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Agricultural Biotechnology: Opportunities and Challenges for the Philippines

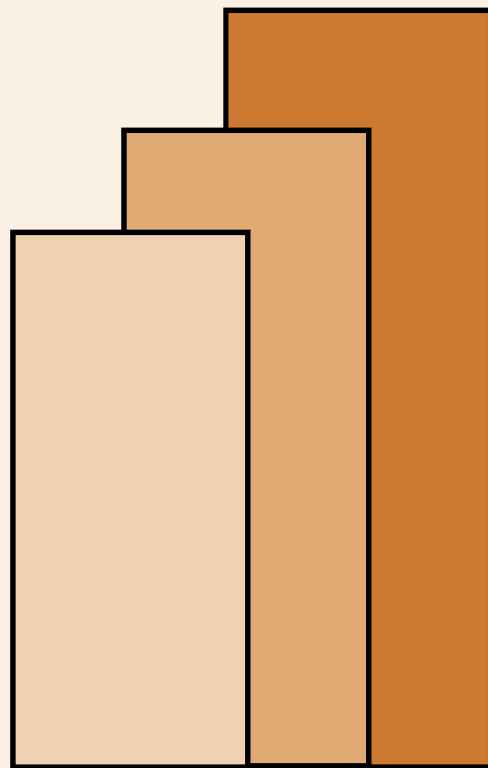
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Agricultural Biotechnology: Opportunities and Challenges for the Philippines

Abstract

Developing countries, still heavily dependent on agriculture, must now harness biotechnology to modernize agricultural production and diversify product outputs. The Philippines was one of the first Asian countries to establish a biotechnology research and development program. However, not much progress in harnessing the tools of biotechnology has been achieved, especially in the area of varietal improvement. Although there was an early realization of the importance of biotechnology in national agricultural development, there was little political will to provide resources for these programs to move forward.

Modern biotechnology must be regarded as one of the tools in modernizing Philippine agriculture. Its role in varietal improvement, biosecurity, product standards, pest and disease prevention and management must be enhanced.

A critical mass of highly trained human resources in the natural and social sciences that will undertake the research and development activities in agricultural biotechnology must be also be assured.

Private sector participation in the development of agricultural biotechnology must be encouraged. The sustainability of these research and development activities can only be assured if they are able to serve commercial purposes. This may form the beginnings of an agricultural biotechnology industry and the much-needed commercial base for modern biotechnology to take-off in the country.

Agricultural Biotechnology: Opportunities and Challenges for the Philippines*

William G. Padolina**

Developing countries, still heavily dependent on agriculture, must now harness biotechnology to modernize agricultural production and diversify product outputs. Agriculture is just the starting point of a large food industry that includes production, processing, transportation and marketing, including domestic storage and cooling. The dependence on traditional export crops must be reduced for the agricultural economy to progress and eventually eliminate poverty. Also, through research and development, new or alternative crops and high valued uses of the raw materials from the traditional export crops must be identified.

One of the ways by which these improvements could be introduced to the agriculture and fisheries sector is to use the tools of modern biotechnology. Traditional biotechnology has been practiced since man learned to prepare his food. Alcoholic beverages and other fermented foods have been produced through the traditional modes. Modern biotechnology, on the other hand, is a knowledge-intensive undertaking, based on the science of molecular biology. Modern biotechnology, using tools that are rapid and precise, has contributed to the understanding of many important processes of life both at the cellular and molecular level. The hallmark of modern biotechnology is the capacity to deliberately alter the genes of microorganisms, plants and animals. This is known as recombinant DNA technology or genetic engineering.

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In summary, biotechnology can be used to denote the following (Schneiderman, 1987):

- “1.) Use of microorganisms, plant cells, animal cells or parts of cells such as enzymes to produce commercial quantities of useful substances;
- 2.) Construction of microorganisms cells, plants or animals with useful traits by recombinant DNA techniques, cell fusion, and other methods besides traditional genetic breeding techniques;
- 3.) The application of molecular biology to understanding how cells and organisms work, so that the activities of cells and organisms can be altered or repaired.”

