

## FACTS & FIGURES

**What is Biotechnology?** Biotechnology is not new. Mankind has been manipulating living organisms for its own ends for thousands of years. Three thousand years ago, civilizations were using yeast in bread, beer and wine production and using bacteria to extract minerals from ore. For the past 500 years we have been selectively breeding crops and since 1920<sup>1</sup> have been able to increase crop yields 6-fold<sup>1</sup>.

Biotechnology, in simple terms, is the use and modification of living things to make useful products to benefit human beings. More scientifically it can be defined as any technique that uses living organisms, or substances from these organisms, to make or modify a product, to improve plants or animals, or to develop micro-organisms.

Today plant biotechnology encompasses three major areas:

- Plant tissues culture
- Plant genetic modification
- Molecular breeding or Marker Assisted selection

<sup>1</sup> Laurie Kitch, Muffy Koch and Idah Sithole-Niang. 2002. FAO - Crop Biotechnology; A working paper for administrators and policy makers in sub-Saharan Africa



**Tissue culture:** Is the cultivation of plant tissues or organs on specially formulated nutrient media. Tissue culture is seen as an important technology for developing countries to produce disease-free, high quality planting material and the rapid production of uniform plants.

**Genetic Modification:** Genetic modification is the process whereby genes are moved into living organisms to give them useful and desired characteristics. Over the centuries, man has learned to accelerate this modification through classical plant breeding and selection, induced mutations, and most recently through recombinant DNA techniques (gene isolation and transfer technologies).

**Molecular breeding or Marker assisted breeding:** This is a marker assisted breeding selection technique, which enables identification and evaluation of plants carrying useful traits in a breeding population. This more precise science allows plant breeders to develop crops with specific beneficial traits and without undesirable traits.

**Any living organism that has had a gene, or genes inserted into or modified in it by modern biotechnology techniques is called a genetically modified organism (GMO). Food and products derived from these GMOs are termed GM foods or GM products.**



## GLOBAL STATUS OF AGRICULTURAL BIOTECHNOLOGY<sup>2</sup>

- The estimated global area of transgenic or GM crops for 2003, was 67.7 million hectares (ha) grown in eighteen countries by 7 million farmers, many of whom were small resource-poor farmers in developing countries.
- During the eight-year period 1996 to 2003, the global area of transgenic crops increased 40-fold, from 1.7 million ha to 67.7 million ha. This ranks as one of the highest adoption rates for crop technologies.
- In 2003, six principal countries grew 99% of the global transgenic crop area. The USA grew 42.8 million ha, followed by Argentina with 13.9 million ha, Canada 4.4 million ha, Brazil 3 million ha, China 2.8 million ha and South Africa 0.4 million ha.
- China and South Africa had the highest year-on-year increase with a 33% growth rate. China increased its Bt cotton area to 2.8 million ha. South Africa increased its combined area of GM maize, soybean and cotton to 0.4 million ha with particularly

<sup>2</sup>Global Status of Commercialised Transgenic Crops:2003

strong growth in white maize which has increased rapidly from 6000 ha in 2001 to 84 000 ha in 2003.

- In the first seven years, 1996 to 2002, a cumulative total of over 235 million ha of GM crops were planted globally and met the expectations of millions of large and small scale farmers.
- Approximately 30 000 field trails have been conducted with more than 50 GM crops in 45 countries<sup>6</sup>.
- More than 300 million commulative hectares of GM crops have been grown commercially over the past decade with no documented adverse effects to humans or animals.

