

**UNCTAD/ITE/TEB/10**

**United Nations Conference on Trade and Development**

**KEY ISSUES IN BIOTECHNOLOGY**



United Nations  
New York and Geneva, 2002

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This publication seeks to contribute to exploring current science and technology issues, with particular emphasis on their impact on developing countries.

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**PREFACE**

This paper reviews several key issues surrounding modern gene technology and its application in the areas of crop agriculture and medicine, and presents the potential benefits and challenges associated with them. It concludes with the major implications for policy makers.

This paper has been prepared by the UNCTAD secretariat in accordance with the work programme of the Division on Investment, Technology and Enterprise Development, and as part of the analysis of the relationship between science and technology and development, and the implications from that for policy formulation and international cooperation in technological capacity-building. In particular, it addresses and provides balanced information on biotechnology, with particular attention to genetically modified crops, health and intellectual property rights.

This paper was reviewed by Professors Richard Braun, Norman Clark, Calestous Juma and Bernd Michael Rode.

**CONTENTS**

<i>Preface</i> .....	iii
INTRODUCTION .....	3
I. GENETICALLY MODIFIED CROPS AND FOOD .....	5
A. Environmental impacts of genetically modified crops .....	5
B. Genetically modified food and human health .....	6
C. Who benefits from genetically modified food and crops? .....	6
D. “Terminator technology” and farmer-saved seed .....	7
E. Genetically modified crops and food security .....	7
II. BIOTECHNOLOGY AND HEALTH .....	8
A. Drugs, vaccines and diagnostics .....	8
B. The human genome project .....	9
C. Pharmacogenomics .....	9
D. Gene therapy .....	9
III. GOVERNING BIOTECHNOLOGY: POLICY CHALLENGES .....	11
A. Building capacity for developing and managing biotechnology .....	11
B. Biosafety and bioethics: capacity for risk assessment .....	11
C. Building awareness of biotechnology .....	11
D. Accessing biotechnology: intellectual property rights .....	12
NOTE .....	13
REFERENCES .....	14
SELECTED UNCTAD PUBLICATIONS ON SCIENCE AND TECHNOLOGY .....	15
QUESTIONNAIRE .....	18

# **KEY ISSUES IN BIOTECHNOLOGY**

## INTRODUCTION

Biotechnology is a collective term for a group of technologies that use biological matter or processes to generate new and useful products and processes. As such, it ranges in complexity and maturity from ancient brewing and bread-making techniques to genetic modification through hybridization and interbreeding of plants and animals, as well as the manipulation of individual genes in humans, animals, plants and micro-organisms.

Biotechnology is a key technology for the new millennium. It has an immense range of applications in agriculture, medicine, food processing, environmental protection, mining, and even nanoelectronics. On the other hand, the potential for altering the genetic structure and characteristics of living organisms, including humans, plants and animals, has resulted in many concerns about safety and ethical implications of the new technologies. So far, most of the safety issues have emerged from agricultural biotechnology, but some cutting-edge developments in medical biotechnology are now presenting the major ethical concerns.

## **I. GENETICALLY MODIFIED CROPS AND FOOD**

The basic argument put forward in favour of genetically modified (GM) crops is that they can provide at least a partial solution to the problem of feeding the world's growing population. Even with improved food distribution and access, this cannot be achieved without dramatic increases in crop production. Converting more land for agricultural use is environmentally unsustainable. Genetic engineering has opened up opportunities for increasing crop yields, reducing crop losses to insects, disease and post-harvest storage problems, and enhancing the nutritional value of some crops. In addition, crops are now being developed to resist abiotic stresses, such as drought and soil salinity. This will allow increased crop production on marginal land and therefore bring possible benefits to poorer rural areas.

Traditionally, new varieties of specific crops have been bred by mutation and cross-pollination of two strains, usually of the same species, in order to transfer desirable traits from each into the new variety. These traits might include higher yield, greater resistance to certain pests or diseases, slower ripening, or better tolerance of drought or soil stresses. Genetic engineering allows the selective transfer of one or more genes that code for desired traits from one variety to another, which means that it is a faster and more accurate method of breeding new varieties. It also allows the transfer of genes between species, which in most cases cannot be achieved by traditional breeding. For example, some of the first commercial releases of GM crops were modified with a gene from a bacterium, *Bacillus thuringiensis* (*Bt*), which codes for a toxin against some crop pests. *Bt* insecticide sprays have been in use for several decades, and are approved for organic farming. However, introducing the *Bt* toxin gene directly into a plant genome raised many concerns about the genetic engineering of crops, and food products derived from them.

### **A. Environmental impacts of genetically modified crops**

One of the major concerns about introducing GM crop varieties is the uncertain impact on the environment. One of the potential problems is that the novel gene might be unintentionally transferred by pollination to other plants, including weeds and also wild relatives of the crop species. Scientific research has shown that this is technically possible, but the potential long-term impacts this might have are still unclear. There are fears that such transfers could lead to the development of resistant "super-weeds", loss of genetic diversity within crop species, and possibly even the destabilization of some ecosystems. This last concern also emerges from the specific application of *Bt*, where the genetic modification results in toxin being produced directly by the crop. Environmentalists argue that the toxin might unintentionally be taken up by non-targeted organisms, which might destroy populations of benign insect species. Much research has been done on the possible impact of *Bt*-engineered crops on the monarch butterfly, with inconclusive results. Laboratory results have differed significantly from those from field tests. So far, despite the fact that millions of acres of *Bt* crops have been planted over the past few years, there is little empirical evidence that the populations of non-target organisms are decreasing in nearby areas. However, it is clear that some of the feared impacts are likely to be ecosystem-specific. As a result, field trial results in one country or ecosystem may not provide

conclusive evidence of environmental safety for other countries or ecosystems. In-depth research on specific ecosystems could provide answers to these questions.

### **B. Genetically modified food and human health**

Concerns have also been expressed about the risks to human health of food products derived from genetically modified crops. This is particularly the case where novel genes have been transferred to crops from organisms that are not normally used in food or animal feed products. Many who oppose genetic engineering suggest that this might lead to the introduction of previously unknown allergens into the food chain. Controversy was sparked when a gene from a Brazil nut was successfully transferred into a variety of soya which was being developed for animal feed. It was confirmed that the allergenic properties of the Brazil nut were expressed in the soya. However, the counter-argument was that this case demonstrated the effectiveness of scientific testing for safety. The allergen was specifically tested for during the development process, and as a result of the positive results, the product was never developed for commercial use. Scientists further argue that the structure and characteristics of known allergens are well documented, and that testing for possible new allergens is therefore relatively easy.

Another fear about food safety is the possible production of toxic compounds resulting from genetic modification. Many scientists argue, however, that by introducing one, or a very few, well-defined genes into a crop, toxicity testing is actually easier for GM crops. In traditional breeding, entire genomes, or parts of chromosomes are transferred, and this often requires a lengthy breeding process to remove undesirable genes from the variety being developed. The last major concern for food safety is the use of antibiotic resistance genes as “markers” in the genetic transformation process. Some of the antibiotics used for this purpose are still used to treat human illnesses, and there is concern that resistance to the antibiotics could be transferred to humans and animals through food and feed products. However, no evidence of this has so far emerged, and scientists have now developed techniques to remove these “marker” genes before crops are developed for commercial use.

### **C. Who benefits from genetically modified food and crops?**

Pro-biotechnology scientists and firms have pointed out that GM food products have now been on the market for several years, without a single reported case of adverse effects on human health. Against this, it has been argued that possible long-term impacts would not become clear for some years.

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