EMBRACING BIOTECHNOLOGY IN NIGERIAN AGRICULTURE: ISSUES AND OPTION

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ABSTRACT

One of the major problems facing the world today is the ability of all existing nations, especially the developing ones to feed their ever increasing population. Culture, science and technology are all doing their best to be seen as basic contributors to this desired objective. As part of the efforts, biotechnology: Genetically Modified Organisms (GMOs) revolution has come to play a significant role in the production of crops and animals, processing of food and agro-industry through the use of a wide range of methods both ancient and modern to manipulate organic matter to meet human needs. Towards this, a continuum of technologies ranging from traditional to modern biotechnology has been employed. But considering the issues attached to the employment of modern biotechnology, options were suggested to ensure continuous food production and biosafety.

Keywords: Biotechnology genetically modified organisms, Agro-industry, and biological research.

INTRODUCTION

During the 1970s the word "Biotechnology which previously had a career in food processing and agro-industry began to be used by Western scientific establishments to describe a relatively narrow range of laboratory based techniques then being developed in biological research. In fact, the term could, perhaps be understood in much broader sense to connote the whole range of methods both ancient and modern used to manipulate organic matter to meet human needs. Biotechnology can be defined as the application of indigenous and/or scientific knowledge to the management of (parts of) micro-organisms or of cells and tissues of higher organisms, so that these supply goods and services of use to human being (Bounders, *et al*, 1996).

According to Thottapilly, *et al*, (1992), biotechnology is comprised of a continuum of technologies, ranging from traditional biotechnology to modern biotechnology. In this context, biotechnology is defined as "any technique that uses living organisms or substances from those organisms to make or modify a product, to improve plants or animals or to develop micro-organisms for specific uses" Office of Technology Assessment (OTA) (U.S. congress, 1999).

Bunders, *et al*, (1996) looked at biotechnology as a continuum of technologies ranging from the sample to the sophisticated and from those long established and widely applied by ordinary people to those more recently developed and, as yet, comparatively little used except by high trained specialists. Agricultural applications of biotechnology covers diverse fields such as traditional fermentation technology in food processing and the use of a particle gun to transfer genes from one plant species to another. The purpose of this study is to review the effect of biotechnology on Nigerian agriculture.

METHODOLOGY

This study is based on desk review of relevant literature on the relationship between biotechnology, agriculture and environment. Secondary sources of information such as textbooks, Journals, Magazines, research findings, memograph, web search and CD-ROMS etc. were adopted.

TRADITIONAL BIOTECHNOLOGIES

Several traditional practices in our community reveal indigenous biotechnology at work. Soil fertility and the protection of natural resource base were secured through the natural process of shifting cultivation, bush fallowing and composting in our communities. Pests were not a major problem to agriculture under our traditional system. Our farmers try to keep infestation at low levels by maintaining biodiversity through the intensive mixed cropping. Akale (2004).

Our forefathers recognized that plant was a complex medical factory. For many generations, these natural factories made compounds which were used in the treatment of various human and animal diseases.

Genetic conservation was once part of the traditional farming system. Each farmer was both a conserver and a breeder of plant genetic resources by selection and choice of planting materials based on the best size, colour and taste. They maintain genetic diversity by borrowing and exchanging seeds, even today. Animal breeding was done by borrowing diverse high producing and disease resistant breeds. Others were bought or borrowed and crossed with their own stock based on size colour and sure-footedness. Simply put, traditional biotechnology covers well established and widely used technologies based on the commercial use of living organisms. These include the biotechnologies currently used in brewing, food fermentation, conventional animal vaccine production and many others.

NEW BIOTECHNOLOGIES

New biotechnologies could play a decisive role in agriculture because of their ability to directly modify plants, animals and agricultural processes in response to new needs. What was seen as promising technologies a few years ago have already produced new varieties (Bunders, 1996). New biotechnologies should not be seen only as a means of solving problems when traditional techniques have failed but also as a way of generating a better understanding of crop plants through the cooperation of scientists from different disciplines, who for the first time are basing their model for their studies on plants. Muscular biologists, biochemists, physiologists and virologists working with plant geochemists, breeders, pathologists and

entomologists, can form research teams capable of bringing about a revolution in the agricultural sciences.