## BENEFITS OF BIOTECHNOLOGY TO FARMERS

- Combating animal diseases - Biotechnology has helped to produce a vaccine that protects animals in the wild against rabies and a vaccine for "shipping fever" of cattle, the biggest killer of beef cattle in feedlots.
- Increasing yield by plant resistance to diseases and pest - Biotechnology can help farmers increase crop yields and feed even more people.
- Reducing environment pollution by reducing pesticide use - Biotechnology can help farmers reduce their reliance on insecticides and herbicides. For example, Bt cotton, a widely grown biotech crop, provides protection against several important cotton pests.
- More effective use of fertilizers
- Facilitate minimum tillage
- Uniform harvest time and product quality
- Small business opportunities

**TABLE 1: POSSIBLE PRODUCTS FOR FUTURE USE IN AFRICA**

<b>Crops</b>	<b>Traits</b>	<b>Regulatory Status</b>
Maize	Stem borer, fungus and virus resistance	Laboratory, greenhouse, Commercialisation, confined field trials
Potatoes	Potato moth and potato leaf rust virus resistance	Greenhouse, confined field trials
Tomatoes	Tomato yellow leaf curl virus resistance	Laboratory, greenhouse
Sugar cane	Quality traits	Greenhouse.
Soya	Herbicide resistance	Greenhouse, commercialisation, confined field trials
Wheat	Salt and drought resistance	Confined field trials
Cotton	Bollworm resistance	Greenhouse, commercialisation, confined field trials
Cassava	Virus and fungal resistance	Laboratory, greenhouse
Melons	Herbicide and virus resistance	Greenhouse
Other crops - such as millet, sorghum & cowpea	Includes traits such as fungal & insect tolerance & protein quality	Laboratory
Sweet Potatoes	Feathery mottle virus resistance	Laboratory, confined field trials

Source: Adapted Cohen *et al.*, 2004<sup>3</sup>



## FOOD SAFETY

- The issue of food safety has been extensively investigated and the common consensus is that food derived from **approved** GMOs poses no greater health risks than that obtained through conventional methods<sup>5</sup>. This is in line with the findings of the World Health Organization, Food and Agricultural Organisation, Codex Alimentarius, the Organisation for Economic Co-operation and Development (OECD) and several national medical associations.
- Governments only grant approval after extensive biosafety assessments of each GM crop.
- All genetically modified (GM) crop plants that will be used as foods or as food ingredients are required to undergo thorough and rigorous safety assessment.
- The bottom line is that food derived from GM crops presently available, is safe. Some of the safety assessment tests carried out include: allergenicity tests, toxicity tests, pathogenicity, stability, biodiversity tests, etc. What is required to ensure ongoing safety of food is, firstly, that regulatory systems be continuously applied to all new foodstuffs and, secondly, that the same assessments be applied to all other food products, including conventional and organic foods.



## PATENTS AND INTELLECTUAL PROPERTY

- Patents are essential to encourage innovation and openness in scientific research.
- Denial of intellectual property rights should not be used as a means to regulate or restrict scientific research. This would discourage transparency, stifle investment in technological advances and confine knowledge.
- Patents provide an incentive to innovation. Without the safeguard provided by patents, industry and other inventors would be unwilling to invest their time and money in research and development. This applies to biotechnology as well as any other area of technology.
- Patents, copyright, breeders rights, etc, are the means whereby companies can recoup the investment they make into the development of new products.
- There are no reasons why biotechnology inventions should be treated differently to any other inventions.
- Benefit sharing from indigenous knowledge is being addressed by some governments in Africa.



## TRANSBOUNDARY MOVEMENT OF LIVING MODIFIED ORGANISMS

The movement of living organisms is largely covered by existing trade and pest control regulations. However, the Cartagena Protocol on Biosafety (CPB) has been specifically negotiated to ensure that **living** GMOs are not sent to countries without their prior approval and without a chance to review their human safety and environmental impact. This Protocol came to effect in September 2003.

Signatories to the CPB will have to bring their national legislation into line with the Protocol's requirements. For many this will mean the development of biosafety regulations.

Details of the Protocol can be found on the CBD website:

<http://www.biodiv.org/biosafety/default.aspx>  
and <http://bch.biodiv.org>



## MYTHS

**GM crops will become invasive.** To date no conventional or GM food crop has shown any tendency to invade the environment.