The commercial production of useful substances is based largely on traditional biotechnology, while the other two activities mentioned above involve tools developed by modern biotechnology.

Developing Strong National Capability in Biotechnology

It has been said that biotechnology relates very well to the needs of developing countries. Although the costs of the equipment and technology may appear to be high, these costs are still small compared to setting up big manufacturing industries. In addition, biotechnology possesses remarkable adaptability to local conditions.

Most of the current advances in modern biotechnology research and development are taking place in the developed countries, mainly under the initiative of the private sector. However, experience has shown that national capacity to absorb and adapt the technology to local conditions influences the successful transfer of technology. In the long term, the national research system

must be able to adapt, repair, maintain, and modify biotechnology for the following reasons:

- a. There exist very diverse situations in field application experiments. Adaptation trials and experiments will have to be handled at the national level, as the sheer number of different conditions will be beyond the capacity of any single international organization, public or private, to manage.
- b. Although the export markets are important, domestic needs should be addressed with equal attention. National programs have the comparative advantage to respond effectively to these needs.
- c. The exploitation and protection of local germplasm or genetic resources is best undertaken by national institutions. There are cases where these genetic resources can only be moved out of their place of origin under great risk, like the pathogenic organisms.
- d. The absorption of new technologies will be enhanced if there is national capacity to assess and add value to the new technology.

Although the task is difficult, there is a strong basis to strengthening national R&D capacity in agricultural biotechnology.

The Current Situation in the Philippines

The Philippines was one of the first Asian countries to establish a biotechnology research and development program. In 1980, the National Institutes of Biotechnology and Applied Microbiology (BIOTECH) was organized at UPLB. In 1997, the UP System formally organized three other biotechnology research institutes to promote various biotechnology-based research and

development activities in UP campuses in Manila, Diliman and in Iloilo. This initiative brought to the fore the biotechnology research and development programs in medicine, fisheries and industry.

Also, many studies have been conducted to assess the prospects of using biotechnology in agricultural research in the Philippines (Krattiger, 1992; Hamada and Cruz, 1997; Halos, 1999; and Rola, 1999). All of them conclude that there are many areas in agricultural research and development where the new tools of biotechnology could be useful. They also noted that among the sciences, biology had the most number of doctoral and master's degree holders.

However, not much progress in harnessing the tools of biotechnology has been achieved, especially in the area of varietal improvement. Most of the initial activities in the biotechnology R&D program were in the field of applied microbiology. This is not surprising as the major biotechnology-based industries in the Philippines up till now are based on traditional fermentation technologies like beer, beverage ethanol, and vinegar and monosodium glutamate production. It is however noteworthy that there were a few significant discoveries in the use of microbial agents to enhance soil nutrient availability and as agents in biomass transformation.

Until the early 90's, not much activity was undertaken in molecular biology and genetic engineering. This indicates that although there was an early realization of the importance of biotechnology in national agricultural development, there was little political will to provide resources for these programs to move forward. Although budget difficulties are always cited as the limiting step in these endeavors, it seems that in this particular case, the non-existence of a critical mass of highly trained and updated researchers especially in molecular biology was a major contributing factor to the slow pace of development.

Furthermore, at that time the various biotechnology R&D proposals were being submitted for funding, the use of transgenic crops globally was not as extensive. Field tests were at an early stage and considered risky. Now, the situation has changed. In 1999, around 40M hectares of land around the world are reported to have been planted to transgenic crops (James, 1999). Since 1996, when there was this big increase in hectareage, 80 million of hectare-years of experience had been accumulated and millions of people and animals had partaken of food containing ingredients from the major transgenic crops - soybean, corn, and canola.

This wide acceptance of transgenic crops has triggered heightened interest in the tools of modern biotechnology, especially recombinant DNA technology. In response to these developments, many developing countries have increased their investments in molecular biology and plant biotechnology, the Philippines being no exception. To date, however, no new biotechnology-based industries have been established in the Philippines. This lack of a commercial base remains a big constraint for the development of agricultural biotechnology in the Philippines. Thus the renewed interest in agricultural biotechnology might just provide the opportunity for a big leap forward.

