In a nutshell

From the "Green" to the "Gene" Revolution

Transforming Agriculture

June 2002
Inter-American Institute for Cooperation on Agriculture

Access to knowledge and information is indispensable to making informed choices and decisions. The ***In a Nutshell*** series provides relevant information, in a reader friendly manner, on issues/topics of importance to the sustainable development of Caribbean agriculture in the context of an increasingly dynamic trade environment.

Genetic engineering (GE) technology is rapidly evolving and its application to agriculture and food production is increasing. There is a great deal of controversy surrounding the use of this revolutionary technology to produce food and food products.

This issue presents the available information on the potential of GE technology for agriculture and highlights concerns about the potential implications for agriculture, health and the environment.

To learn more about genetic engineering technology, genetically modified organisms and their application to agriculture and food production, readers are encouraged to contact:

- their national IICA Offices, or
- the Department of Life Sciences, St. Augustine Campus, UWI Trinidad.

OR. . . . . log on to:

- www.anth.org/ifgene (International Forum for Genetic Engineering)
- www.nature.com
- www.ams.usda.gov
- www.globalissues.org

SO, . . . if you are . . . . .

a farmer, . . . an agricultural planner . . . a scientist/technician . . . .a producer/processor . . . a retailer/distributor . . . a consumer . . . a health professional . . . an educator . . . a student, . . . or simply an interested reader. . . then read on!.

Science and Agriculture –
. . . from the "Green" to the "Gene" Revolution

. . . simple breeding techniques. . .

- From as early as 5000 BC, man started cross-breeding between similar species, such as, taking pollen from one plant and resting it on another to create an improved genetic variety or 'hybrid". The birth of plant breeding!

. . . led to the green revolution. . .

- In the1960s, hyrbidisation and selective breeding were used to improve the quality and quantity of grains (cereals, such as wheat, rice, oats). By using scientific techniques to improve crop varieties and seed quality and fertiliser and pesticide use, agriculture was transformed, resulting in a doubling of global cereal production!

. . . to more sophisticated science. . .

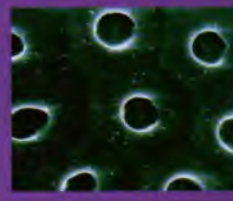
- In the early 1940s, DNA (deoxyribonucleic acid) was discovered, and, in the mid-1950s, the first model of the structure of the DNA, the double helix, was built. The seed for biotechnology!

. . . to modern biotechnology. . .

- In the 1970's, scientists began inserting a specific gene from one bacterium into another, a procedure called 'recombinant DNA technology or **genetic engineering (GE) technology - The birth of modern biotechnology!**

- In the1980's, scientists experimented with creating "genetically modified organisms", such as, making tobacco disease resistant and genetically engineering viruses to vaccinate swine against disease.

- In the 1990's, there was the more widespread use of GE technology in agriculture, and more genetically modified foods and processed food products were commercialised and traded.



Did you know that . . .

- All living organisms contain genes, each carrying a code (or set of instructions) for a particular characteristic of that organism. A gene is modified by altering its DNA (deoxyribonucleic acid), which is the material that genes are made up of.
- **Genetic engineering (GE)** is the technique of altering the genetic make-up of living organisms by cutting and pasting genes from one species (related or unrelated) into another.
- **Modern biotechnology:** is the application of biomolecular and GE technology to create processes and products of scientific and commercial value.
- **Genetically modified organisms (GMOs)** are plant and animal varieties "created" using GE technology, to improve and/or produce certain characteristics. Also referred to as "transgenic" plants and animals.

Transforming Agriculture – The Gene Revolution!

. . . the Potentials!

Because of rapid population growth, increased demand for food and the limitations of conventional production methods, GE technology appears to offer tremendous potential for agriculture and food production, as for other industries.

HOW? . . . by using GE technology, certain plant and animal species are genetically modified and GMOs are produced. Commercial crops which have been genetically modified include, rice, corn, cotton, soybean, potato, tomato, squash and papaya.

WHY? . . . because some plant and animal species possess desirable characteristics (eg. are very hardy and can survive under the most difficult conditions), while, others are more vulnerable. Transferring the desirable genes from one specie into another can enhance the qualities of commercially important species. This can have major implications for commercial agriculture both in terms of productivity and geographical spread.

WE MUST ACKNOWLEDGE the benefits that have already occurred by using GE technology to modify certain crops offers in terms of:

Improved Productivity and Competitiveness:

- greater yields in agriculture products;
- resistance to certain insects and diseases and tolerance to herbicides;
- growth adaptation to marginal conditions (dry areas, poor soils etc);
- flexible crop management
- lower cost of production hence improved market competitiveness;
- lower post-harvest losses and longer shelf life,
- superior quality – flavour, colour, texture, nutritional value, etc.

Nutritional Benefits:

- Positive implications for human health due to enhanced characteristics, such as:
  - increased protein content;
  - reduced fatty acids per gram of seed crops;
  - greater vitamin A in rice.