**GM crops will reduce biodiversity.** The same argument is used against conventional varieties and hybrids. South African farmers have access to some 3 000 to 3 500 crop varieties, more than ever before.

**Horizontal gene flow from GM crops by cross-pollination.** Cross-pollination can only be a threat if the crop plant can fertilize wild species to produce seeds which can germinate and produce fertile off-spring.

**GM crops will become superweeds.** No Bt crop can become a superweed. There are no herbicide resistant GM crops which have become superweeds. One can always spray a herbicide tolerant plant with another herbicide to knock it out or destroy it by mechanical methods.

**GM crops will result in pest resistance.** Inevitably over a long term, perhaps, but the same happens in conventional varieties. Why hasn't cotton bollworm become resistant to Bt toxin after 40 years of use as spray-on insecticide? Many Bt genes are now available with different modes of toxic effect, making resistance less likely. In addition, farmers are

required to implement resistance management strategies to minimize the chance of resistance developing.

**Bt crops will affect non-target insects (Losey's Monarch butterfly test).** Spray-on insecticides affect all insect, frogs and fauna in the field. GM plants with the Bt gene kill only larvae that feed on the plant. The Monarch story was based on poor science and disproved by follow up studies. Dozens of independent studies have shown Bt crops to have less impact on non-target fauna, including lacewing.

**GM crops will make people lose jobs.** GM crops reduce time spent on weeding and insecticide spraying, enabling time for family care, self-development and expanding business. New technologies create new job opportunities.

**Organic farming can feed the world.** Organic production yields are lower than conventional and have an increased food health risk. Informal organic farming can help address household food security in rural areas, but cannot meet the national demand for good quality, safe basic foods like wheat, maize and potatoes.

\* Bt: see glossary



## AGRICULTURAL BIOTECHNOLOGY IN AFRICA

- Malnutrition is widespread in Africa, even when growing conditions are satisfactory.
- In Africa, farming is the most important economic activity, occupying 60 to 80% of the population and contributing 30 to 50% of the national GDP. 80% of food production is in the hands of small-scale farmers, most of whom farm on small, low-yielding holdings.
- New approaches that will empower African farmers are urgently needed. Just as today's population of 6 billion people could not be fed if farmers relied on farming methods used in the 1940's and 50's, so today, farmers need to adopt new farming methods and improved plant varieties to meet present and future needs.
- When accompanied with the appropriate farming practice, plant biotechnology has shown that it can help farmers improve their productivity.
- Biotechnology in Africa must be considered in the context of Africa's needs for increased food production, poverty alleviation and environmental protection.

- Plant biotechnology is a powerful tool for agricultural research that allows plant breeders to develop plants with special characteristics.
- Africa, in the light of its own priorities and circumstances, needs to determine how it will use the products of modern biotechnology. Considering the overwhelming need to grow more food, fibre and feed in a productive, profitable and environmentally sustainable way, avenues need to be found to maximize the benefits and minimize any potential risks, associated with biotechnology.
- Agricultural biotechnology is not the only tool that can alleviate hunger in Africa, but it is one of the many tools that Africa needs to solve its food shortage problems.
- Biotechnology research is currently underway in crops that are important to Africa e.g. maize, banana, millet, sorghum, cowpea and cassava. Key traits such as disease, pest & drought tolerance, nutrient enrichment and quality improvements are being addressed.

## OVERVIEW OF AGRICULTURAL BIOTECHNOLOGY IN SOUTH AFRICA

- The South African government ran an interim biosafety assessment and decision-making process from 1990 to 1999 that led to the establishment of the Genetically Modified Organisms (GMO) Act No. 15 of 1997.
- Controlled field trials with GMOs began in 1990 and resulted in the 1997 issuance of the first conditional commercial release permit by the National Department of Agriculture.
- The first GM crop tested was Bt cotton in 1990. Approval for commercial release was only given in 1997.
- Adoption was very rapid after full assessments had been carried out. The present national cotton crop is over 80% GM. Over 90% of small scale farmers grow GM cotton.
- GM maize was approved for commercial release in 1998 and the first application comprised some six yellow maize hybrids.
- GM soybeans were approved in 2000 and some 5% of the 2001/2002 crop was GM. The present crop is about 35% GM.