According to Bunders (1996) biotechnology represents the latest front in the ongoing scientific progress of this century. However, it's increasing importance at least in plant improvement should not obscure the fact that traditional plant breeding, based on hybridization, followed by selection and evaluating of a large population on the field accounts for over 50% of the global increase in agricultural productivity. Hence, increase in agricultural productivity today should be based on integrated system – traditional biotechnology complementing the modern biotechnology.

DIFFERENCES BETWEEN BIOTECHNOLOGY AND TRADITION AL AGRICULTURAL TECHNOLOGIES

- First, the creation of biotechnologies involve inputs from various scientists such as molecular and cell scientist and cytogeneticists, who are not a part of the traditional agricultural research extension network. In fact, many of the scientists engaged in agriculture – related research are not in the colleges of agriculture or agricultural research stations, and they may have little, if any, familiarity with agriculture. This poses a problem in establishing research priorities that reflect the needs of farmers and consumers.
- Second, the processes and products of biotechnology are often patentable. This has greatly stimulated the private investment in agricultural research. Whereas, traditionally the back of agricultural research was conducted in the public sectors today, private sector investment in biotechnology – related research exceeds public sector investment. A division of labour is developing between the two – sectors, with the public sector focusing on basic science and private sector on technology development.
- Third, research in between technology is expensive. Simple forms of biotechnology research, employing techniques such as tissue culture to propagate a disease free perennial, may cost not less than1 million US Dollars and take 3-6 years. However, genetic engineering or gene transfer may require between 50 million and 500 million US Dollars and 1-4 decades to achieve the goal.

  The implications for developing countries are clear. Basic biotechnology research is too costly and too demanding of scientific skills for the limited resources of most of these countries. Access to biotechnology may be further restricted by the private sector. However, in other to gain access to biotechnologies and to adopt these technologies to local conditions, developing countries should first and foremost develop a research establishment strongly founded in the traditional agricultural disciplines, such as plant breeding, agronomy, plant pathology and entomology.

THE RELATIONSHIP BETWEEN BIOTECHN-OLOGY, AGRICULTURE AND ENVIRONMENT

The growing human population and concomitant increase in use of natural resource are generating a series of negative effects on ecosystem, such as pollution, lose of genetic diversity, soil fertility decline, climatic changes, deforestation and desertification. Agriculture is asked to satisfy two apparently contradictory needs – to become more productive and at the same time more sustainable; that is, to supply the food needed without depleting renewable resources. Breeding plants that have higher yields of better quality but do not already affect the ecosystem can be achieved only through a very broad scientific input.

CURRENT ROLES OF BIOTECHNOLOGY IN CROP IMPROVEMENT

Biotechnology has done a lot in the area of crop improvement. A summary of this effort can be seen in the table below.

	TECHNOLOGY	APPLICATION
i	Meristerm and bud culture	Micro-propagation for commercial purposes, genetic conservation and exchange of material.
ii	Zygote embryo culture	Inter-specific crosses.
iii	Anther and microspore culture	Haploid production
iv	Cell and tissue culture	Invitro selection, soma clonal vanation, somatic embryo genesis, artificial seeds
v	Chromosome engineering	2n gamates for interspecific crosses
vi	Protoplasm culture	Fusion for somatic hybridization
vii	Genetic engineering	Gene transfer
viii	Molecular markers	Aid to breeding programmes
ix	Monoclonal antibodies	Diagnosis of plant diseases

Source: Bunders, *et al,* (1996)

FUTURE OF BIOTECHNOLOGY

In the near future, efforts should be devoted to obtaining transformed plants from apparently recalcitrant species. As noted above, there is the need to increase the number of isolated genes, particularly those conferring resistance to pests, diseases and abiotic stresses and for quality improvement. Attention should be given to genes coding for the reproductive process, such as genes for self compatibility and for male sterility, and to genes which influence the interaction between host and symbols in nitrogen fixation. The development of an appropriate methodology for producing artificial seeds will open the way to considerable progress in agriculture through better establishment and uniformity of crops. Mapping of the genemes of the most important crops should be one of the priorities of current and future genetic research. This will result in the production of new crop planted with desirable traits and in a better understanding of plants physiological processes. However, there is the risk that while new biotechnology will certainly improve knowledge of crop genetics, patents could severely limit its application in crop improvement. This problem should not be underestimated; a solution must be found that takes account of both private interests and agricultural progress.