Environmental Benefits:

- Lower levels of harmful chemical residues on foods due to reduction in the use of pesticides, development of pollution clearing genes and bio-pesticides;
- Identifying and saving endangered species.

Note that . . . . .

- GMO is a broad term used to define animals, plants and microbes modified through GE technology (rDNA technology) as well as products, including food and enzymes derived from them.

But. . . . .

- LMOs (Living Modified Organisms) specifically refer to GMOs that are living and are hence capable of propagating and dispersing themselves.

And. . . . .

- GM foods and specifically, additives, refer to products including foods derived from LMOs.

Agriculture and the GE Controversy!

Use of GE technology in agriculture and food production is still relatively new and the residual impacts are still unknown.

Although the revolutionary nature of this technology has contributed to significant increases in agricultural production in some, mainly developed countries, it has also fuelled fear and concern over dependence on food imports by developing countries.

. . . the Unknowns!

GE technology in food production is an untested technology, with a number of unknown effects, such as:

- will a gene extracted from one specie have the same effect if transferred into a totally unrelated specie?
- what are the long-term effects of modified genes 'escaping' and mixing with or contaminating non-modified related species, i.e., 'genetic pollution'?
- how predictable are GE food and fibre products since scientists cannot control where the gene goes after insertion into the recipient organisms or how they will interact with other genes and humans/animals?

The general lack of information has raised concerns over the impact of GE technology on human health and on agriculture and the environment. Many concerns could be valid; some could also be exaggerated, consequently, the benefits and risks and their long-term effects need to be evaluated on a case-by-case basis.

continued on p. 8

Using GE Technolo
The Case of a Genetically Modified, Cold

Problem: Difficulty in growing tomatoes in colder climates.

Solution: Transferring a gene from a species that is resistance to cold climates, into the tomato.

Result: Tomato can now be economically grown in colder climates

1. Starting

Identify and isolate th
from the DNA of the
(such as a cold tolera
the arctic fi

9. End Result

Field-test the genetically modified, cold-resistant tomato for commercialization and marketing.

8.

Test for the desired characteristic to determine how well the genetically modified tomato grows in cold conditions using a controlled green house environment.

7.

Multiply the genetically modified, cold tolerant tomato, using standard in-vitro propagation techniques.

Select only cell
"genetically modif
the marker (antibi
that the desired g
genetic materi

gy to modify a crop.
Tolerant Tomato: A Simplified Illustration!

Point
e desired gene
Honor' specie,
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sh).

2.
Extract and prepare donor gene (from fish) for expression in 'recipient' organism (the tomato.) The combined donor gene and 'expression signals' are called recombinant DNA or rDNA.

3.
The donor gene is combined with expression signals and is "marked" to enable scientists to identify it after it is inserted into the organism.

4.
Use bacteria to make multiple copies of the rDNA.

5.
Insert the rDNA into the genetic material of the recipient (tomato) using specific instruments, such as a 'gene gun', or through microinjection.

6.
that have "transformed" or
ied", which can be identified by
otic resistance). This indicates
ene (from donor) is now in the
l of the recipient (tomato).

. . . the Concerns!

Health Impacts:

The introduced gene, if not properly screened, **could**:

- produce toxins/allergens and alter nutritional value;
- lead to the development of antibiotic resistance to food borne illnesses;
- reduce levels of certain naturally-occurring beneficial elements in certain GM foods and increase vulnerability to certain diseases;

Agriculture and Environment Impacts:

Plants and animal species made resistant to pests, insects, weeds and diseases through GE technology, **could negatively affect:**

- indigenous biodiversity by disrupting the natural ecosystem, threatening wild species with extinction and creating "super" weeds, pests and insects, resistant to conventional agro-chemicals and treatments.
- soil fertility and water supplies.

Social Impacts:

- GE technology is expensive, controlled by large multinational corporations and protected by Intellectual Property (IP) rights. Developing countries generally lack the resources to access this technology. If not properly regulated, GE technology could further reduce the competitiveness of small-scale agriculture and food producers.

Ethical Questions:

. . . such as should:

- genes be transferred from animals to plants; and
- the majority of improved genetic material be the property of a few large companies and, what are the potential consequences of such control, on world food security?

Trade in Genetically Modified (GM) Foods:

. . . current issues!

TRADE liberalisation has increased the spread of genetically modified (GM) food products and ingredients in markets all over the world.

Consumers, especially in the United States of America, have been using GM foods for almost a decade, apparently without their knowledge since labeling is not mandatory or required!

Q: SHOULD we expect any health disasters associated with consumption of GM foods?

A: NO one is really sure, because GE technology in agriculture and food production is still emerging and risk assessment procedures and international standards for GM food safety are now being developed.

Q: HOW are consumers reacting to GM foods?

A: SEVERAL consumers are uncertain about the safety of consuming foods containing GMOs, GM materials and inputs and worried about the lack of information on which foods contain GMOs and those which do not.

By labeling which foods and products contain GMOs, much of these concerns may be addressed. However, there are differing views on labeling and the issue continues to be widely debated.