- The area in South African planted with GM crops in 2003.

<u>Crop</u>	<u>Hectares</u>	<u>% of total crop</u>
White maize	140 000	8
Yellow maize	190 000	20
Soybean	42 000	35
Cotton	28 000	80

- The number of GMO permits applied for and issued by the National Department of Agriculture between 2000 and 2003.

<u>Year</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>
No. of applications	79	173	232	213
Field trials	45	62	49	16
Greenhouse trials	1	2		4
Export	3	22	42	71
Import	63	67	98	76
Commodity clearance	6	6	4	6
General release	1	3	1	1
Commercial planting		9	11	33

## THE GENETICALLY MODIFIED ORGANISMS ACT, 1997

- The Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997) was implemented on 1st December 1999, making provision for the biosafety assessments of GMOs.
- The objectives of the Act are to provide safety measures, for humans, protect the environment and establish acceptable standards for risk assessment for the application of biotechnology in South Africa. Before the Act was implemented, the Department of Agriculture used interim guidelines to regulate the safety of all GMO trials and commercial releases i.e. an amendment under the Agricultural Pests Act No. 36 of 1983.

## SOUTH AFRICAN LABELING LEGISLATION

The new South African labeling Legislation came into effect on the 16th of January 2004. This is to guide the labelling of a foodstuff significantly different in respect of the composition, nutritional value, and mode of storage, preparation or cooking, allergenicity or containing genes of human or animal origin.

The full labeling legislation can be found on the South African Department of Health website, at: [www.doh.gov.za](http://www.doh.gov.za)

Other legislation relevant to biotechnology in South Africa includes the Patents Act of 1978 and two amendments bills passed in 1997, the Counterfeit goods bill and the Intellectual Property Laws Amendment bill; the Cartagena Protocol on Biosafety 2003; Act 36 of 1947 Governing agricultural products; plants Breeders Act; the Biodiversity and Protected Areas Bills; and the Medicines Control Act no. 101 of 1965. In addition to the above legislations, South Africa has signed bilateral agreements with at least 12 countries that include co-operation on biotechnology.

In a recent survey of biotechnology activities in South Africa the following facts were identified<sup>4</sup>

- South Africa has been involved with biotechnology research and development for over for 20 years. Plant trials have been carried out under the existing legislation for over 10 years
- There are 106 research organizations and companies participating in biotechnology activities
- A total of 622 research groups were identified as being involved in biotechnology –related activities
- At least 154 biotechnology products and/or services were identified
- There are some 1650 plant breeders rights of which 40% is owned by South Africans (details per species group are available)

By making use of new technologies South Africa has being able to achieve the following:

- Adoption of improved seed, new varieties, fertilizers, crop protection chemicals and improved farm management systems have resulted in increasing yields per hectare 5 fold for maize and 4,5 fold for wheat since 1950.
- Over 20 million pine and eucalyptus trees are being produced p.a. by tissue culture and micro propagation; some 12 million banana plants through tissue culture of which over 50% are exported, 90% of banana plantations are from tissue culture, and yields have increased 2,5 fold in 15years. Add to this tissue culture papaya, citrus and ornaments.
- Profile of farmers: 50-60 000 commercial, 590 000 emerging and 1 million subsistence households.
- Some research organization and companies are presently utilizing maker assisted techniques in their programme.

## OVERVIEW BIOTECHNOLOGY IN ZAMBIA

In the summer of 2002, Zambia was in the midst of a food security crisis induced by erratic rains and other factors. Despite severe shortages that put nearly 3million people at risk of starvation, the Zambian Government rejected US- donated maize because it could not be certified as being free of GM maize. Since then, there has been more or less a moratorium on GM products in Zambia.

