SUMMARY

Background
Different scientists have defined the term biotechnology. These definitions reflect the particular perspective of the scientists. To some, it is the application of scientific and engineering principles to the processing of materials using biological agents, to provide goods and services. To others, it refers to any technique that uses living organisms or substances from living organisms to make or modify a product, to improve plants or animals or to develop microorganisms.

From these definitions it is obvious that the concept of what started as the science that deals with the application of living organisms to provide goods and services has now been modified to the more recent definition of the commercialization of the products of genetic engineering based on the use of new techniques of recombinant DNA technology, monoclonal antibody technology, new cell and tissue culture methods; hence, the now two clear groups of “traditional” and “modern” biotechnologies. The traditional biotechnologies such as biological nitrogen fixation, plant and animal breeding and microbial fermentation are based on the use of whole, living organisms. Modern biotechnology on the other hand, deals with the more recently developed technologies based on the use of recombinant DNA technology otherwise known as genetic engineering, new cell and tissue culture techniques, bioprocessing, etc.

The conventional breeding process being the basis for the development of essentially all varieties of plants used in African agriculture today is slow, commonly requiring 10 years before a new variety is ready to be released. One of the biggest problems with this process is that a desirable characteristic being sought to improve a given species may not be found among any of the plants of that species in the world. Improvement by conventional breeding can thus reach a dead end for that desired trait. For example, if resistance to a particular insect is needed in a given crop species and no such resistance is found in any plant of that species in the world, then protection of that crop
may be dependent upon insecticides which can have environmental consequences. Recombinant DNA technology has the potential to avoid some of the difficulties limiting conventional techniques and brings the possibility of introducing into cultivars traits from an unlimited gene pool. The same method could be used to increase yield, improve cold hardiness, drought resistance, or add any desirable characteristic. Such crops are commonly referred to as genetically modified (GM) crops. They are only the last development stage in a long row of breeding method enhancements, and the list is fast on the increase.

Productivity of crop plants is challenged by abiotic and biotic stresses. Abiotic stresses include water challenges—drought, temperature extremes, soil infertility, acidity, alkalinity and salinity. Biotic stresses include weeds, insects and plant pathogens such as fungi, viruses and bacteria. Biotechnology is therefore a valuable tool in plant breeding to transfer new genes into crop varieties and introduce desired characteristics, as well as a tool for acquiring knowledge. Crop development and the use of new or improved food, fiber and plant–made pharmaceutical products through biotechnology have been the subject of widespread discussion and debate. Examples of these new products include plants that make more protein or resist pests better than conventional varieties. But what is biotechnology? How does it work? Are the products safe? What are the successes and challenges of this technology?

The Successes
Modern biotechnology in the field of medicine and human health has been accepted as a safe and effective means to provide more and better treatments. But the extent to which the technology is fully utilized in agriculture and crop production depends on the support for innovation and improvement in farming and crop production systems as well as support for scientifically sound regulatory policies that protect against safety risks. However, with the continuing accumulation of evidence of safety and efficiency and the absence of any evidence of harm to the public or the environment, more and more consumers are becoming as comfortable with agricultural biotechnology as they are with medical biotechnology (Alan Mchughen, 2002). Only recently, the European Union lifted a six–year moratorium on genetically modified maize
called Bt–11 developed by the Swiss biotechnology company –Syngenta. The maize is to be canned and labeled as GM food and sold for human consumption in supermarkets. Whereas Europe calls GM foods “Frankenstein foods” and argue that such foods may cause cancer or fatal allergy, Scientific evidences point to the fact that the foods are safe (United Nations Food and Agriculture Organization, 2004 annual report). FAO’s message is that farmers in Africa struggling with a patch of millet, cowpeas or cassava – armed only with a hoe and a prayer – need crops engineered to resist drought or local pests. Agriculture is the livelihood of 70% of the world’s poor, a population that is growing considerably, even as soil and water are depleted. Billions of people are already malnourished because their staple crops supply few nutrients. Genetic engineering can help. The poor need a “gene revolution” to follow the 1960’s “green revolution” which helped hundreds of millions by increasing yields of wheat, rice and other crops. The world will have 2 billion more mouths to feed during the next 30 years. The possible solution to feeding them is to enable poor farmers grow genetically modified crops that are higher yielding. The UN agency found no health or ecological drawbacks to GM crops. The benefits to poor farmers are that GM seeds offer higher yields and are resistant to disease, pests and droughts, and have environmental benefit of needing less chemical fertilizers and pesticides as well as herbicides. The Agency rightly urges wealthier agricultural nations to develop and disseminate GM seeds for poor farmers and to develop GM seed for “orphan crops” – millet, sorghum, cowpeas – typically grown in poor countries as well as such Third World crops as bananas, cassava and rice (‘A call for gene revolution’ – New York Times (Editorial), May 24 2004).

