Philippines: Challenges, Opportunities, and Constraints in Agricultural Biotechnology

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The Philippines has a land area of 30 million hectares and a population of over 70 million (1998). In 1997, the combined area devoted to agriculture was 10.3 million hectares, with coconut being the most widely planted crop, followed by rice, corn, banana, pineapple, and others. The area and production of some important agricultural crops are presented in Table 1. Rice and corn lead in area and production. The country is a major producer of coconut, sugarcane, banana, and pineapple. The export value of sugarcane has gone down considerably in recent years.

More than 70 percent of the population is directly or indirectly dependent on agriculture. Most of the land is owned by small farmers. Significant increases in population have placed tremendous pressure on agricultural lands. Prime lands are now being converted into resettlement areas and for industrial uses. Agricultural land area has therefore been decreasing through time.

Table 1 Area and production of some important agricultural crops

Agricultural crops	*Area in million hectares*	*Production in million metric tons*
Rice and corn	4.75	26.9
Coconut	4.00	12.0
Sugarcane	0.70	3.4
Banana	0.21	21.6
Pineapple	0.04	1.6
Coffee	—	0.1
Others	0.60	2.4
Total	**10.30**	**68.0**

Source: Bureau of Agricultural Statistics Report, 1997.

Biotechnology in the Philippines

The Philippines started its biotechnology programs in 1980 with the formal creation of the National Institute of Molecular Biology and Biotechnology (BIOTECH) at the University of the Philippines at Los Baños (UPLB). In 1995, three other biotechnology institutes were established within the University of the Philippines System. They are located in the UP Diliman campus to focus on industrial biotechnology, UP Manila to focus on human health biotechnology, and UP Visayas to focus on marine biotechnology.

The biotechnology institute in UP Los Baños continues to provide leadership in agricultural, forestry, industrial, and environmental biotechnology. Other research institutes at UPLB are also doing biotechnology research. Among these are the Institute of Plant Breeding, Institute of Biological Sciences, Institute of Animal Sciences, Institute of Food Science and Technology, and the College of Forestry and Natural Resources. Outside UPLB, other research institutes and centers such as the Philippine Rice Research Institute, Philippine Coconut Authority, Cotton Research and Development Institute, Bureau of Plant Industry, the Bureau of Animal Industry, and the

Industrial Technology and Development Institute are also involved in biotechnology R&D.

The type of research undertaken in the Philippines from 1980 to 1999 is mainly conventional biotechnology, with the exception of a small amount of work on molecular markers and the development of genetically improved organisms (GIOs) with useful traits. The results of a survey on the budget spent for biotechnology R&D in the country from 1980 to 1999 are given in Table 2.

In 1998, five high level biotechnology research projects were funded by government:

- Transgenic banana and papaya resistant to banana bunchy top virus and papaya ringspot virus, respectively
- Delayed ripening of papaya and mango
- Bt corn
- Marker-assisted breeding in coconut
- Coconut with high lauric acid content.

Almost 80 percent of the total annual budget for biotechnology R&D comes from the government. Fifteen percent comes from international development agencies, while the private sector contributes approximately 5 percent. The private sector is expected to provide more funding in future as they see the potential of biotechnology in agriculture.

In 1997, the Agriculture Fisheries Modernization Act (AFMA) became law. The main objective of AFMA is to modernize agriculture, including infrastructure, facilities, and R&D.

Table 2 Type of biotechnology R&D, number of projects, and percentage of total projects funded from 1980 to 1999

Type of biotechnology R&D	*Number of projects*	*Percent of total*
Biocontrol	55	20.5
Soil amendments	44	16.5
Food/beverage	43	16.3
Tissue culture	52	19.5
Feed component	20	7.5
Enzymes	16	6.0
Diagnostics	7	2.6
Farm waste utilization	4	1.5
Vaccines	3	1.1
Animal reproduction	3	1.1
Molecular markers	12	4.6
GMOs	7	2.7
Total	**266**	**100.0**

Source: Survey conducted by UPLB BIOTECH, 1999.55

AFMA recognized biotechnology as a major strategy to increase agricultural productivity. The law states that AFMA will provide a budget of 4 percent of the total R&D budget per year for biotechnology during the next 7 years. This allocation provides an annual budget for biotechnology of almost US$20 million. Before AFMA, the annual budget for biotechnology averaged less than US$1 million.

AFMA operates through National Research, Development and Extension (RDE) network systems of 13 commodities and five disciplines. The 13 commodity networks are rice, corn, root crops, coconut, plantation crops, fiber crops, vegetables/spices, ornamentals, fruit/nuts, capture fisheries, aquaculture, livestock and poultry, and legumes. All of these commodities include biotechnology in their RDE agenda. The five discipline-oriented RDE networks are fishery postharvest and marketing, soil and water resources, agricultural and fisheries engineering, postharvest, food and nutrition, social science and policy, and biotechnology. As a discipline, biotechnology focuses on upstream basic research, which includes work in molecular biology. The commodity networks focus on downstream (application) research.

The main goal of biotechnology R&D under AFMA is to harness the potential of this cutting edge technology to increase productivity of all the commodities in the agriculture and fishery sectors. Biotechnology will therefore play a major role in the selection and breeding of new varieties of plants and animals. It will also provide the inputs required such as biofertilizers and biocontrol of harmful pest and diseases. Biotechnology will also be tapped to produce genetically improved crops with resistance to harmful pests and diseases, for accurate diagnosis and control of diseases in plants and animals, for bioremediation of the environment, and for bioprospecting. AFMA envisions that the benefits derived from biotechnology will reach the small farmers and fishermen.