The Changing Environment

In addition to the tremendous advances in the application of modern biotechnology to enhance agricultural productivity, there are some new developments that were not present when the Philippine biotechnology program was started in 1980.

First, is the change in the rules of global trade accompanying the establishment of the WTO. Each nation is now expected to trade freely with other nations and all trade barriers are expected to be dismantled. Goods are

now expected to flow on the basis of competition and market forces will govern productivity.

Second, as part of the new global economic order, each country is committed to protect intellectual property rights. This is intended to enhance innovation even across national borders.

Third, the Convention on Biological Diversity has declared that genetic resources are owned by sovereign nations. This is having an impact on the multilateral system of access to genetic resources in food and agriculture.

Fourth, Biosafety and the Precautionary Principle have now been invoked in the control of the movement of goods across national borders. This was in response to the concerns raised about the safety of food derived from genetically modified organisms. These concerns are also being used to regulate the flow of agricultural products, especially transgenic crops, across nations.

Fifth, there is strong anti-science movement that is being promoted globally. This anti-science movement has picked up many issues in order to elicit public distrust of science and technology. These issues could be environmental, health, social and political.

Sixth, due to the enormous investments required to bring a biotechnology undertaking to its conclusion, private corporations have dominated the initiatives to generate new knowledge using the tools of modern biotechnology and molecular biology. These operational elements include well-equipped laboratories, highly trained staff to review compliance with biosafety protocols, a legal staff to handle IPR.

Lastly, the tremendous advances in information and communications technology have affected the knowledge traffic including those in modern

biotechnology. Thus, the emergence of bioinformatics to handle the large amount of information related to the genetic makeup of several organisms. Furthermore, in a recent report attributed to the Goldman Sachs Group, agriculture is expected to account for 8% of the internet business-to-business market by 2004 (Lorek, 2000).

Implications of these Changes

The globalization of the market forces and the need for product competitiveness requires more rigorous reading of the market trends. This makes it necessary to have capacity in technology forecasting and assessment and a well-oiled machinery for technology scanning.

The introduction of new modes of transactions requires the revision of the legal and regulatory structures of countries. A competent and predictable legal environment within a country including policies and procedures for handling biosafety, bioprospecting, intellectual property rights can facilitate the flow of products and research materials. In view of the new experiences, the judicial systems will have to adjust in order to be able to adjudicate the issues affecting the conduct of biotechnology research and development with fairness and dispatch.

The information and communication technology infrastructure and governance will have to be updated in order to cope with new developments. The use of ICT in a farming operation is becoming more evident not only in the production activities but also in trade. Thus, all efforts must be exerted to allow farmers to access efficient and reliable communication facilities.

There is a need for a global effort to make the public aware of the benefits of scientific activity. The global research and development community, public and private must show utmost transparency in dealing with public concerns.

They must be able to communicate their views in a comprehensible manner, devoid of technical language, which can be intimidating. This will stem the tide that is slowly moving to make certain scientific activities criminal.

Private sector must be considered partners in all of the efforts to adjust our habits of mind, perception, social processes, our modes of governance to fit the tremendous advances in new knowledge. The public image of private sector as an instrument of exploitation must be corrected. These efforts however must be undertaken mainly by the private sector itself, especially the multinationals.

The Prospects

Modern biotechnology is to be viewed as a tool to help us unlock some of nature's secrets so we can apply this knowledge to solve some of the problems in the agriculture and fisheries sector. However, modern biotechnology must not be viewed as a silver bullet that will provide the miracle solutions to all our problems, some of which are age-old. Modern biotechnology is simply an array of tools and must often be used in combination with the other time-tested techniques in agricultural research. As a tool, it must be mainstreamed with the major directions of our research programs in agriculture and fisheries and must not be considered or developed apart from the major needs of agricultural development. It will be a big mistake to establish a biotechnology lab simply as a showcase.