ISSUES IN EMBRACING BIOTECHNOLOGY

Biotechnology has many advantages but that does not define it without limitations in deciding to embrace biotechnology, several issues of great significance are put into consideration. Some of these issues are;

- **Funding:** Research in biotechnology is expensive. The implication of this for developing countries is clear. Basic biotechnology research is too costly and too demanding of scientific skills for the limited resources of most of these countries. Access to further biotechnologies may be restricted by the private sector. However, in other to gain access to biotechnologies and to adapt these biotechnologies to local conditions, developing countries should first and foremost develop a research establishment strongly grounded in the traditional disciplines such as plant breeding, agronomy, plant pathology and entomology.

- **Crop priority**: The place of private sector in basic biotechnology is central. Private sectors go in for crops that are popular and have public acceptance. Crops such maize, wheat, rice etc are their central areas of target, which in most developing countries have low scale of production, but they give low priority to crops like yam, cocoyam etc which form basic stapless of the people.

- **Terminator technology**: Most seeds of genetically modified organisms (GMO) are not productive and the few that are productive have span of life that is not too long, hence, the production of GMO materials on a continuous basis become difficult.

- **Intellectual property management**
  The major issue that will affect the application of biotechnology in agriculture is the protection of intellectual property. The lack of patent protection is a major disincentive for private sector (local and transnational) investment in biotechnology in the developing world. The advantage of the availability of intellectual property protection (by various mechanisms) is that it encourages the development of local research capability and greater in-country investment in biotechnology. The major disadvantage is that it involves giving proprietary protection to living organisms which some consider being part of the common heritage of mankind. Each country needs to weight the benefits and cost of intellectual property rights in biotechnology and frame its policies accordingly.

- **Biosafety**
  Another important issue that will affect the application of biotechnology to agriculture concerns the regulations governing the release of model products. A safe and efficient regulatory environment is in itself a comparative advantage in biotechnology. Actions have been taken in several countries to ensure environmental safety and public health in biotechnology applications in agriculture procedure have been developed to access high, medium and low level of risks associated with the release of genetically engineer

organisms, and guidelines formulated to govern national regulatory systems, these systems are based on tiered structure of responsibility involving a national review body: Institutional biosafety committees and project biosafety reviews.

- **Public/private sector collaboration**:
  The major change in the funding of agricultural research in the individualized countries in the past decades has been the greatly increased role of the private sector, largely in modern biotechnology. It has been estimated that at least half the current funding of research and development (R&D) activities in agricultural biotechnology worldwide comes from private sector, the major reason for this is that for many of the new technologies, the process and/or the product" is patentable. A company is able to appropriate many of the benefits of it's research investments. Private companies are therefore much more likely to invest in modern biotechnology than in conventional agricultural research.
  There is need for greater public/private sector collaboration in relation to biotechnology and its application to problems in the developing world.

- **Training**
  Another issue is that of training. Training is important and required at all levels.
- Bridging courses for resource managers and mature scientists
- Post doctoral fellowships
- Graduate training (M.Sc. and Ph.D.)
- Undergraduate courses

  This is because there is need for bridging courses to introduce policy makers on biotechnology, research managers and mature scientist to the new possibilities offered by biotechnology. This will allow more informed decision to be taken on resource allocation, post doctoral fellowships in advance laboratories are key components of keeping abreast of the latest advances worldwide. Graduate and

undergraduate training underpin the development of in-country capacity in the basic biological sciences. Mobilizing the basic scientific skills usually found in university to solve agricultural problem will require new policy and institutional arrangements and/or financial resources.

Generally, there are ethical and regulatory issues associated with biotechnology.

- How can regulatory regimes be established that will ensure health, safety and protection of the environment without unduly dampening the incentives for research?
- What scientific, technical, economic and psychological pieces of information are needed to rationalize regulatory regimes?
- How would we deal with the often false public perceptions of the risk involved?
- What position should be taken on private sector conduct of research, testing and dissemination of technologies in developing countries which have no regulation?