About half of all the corn and more than 80% of all the soybeans being planted in the US this spring are genetically enhanced, according to the US Department of Agriculture. These figures have been rising steadily since biotech crops first were introduced commercially about a decade ago and will increase even more in the years ahead. That’s because biotechnology has improved the bottom line for farmers. It has enabled the boosting of productivity and the growing of crops in cleaner fields. A friendlier environment for wildlife and the reduction of soil erosion is being created.
Soybean is one crop in the world where the transgene has been so successful in raising yields such that within the next 18 months to two years it will be all but impossible to find secure supplies of non-GM varieties. Soybeans and soymeal are grown mainly in the United States, Argentina, Brazil and parts of Asia. They have wide use in the food chain and are used in large quantities as a high-protein feed for animals, as well as in processed foods for humans. They come very close to being the ubiquitous food crop, ranking alongside wheat and corn.

An application to conduct field trials on GM potatoes at six sites in South Africa has been submitted to the government. The application is by the Agricultural Research Council and is for trials designed to test potatoes that have been genetically manipulated to prevent damage by moth larvae that feed on the plants, and damage by antibiotics.

China, India and the Philippines are getting good responses from the field trials of GM rice, but their first commercial crop may be about three years to five years.

Argentinean grain production underwent a dramatic increase in grains production (from 26 million tons in 1988/89 to over 75 million tons in 2002/2003). Many factors contributed to this ‘revolution’, but perhaps the most important was the introduction of new genetic modification technologies, specifically herbicide-tolerant soybeans. Institutional factors that led to the successful adoption of GM technologies, include the early availability of a reliable biosafety mechanism, a special intellectual property rights situation, the favourable market pricing for GM soybeans and glyphosate and agreeable trade relations.

GM crops are being grown extensively in North and South America and China and have become part of the normal diet there. In Europe the contention continues despite the fact that millions of US citizens eat GM soya without any ill-effects. European consumers’ opposition to GM foods has had serious repercussions for plant research, for the commercial development of new crops and, most importantly, for developing countries that could benefit most. Several countries in Africa and elsewhere have resisted growing them, mainly for fear of being unable to export them to European market. These concerns
have resulted in an unprecedented effort to investigate those anxieties and communicate with public, particularly in the UK.

**The Challenges**

From all these success stories, it's only reasonable to recommend that African nations join the bandwagon or we shall forever be left behind as in the ‘green revolution era.’

A review of agricultural biotechnology in Sub-Saharan Africa in 1999 shows that the major players in this new technology are the International Agricultural Research Centers (IARCs) such as International Institute of Tropical Agriculture, Ibadan, Nigeria and International Livestock Research Institute, Nairobi, Kenya; some national agricultural research services (NARS) and various University Departments (ISNAR 1999). South Africa has an extensive research base in plant biotechnology. Several countries – Botswana, South Africa, Swaziland and Zambia increased their investments in scientific research. Both South Africa and Zimbabwe have enacted legislation to regulate the safe introduction of GM technology. South Africa has undertaken over 200 field trials with GM plants produced through collaborative arrangements using international and local technology. South African government has granted approval for the commercial production of four GM crops (insect tolerant cotton, insect tolerant maize, herbicide tolerant cotton and herbicide tolerant soya). Egypt, Nigeria, Cameroon, Uganda, Kenya, Malawi, Zambia, Namibia and Mauritius have draft regulations ready for submission to parliament. Of these countries Egypt, Uganda, Kenya and Zambia have carried out GM trials under confined conditions. Mauritius has locally developed GM sugar ready for field trials, but is awaiting the adoption of a biosafety framework and protocol to initiate tests. Twenty-eight countries have signed the Cartagena Protocol on Biosafety and have either developed or are beginning to develop their respective national biosafety regulations. Nigerian has biosafety guidelines that have been approved by the Federal Executive Council and its about to complete its national biosafety framework. South Africa, Kenya, Zimbabwe, and Egypt are obviously ahead of the rest of Africa in the adoption of Biotechnology as a tool for ensuring increased agricultural productivity. **Other African governments should ensure that**
mechanisms are put in place to create enabling environment for the successful conduct of research in biotechnology.

Finally, appropriate infrastructures and agricultural policies, access to land and water are all-important for crop production. GM crops can contribute to substantial crop production. The crops can also be used to prevent environmental degradation, and to address specific ecological and agricultural problems, which have proved less responsive to the standard tools of plant breeding and organic or conventional agricultural practices.

The use of GM crops should however, be on a case–by–case basis. Agro–ecology and the economy of the countries within Africa vary and, therefore, it is important to know how the use of GM crop compares to other alternatives in each country.

It is pertinent to note that the use of GM crops can have considerable potential to increase yields of crops thereby improving agricultural productivity and the livelihood of the rural populace. This will contribute to the reduction of poverty and to improve food security and economically valuable agriculture. Let me end by reminding us of this statement by scientists

“Eco–friendly” Genetic Manipulation will provide the Answer to Agriculture’s Greatest Challenge”