Q: Given concerns over food safety and biosafety, is trade in GMOs and GM products currently being regulated?

A: Control of trade in genetically modified foods is being addressed by:

i. **the World Trade Orgnisation (WTO),** Agreements on Agriculture and Technical Barriers to Trade specify ***"Production and Processing Method (PPM)"*** standards that prohibit discrimination based on how or where something is produced. They apply before and during the production stage, and before the product is placed on the market, and should also apply to production and processing of GMOs and GM foods. The WTO Trade Related Aspects of Intellectual Property Rights (TRIPS) and the Sanitary and Phytosanitary (SPS) Agreements also offer some opportunity for regulation of the use of GMOs and GM products. Under the WTO, an import can be banned only on if there is scientific evidence that it can cause harm.

ii. **the Codex Alimentarius Commission (Codex)** of the Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO), is also responsible for establishing food quality and safety standards, codes of practice and other guidelines to protect public health.

iii. **the Cartagena Protocol on Biosafety** to the Convention on Biodiversity is an international framework set up to control the transboundary movement, handling, use and disposal of LMOs. The protocol includes a ***"Precautionary Principle"*** which states that a country has the right to take action to protect itself by barring import of GMOs and GM products, even if there is lack of scientific evidence that it could be dangerous.

Q: How have countries responded to concerns on GMOs and GM products?

A: Several countries have introduced national measures to regulate use of GMOs and GM products to safeguard human health and their biodiversity. The European Union introduced mandatory labeling for GM products and a pre-approval requirement for the deliberate release of LMOs and GMOs into the environment. In the United States of America, permission must be obtained from Agricultural Plant Health Inspection Service (APHIS) of the US Department of Agriculture for field testing and possible release of any transgenic material.

Q: Are these measures adequate to fully address consumer concerns and to properly regulate trade in genetically modified foods?

A: These measures still have some weaknesses, but they are a start!

– The WTO agreements were signed before public concern and interest over GMOs and GM products became a major issue. As such, they do not fully address these concerns specifically. Regulation of GE technology and products containing GMOs is now a critical topic on the agenda of the new Doha Round of WTO negotiations in agriculture.

– The Codex, in 1999, established an inter-governmental task force to expedite the development of standards for food derived from biotechnology for implementation by 2003.

– The Cartegena Protocol on Biosafety still has to be signed and ratified, by at least 50 countries before it can take effect. If agreed to, then its rules will allow countries to ban the import of GM seeds, microbes, animals and plants that they believe are harmful to their environment. The rules also stipulate that all GM foods must bear the label "may contain" before they are shipped to other countries.

GE Technology, Agricultural Trade and Food:

. . . priorities for a Caribbean response!

The controversy over GE technology, GMOs and GM products and their impacts on health, agriculture and the environment is far from over. The challenges of proving its benefits, discovering its unknowns and resolving the concerns still lie ahead.

HOWEVER, GE technology is being rapidly applied to agriculture in many countries, including developing ones, such as, Argentina and Brazil. Certain aspects of GE technology **MAY BE** beneficial to improve the efficiency and competitiveness of agricultural production in developing countries, and certain aspects **MAY NOT!**

To effectively take advantage of the best of what GE technology has to offer, **PRIORITIES FOR A CARIBBEAN RESPONSE SHOULD INCLUDE:**

- **acknowledging**, the potential that biotechnology and genetic engineering technology offers. Our competitors do recognise same!

- **keeping abreast of appropriate information** about this rapidly evolving technology so that regional governments and stakeholders TOGETHER can make informed choices and decisions on this subject.

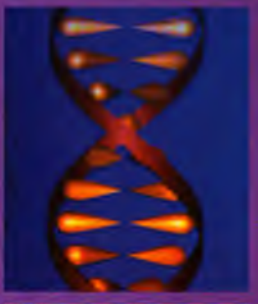
- **participating** in the development of international guidelines and national approaches for research, trial, release and commericalisation of GMOs and GM products.

- **focusing attention** on formulating national rules and guidelines to monitor and regulate any attempts to trade, particularly imports of LMOs, GMOs and GM products to prevent/limit harmful effects to humans and natural biodiversity.

Using GE technology **CAN** help to improve food and fiber production, enhance food security and protect the environment in the Caribbean. However, its applicability for use by small-scale producers and its effect on poverty and rural welfare remain under review.

AS SUCH, . . . there may be many other approaches that plant and livestock scientists can take to improve the performance of agriculture, which may not necessarily require genetic or transgenic technology.

THEREFORE, ... Caribbean countries MUST increase investment in research to give the region options for the future and MUST evaluate all available tools and techniques to improve current and potential systems, to diversify production and to add value to the region's outputs.



PREVIOUS ISSUES

Caribbean Agriculture and the WTO Agreements (1997)
Caribbean Agriculture and the WTO SPS Agreement (1998)
Understanding the WTO Dispute Settlement (1999)
Food Safety, Trade and Public Health (1999)
Caribbean Agriculture and the WTO Agreements 2nd Edition (2000)
– Closing the Information Gap (2001)

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