes and squash and commodity crops like corn and soybeans. Most have been engineered for one of three traits: herbicide tolerance, insect resistance, or virus tolerance.

b) Genetically Engineered Fiber Plants: Genetically engineered cotton has been approved for commercial use.

c) Engineered Insects Used in Agricultural Systems: Researchers have engineered honeybees and other beneficial insects to tolerate pesticides.

d) Engineered Microorganisms Used as Pesticides: Several bacteria engineered to enhance their ability to kill or repel pests have been approved for commercial use. These products are used as pesticides in agricultural fields and gardens.

e) Food Processing Aids Made from Engineered Bacteria: Bacteria have been genetically engineered to produce rennet, an enzyme important in making cheese. Genetically engineered rennet (chymosin) is approved for commercial use.

f) Genetically Engineered Livestock and Poultry: Goats and sheep have been engineered to secrete bioactive molecules into their blood, urine, or milk. Companies are in the process of developing commercial enterprises based on these animals.

g) Genetically Engineered Fish and Shellfish: Fish and shellfish have been engineered to cause changes in hormones that accelerate growth in several laboratories, but so far not commercialized in the United States.

h) Bio fertilizers: Certain micro-organisms and minute plants which can absorb gaseous nitrogen

and phosphorous directly from the atmosphere and make it available to the plants can be identified, multiplied in the laboratories and introduced into the root zone of crop plants to supply nitrogen and phosphorous. Materials containing such organisms are called bio fertilizers. Some of the bio fertilizer are Rhizobium, Azotobacter, Azispir illiumm Blue-green algae, Azolla etc.

8. Impact of Biotechnology:

As discussed in the 1996 Ecology -authored report, The Ecological Risks of Engineered Crops, genetically modified crops pose six kinds of potential risks.

1) First, the engineered crops themselves could become weeds, a broad term that covers plants with undesirable effects.
2) Second, the crops might serve as conduits through which new genes move to wild plants, which could then become weeds.
3) Third, crops engineered to produce viruses could facilitate the creation of new, more virulent or more widely spread viruses.
4) Fourth, plants engineered to express potentially toxic substances could present risks to other organisms like birds or deer.
5) Fifth, crops may initiate a perturbation that may have effects that ripple through an ecosystem in ways that are difficult to predict.
6) Finally, the crops might threaten centers of crop diversity.

Although few problems of the sorts listed above would be expected to surface within the three-to-four-year time frame that the new crops have been in widespread use, the good news is that there have been no serious environmental impacts—certainly no catastrophes—associated with the use of engineered crops in the United States.

9 .Government of India's Task Force on "Applications of Biotechnology in Agriculture

The Ministry of Agriculture, Government of India, constituted a Task Force on **"**APPLICATIONS OF BIOTECHNOLOGY IN AGRICULTURE**"**, with Dr.M.S Swaminathan as the Chairman. The FBAE was invited to meet with the Task Force on November 18, 2003, at the Ministry, New Delhi, to present the FBAE's views on the subject. The following was submitted by the FBAE, to the Task Force

a) Technology Development:

- Review the current efforts in different institutions engaged in research in agricultural biotechnology in India
- Encourage institutional collaboration to pool up expertise and facilities
- Monitor funding by deferent agencies to avoid duplication/overleap work.

b) Technology transfer

- For certain genetic events and crops transfer of technology is more expedient than indigenous development
- Government should bear the costs of technology transfer and development of local varieties, in such cases

A number of genetically engineered crop varieties, ready for commercialization on regulatory approval, are available from public and private institutions outside India. Some examples are Bt rice, abiotic rice, rice with high iron, low phytate and high photoset, rice with human milk proteins, tobacco with functional human hemoglobin, and gene stacked Bt cotton.

c) Public and private sector collaboration

- Facilitate public and private sector collaborative efforts
- Establish new models of academy-industry partnership to foster academic brilliance without losing focus on commercial application

d) Encourage entrepreneurship

- Support budding entrepreneurs with scientifically sound and implementable ideas addressing real problems in Indian Agriculture.
- Support to early commercialization of ideas in Agricultural biotechnology.

e) Unauthorized products

- Illegal development of approved or unapproved genetic events for private benefits must be stopped.
- Such products serious risks to the farmers, environment and economy.
- Damaged the country's reputation.

- Legal & admistrative mechanisms to check this menace effectively are urgently needed
- A letter of authorization, from the registered holder of a genetic event, permitting its deployment it into a crop plant in India, should be mandatory, from the time of the first application, to prevent unauthorized commercialization.

f) Regulatory Process

- A statutory Apex Body exclusively concerned with biosecurity commercialization and deregulation
- Should be independent of Ministry and Government departments
- Acts upon the advice of a scientific committee or other committees constituted by it, to advice on specific issues
- Conducts public hearings before final decisions
- An Authority to redress grievances against decisions of the Apex Body is needed.

g) Awareness and Education:

- Public awareness of risks and benefits of biotechnology is very low and is largely based on misinformation and disinformation and not science
- Public acceptance of transgenic products needs vastly enhanced awareness of the benefits and safety of technology

h) General Policy:

- Resource poor farmers would directly benefit from a wider deployment of biotechnology in agriculture
- Indian agriculture should be on an international technology base
- Agricultural biotechnology should receive full support and commitment of the Government of India, as a part of the Agri Vision 2020 document of the Government
- A clear policy document on GEOs in agriculture is needed

10. Conclusion:

Agricultural biotechnology innovations aimed directly towards consumers, sometimes collectively referred to as output traits, have been a longer time in development. As the technology advances, and we learn more about the genes and biochemical pathways that control those attributes that could offer more direct consumer benefits, the long-awaited promise of genetically engineered food with more direct consumer benefits moves closer to reality. Biotechnology could help solve many problems limiting crops and livestock production in developing countries. For example, biotechnology-derived solutions for biotic and abiotic stresses, built into the genotype of plants, could reduce use of agrochemicals and water, thus promoting sustainable yields. The development of genetically modified foods and other agricultural biotechnology products has generated significant in Agricultural development..The development of genetically modified foods and other agricultural biotechnology products has generated significant public debate. The potential for creating foods enhanced for health benefits or increasing crop yields was tantalizing, but there was also widespread concern about the technology's health and environmental risks

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