Varietal Improvement. The progress in genomics has reached a point where genetic manipulation has been made to work for many crop species. It is however of utmost importance that a priority list of Philippine crops to be improved using genetic engineering be drawn up. We simply cannot afford to produce transgenic lines for all crops, as the costs of manipulating all the crops will be prohibitive. Furthermore, close collaboration with the agronomist, the

animal husbandman, and the fisheries experts should be required in order to assure that the experiments meet the criterion of doability and robustness.

Diagnosis and Prevention of Plant and Animal Diseases. It will probably take time before the pests and disease of plants and animals could be completely controlled, if ever. However, there are now new tools, based on molecular biology, which are more sensitive and specific in diagnosing certain diseases and controlling certain pests. New, cheaper and more effective vaccines for animal diseases have been produced due to progress in immunology.

Biomass and Waste Processing. The biomass of the by-products derived from agriculture are often wasted and left unused. The production of value-added products from agriculture and fisheries can be realized by using appropriate and economically viable processing technologies to the raw materials. Many of these processing technologies are biotechnology-based such as the use of enzymes and other fermentation techniques. The application of biotechnology to transform biomass and processing wastes into food, feed, energy, and chemicals can add value to these by-products. The harmful environmental effects of these by-products could also be minimized using these biological transformation technologies.

Biosecurity. The entry of large amounts of fresh, frozen or processed food products into the country makes it important that these are tested for the presence of harmful substances or organisms before they are sold to the consumers. The recent events in other countries involving BSE and infected chicken and goats is a wake-up call for the Philippines to make sure all its food products whether locally produced or imported are safe for human consumption. Again, there are now many tools available through biotechnology that will enable us to apply rapid, sensitive and accurate tests on these food materials to determine their safety.

Product Standards. Product standards are important to ensure free movement of goods in the world market. The scientific basis for monitoring compliance with product standards, especially for exportable goods, involves procedures for laboratory analysis in order to assess with precision and accuracy the quality and safety of the products. The progress in immunology and biochemistry has resulted into the development of a number of highly accurate, precise and high-throughput analytical procedures to assess the quality of the products and monitor compliance with global standards. These tools have been applied to both fresh and processed foods and are now widely used in many countries.

Concluding Statements

The initiatives to increase investments in modern biotechnology to improve agricultural productivity are steps in the right direction. While financial resources will enhance the development of agricultural biotechnology, there are other factors that will influence its growth and development in the Philippines.

Modern biotechnology must be regarded as one of the tools in modernizing Philippine agriculture. Its role in varietal improvement, biosecurity, product standards, pest and disease prevention and management must be enhanced.

A critical mass of highly trained human resources in the natural and social sciences that will undertake the research and development activities in agricultural biotechnology must be assured. A massive program to allow bright, young Filipinos to pursue advanced degrees must be implemented immediately. For their thesis, these scholars must be encouraged to select research problems which are of highly relevant to the needs and priorities of the agriculture and fisheries sector of the Philippines.

The competent legal and regulatory systems to facilitate the conduct of research in agricultural biotechnology must be installed without delay. This will not only assist the researchers in the work but also enhance public confidence in biotechnology including genetic engineering.

In order to save lead-time while we are increasing the ranks of the researchers, the government might explore the outsourcing of research projects to selected laboratories abroad. This should cover mission critical areas that need to be addressed without delay.

Private sector participation in the development of agricultural biotechnology must be encouraged. The sustainability of these research and development activities can only be assured if they are able to serve commercial purposes. This may form the beginnings of an agricultural biotechnology industry and the much-needed commercial base for modern biotechnology to take-off in the country.

These are strong indications that modern biotechnology offers tools that can enhance the quality of our food and improve the manner in which we grow crops in order to make food more affordable and also protect the environment. Let us not forget that aside from genetic engineering, agricultural biotechnology offers other tools that are useful for crop improvement and crop management. These tools should enable our researchers to generate technologies and information to make our farmers competitive.

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