Genetically modified crops could boost Zambia's agricultural productivity and sustainability but these products should be managed effectively. Currently, there is no research and development underway in Zambia on GM crops or other GMOs because potential technology providers are awaiting the adoption of the policy on biotechnology and biosafety and legislation before conducting field trials. However, Zambia has a strong history of success in the first and second generation biotechnology such as plant and animal breeding, tissue culture, microbial processes and diagnostics.

Zambia does have a biotechnology policy that was ratified by cabinet in 2003. A strategy and action plan is in place to help Zambia rationalize and streamline biotechnology in the country. What is missing is the legal framework but this was supported at the

opening of third session of the ninth national assembly, when the Zambian President implored the members of parliament to support the biosafety bill **when** it is presented by government - quote "so that we move with the rest of the world in harvesting from the bounteous promises of biotechnology" end of quote.

By BOSZ, 2004

## STATE OF BIOTECH IN THE SADC REGION

The SADC Member States have no harmonized regional position on biotechnology and biosafety and in particular the handling of GMOs.

In order to develop a common position and harmonized legislation on biosafety, the SADC Council of Ministers has directed all Member States to enact national legislation by 2004 taking into account the Cartagena Biosafety Protocol and the Draft OAU Biosafety Model Legislation. At present only South Africa and Zimbabwe have implemented their legislation on GMOs, while Malawi and Mauritius have just passed their legislation on GMOs.

In October 2002, a meeting of the SADC Council of Ministers established an Advisory Committee on biotechnology and biosafety. This Advisory Committee was tasked to develop **Capacity Building** at national and regional level in order to develop and exploit the benefits of biotechnology, assist member states with **Policy and Regulations** and expedite the process of establishing national biosafety regulatory systems.

The Advisory Committee also started developing guidelines to safeguard Member States against potential risks in the following areas:

- food safety;
- the environment;

- ethical issues;
- trade related issues;
- consumer concerns; and
- assistance to member States in the development of legislation on GMOs.

## NEPAD

The New Partnership for African Development (NEPAD) has set up an Advisory Panel on biotechnology and biosafety under the Forum for Agricultural Research in Africa (FARA) to guide African leaders on biotechnology and biosafety.

The panel has been charged with developing an African strategy on biotechnology, including genetically modified crops. The panel will also attempt to harmonize biosafety regulations between African countries to facilitate trade.

"Biotechnology has a wide scope of applications that covers almost all major industrial sectors. As early as 1992, its relevance to the developing world was recognized when Agenda 21 outlined the potential of biotechnology to key areas in sustainable development. More recently, the Human Development Report (2001) acknowledge biotechnology's potential to tackle major health challenges that face poor countries such as HIV/AIDS and malaria, as well as its potential to be the only or the best 'tool of choice' for food production in marginal ecological zones". - UNIDO

NEPAD has also recognized the role that biotechnology can play in sustainable development, agriculture and health in Africa.

NEPAD's approach has been to mandate specific structures, such as FARA, with developing strategies for biotechnology and biosafety.

## STEPS TOWARDS ESTABLISHING A BIOSAFETY FRAMEWORK<sup>2</sup>

1. A national policy on the use of modern biotechnology should be established to guide decisions taken about the use of GMOs;
2. Development of a national biosafety framework should follow extensive consultation to ensure public awareness and input;
3. Consultation within existing departments of environment, agriculture, trade, industry, science & technology and health will ensure that the infrastructure is cross-sectoral, efficient, cost-effective and implementable;
4. An interim framework can be implemented using biosafety guidelines and an existing permit system for approvals (e.g. a plant Pest Act) while the legislation for the final framework is being modified or developed;
5. Implementing the biosafety administration will be facilitated by capacity building in both handling of GMO applications and biosafety review training;
6. Reasonable fees charged to applicants can cover efficient review process.