Another way to state the issue the issue is: can it be anticipated that environmental pressures are likely to stimulate the development and diffusion of biotechnologies for sustainable agricultural production systems? Or will the regulatory processes, problems related to the protection of the in the intellectual property rights, and public fears about new technologies in food and agriculture inhibit their development?

OPTION

The aforementioned issues in biotechnology are glaring. With the high cost involved, training, biosafety, crop priority and other complex conditions attached. It is therefore imperative to seek an option, and undoubtedly, the option is to build on tradition and the consequential indigenous biotechnology.

We must build on these traditions as we undertake to develop biotechnological innovations for the small scale farmer. Our efforts should

be directed towards modifying and improving traditional biotechnologies and to strengthening or restoring farmer rights. To avoid antagonizing nature, innovations should be based on natural rather than synthetic mechanisms.

With these conditions in mind, the following options will be proposed for sustainable biotechnologies for today's small scale farmers.

- **Soil fertility**:- The farmers traditional methods of replenishing the soil through fallowing, composting can be accelerated through:
- ***Activated composition***: Accelerated microbial degradation of inorganic matter through solid state fermentation can be developed for use on the farm and ashes used in place of lime.
- ***Improved simultaneous fallowing***: The best alternative to shifting cultivation is improved simultaneous following through multiple cropping systems involving a wide range of legumes, trees, hedges and tuber crops grown with food crops in a deliberate configuration.
- ***Improved nitrogen fixation***: The ability of leguminous plants to fix atmospheric nitrogen is now well understood. Biotechnology could assist small farmers in selecting the best combination of leguminous and grain crops to make use of this ability. Microbial inoculants to accelerate N. fixation should be made more stable and practical for use by farmers.

i. Crop, Animal and human health

This is a great potential for herbal medicine today unlike in the 60s and 70s when our traditional medicine was regarded as witchcraft. Many people today value traditional medicine. According to Mathias (1989) ethno-vertinary medicine deals with folk beliefs, knowledge skills methods and practices pertaining to the health care of crops, animals and man. Biotechnology can help our traditional develop better preparations and prescription methods. Extracts from various plants has already been used to make bio- pesticides. Others could be developed safe and effective.

- **Genetic resources:** there is urgent need to stop genetic erosion and guarantee stable agricultural production in the future by conserving the genetic resources of food crops. This will only be possible if the farmers' right to be the custodian of plant genetic resources is restored. Many farmers blame

hybrid seeds for their poor harvest and have a great need to produce their own genetic resources simple seed production and breeding practices should be developed and promoted among farmers.

- **Renewable energy**:- Biotechnology can play an important role in the production of fuel from renewable sources. Methane, ethanol and methanol can all be produced through energy in the intensive biotechnical reactions, the major inputs are organic residues.
- **Food processing**: In this field, our community has agreed to return to one of it's traditional and best loved biotechnologies, fermented porridge has grossly been employed replacing expensive drinks at gatherings. Better fermentation procedures for our food products could be developed. The enzymes used should be made more efficient so that they can be deployed to produce a wider range of food products.
- **Generally,** before the advent of modern day sophisticated textile industries, local ways of fabrication (weaving) and dyeing of clothing materials existed, local people molded varying sizes of local pots and dishes, local materials like wood and grasses were used for biotechnology for the safety and welfare of man.

CONCLUSION

Biotechnology is already an old practice employed to improve on one thing or the other. It is could be the traditional biotechnology or the new biotechnology but the central aim is to improve in food processing and agro-industry. The list of areas for biotechnology is endless.

It includes pest and pathogen resistance, quality enhancement, manipulation of growth regulators, improved tolerance to stresses, enhancement of photosynthetic activities and a host of others.

There are glaring issues which, despite the lots of advantages attributed to new biocenology to portray it as difficult task. These are issues such as cost, biosafety, training needs etc hence it is advisable to seek for option as much as possible that can adequately replace the new biotechnology. It is profitable to use or employ the traditional biotechnology since they are less costly, safer, demands less trainings and are useful to small scale farmers. The traditional biotechnology can be employed successfully in areas of agro-industry such as soil fertility, crop, animal and human health, genetic resources, food processing etc.

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