## BIOTECHNOLOGY FACTS IN THE EU

- Towards the end of 2003 the EU guidelines on genetically modified food and its traceability came into action.
- These guidelines will come into force in April 2004. From that date all food that has either been produced from genetically altered raw material or that contains more than 0.9% genetically modified ingredients will require labeling with this information in its list of ingredients.
- The following products are excluded from authorization, labeling and traceability requirements: processing aids (i.e. enzymes) used in food/feed processing, food/feed manufactured with the help of GM (i.e. GM micro-organisms), and meat products from animals fed on GM feed or treated with GM medicinal products.
- Since Directive 90/220/EEC entered into force in October 1991, the commercial release of 18 GMO's has been authorized in the EU by a Commission Decision, mostly following a qualified majority vote in the Regulatory Committee. In two cases the Commission Decision has not yet been implemented by the Member State. Since October 1998 no further authorizations have been granted and there are currently 14 applications pending.
- Out of the 18 approval 8 are for feed, and two are for use in food products (a variety of maize and a variety of soya)

## GLOSSARY

- **Agrobacterium:** a naturally occurring bacterium that has the ability to transfer genes into plants such as tobacco and soybean.
- **Bacillus thuringiensis (Bt):** a bacterium which is present naturally in the soil worldwide. A unique feature of this bacterium is its production of crystal-like proteins that selectively kill specific groups of insects. The Cry1 ab provides excellent protection against stalk borers.
- **Biodiversity:** the wide diversity and interrelatedness of earth organisms based on genetic and environmental factors, the variety of flora and fauna and microorganism in the natural environment.
- **Biotechnology:** is the use and modification of living things to make useful products to benefit human beings. More scientifically it can be defined as any technique that uses living organisms, or substances from these organisms, to make or modify a product, to improve plants or animals, or to develop micro-organisms.
- **Bt crops:** genetically modified crops that carry the gene from the soil bacterium *Bacillus thuringiensis*. The bacterium produces a protein that is toxic when ingested by certain lepidopteran insects.

Crops containing the Bt gene are able to produce this pro-toxin, thereby providing protection throughout the entire plant.

- **Bt cotton:** genetically modified cotton for the control of budworms, bollworms, and pink bollworms.
- **Bt maize:** genetically modified maize that provides protection against the stalk borer.
- **BOSZ:** Biotechnology Outreach Society of Zambia.
- **Genetically modified organisms (GMOs)** any organism whose genetic makeup has been altered by the insertion of small fragments of genes or genetic material to enhance desirable characteristics.
- **Genetic modification:** a technique whereby individual genes can be copied and transferred to another living organism to alter its genetic make up and thus incorporate or delete specific characteristics into or from the organism.
- **Genetic engineering (GE)** same as above.
- **Herbicide tolerant:** a plant that is tolerant of (specific) herbicides. Herbicide-tolerant crops were developed to survive certain herbicides that previously would have destroyed the crop along with the targeted weeds, and allow farmers to use them as post emergent herbicides, providing an effective weed control.

## REFERENCES

1. **Laurie Kitch, Muffy Koch and Idah Sithole-Niang. 2002.** FAO - Crop Biotechnology; A working paper for administrators and policy makers in sub-Saharan Africa
2. **Dr. Clive James** "Global Status of Commercialised Transgenic Crops:2003",
3. **Joel I. Cohen, John Komen and Jose Zepeda. 2004.** African Agriculture and Biotechnology – Assuring Safe Use While Addressing Poverty. Report prepared for the World Bank, African Region
4. SA National Biotechnonology Survey 2003
5. **Klaus Ammann:** The impact of agricultural biotechnology on biodiversity a review. Full version 12, April 2004
6. Comprehensive Reviews in Food Science and Food Safety. ILSI Vol. 3, 2004