The Philippines does not have the critical human resources required for biotechnology R&D. As of 1999, there were about 250 scientists qualified to do high-level biotechnology R&D. Most of the researchers are affiliated with universities, particularly UPLB.

Adequate laboratory facilities and equipment for upstream biotechnological research exist at a

number of institutions in the Philippines, including BIOTECH based at UPLB and UP Diliman, the Institute of Biological Sciences, Institute of Plant Breeding, and Philippine Rice Research Institute. There is a need, however, to upgrade most of the laboratories in the country.

Challenges

Although the country recognizes the tremendous potential that can be achieved from biotechnology, several challenges need to be met before the goals set can be achieved.

Increase Productivity

Yields of crops and livestock have been declining, while demands are increasing, because of the rapid increase in population. Conversion of prime agricultural lands into other uses has placed tremendous pressure on the agricultural sector to increase productivity per unit area. Productivity has been affected by poor soil fertility, the incidence of pests and diseases, abiotic stresses such as drought caused by El Niño and climatic factors especially typhoons. The challenge is to use biotechnology to increase productivity and yield on the farms using minimal inputs.

Global Competitiveness

With impending trade liberalization, the country expects to receive cheap agricultural products from other countries, thus widening its balance of trade. In 1997, the value of Philippine exports was US$25.2 million while imports were valued at US$35.9 million giving a negative trade balance of US$10.7 million. The challenge is to use biotechnology to produce local products that are highly competitive with those from foreign sources, thereby promoting exports of quality products while reducing imports.

Biosafety and Risk Assessment

The Philippines is sensitive to the issue of biosafety. We have one of the strictest biosafety guidelines in the world to undertake R&D and for field testing. The challenge is to improve and better implement the current biosafety guidelines, taking advantage of knowledge generated worldwide. Protocols are needed to assess risk of GIOs and to manage any identified risk factors. The challenge is for the Philippines to develop its capability to undertake risk assessments and management, based on scientific evidence.

Regulation of Biotechnology Products

The commercial release of new products must be regulated. At present, all regulatory bodies such as the Bureau of Plant Industry (BPI), Bureau of Animal Industry (BAI), Fertilizer and Pesticide Administration (FPA), Bureau of Food and Drugs Administration (BFAD), and the Environment and Management Bureau (EMB) do not have a policy and guidelines to regulate the commercial release of new genetically improved products. In addition, the institutional support system, such as laboratories and infrastructure is not in place. The challenge is to create guidelines to regulate commercialization of GIOs, the establishment of support laboratories and infrastructure, and the training of people for these regulatory bodies.

Transfer of Technology/Commercialization

Products of research will not create any measurable impact unless they are transferred to end-users and/or commercialized. The challenge is to transfer products to users, particularly to small farmers and fishermen. This requires the proper packaging of the product to attract private investors for eventual commercialization.

Trade-Related Issues

Transgenic crops and other GIO products may become trade-related issues in the future because of trade liberalization. It is expected that new genetically improved crops will be imported into the Philippines. The challenge is to create public awareness of the benefits and risks of any new product and assist acceptance of new technologies by consumers, where these are beneficial.

Intellectual Property Protection

Because the process, products, and genetic materials used in biotechnology R&D have proprietary considerations, issues of intellectual property

protection by patents and plant variety protection (PVP) will arise. The present Intellectual Property Code of the Philippines allows the patenting of microorganisms, but not plants and animals. Plant varieties will be protected by *sui generis* mechanism if the PVP bill is passed by both houses of Congress. The challenge is for the country to strengthen its IPR laws to provide protection to researchers, discoverers, and investors.

Opportunities for Biotechnology

Although the Philippines is lagging behind the industrial countries and its ASEAN neighbors in terms of R&D in biotechnology, many windows of opportunities are open.

Increased Yield of Plants

Biotechnology provides the opportunity for researchers to improve plant growth, development, and yield by providing for the basic needs of the plant such as biofertilizers and biocontrol agents.

Genetically Improved Plants

The country recognizes the tremendous potential of improved crop plants containing genes that provide pesticidal properties, resistance to herbicides, tolerance to pests, disease, and stress (salt, heavy metals, and drought), or combinations of these properties. Such improved plants are expected to reduce considerably production costs such as inputs of fertilizers and pesticides. Once the issues of biosafety regulations and intellectual property have been settled, the country will be open to use such new plant technologies that are now limited to only a few countries.

Marker Technologies

These technologies may help speed up the selection and production of more effective hybrids. Most breeding work in the country is now using this technology, specifically in rice, corn, banana, and coconut.

Livestock

Tremendous opportunities are available for livestock biotechnology, including the production of vaccines for foot and mouth disease and hemorrhagic septicemia, for diagnostics, and *in vitro* fertilization.

Microbial Products

Opportunities are available for the use of microorganisms for biofertilizers, biopesticides, and bioremediation of the environment.

Bioprospecting

The Philippines is blessed with rich genetic resources waiting to be tapped for food, fiber, enzymes, and drugs. New beneficial genes are expected to be discovered in the highly diverse species of plants, animals, microorganisms, and marine organisms. The challenge is to save and use judiciously the rich biodiversity of the country which make it one of the *hotspots* of biological diversity in the world.

The rich biodiversity of the country offers many opportunities in the search for novel genes and gene products. The Philippines has in place a law governing access of genetic resources by foreign and local bioprospectors. This law is designed to protect both the bioresource and the bioprospectors.

Introduction of Foreign Technologies

Because of the importance given to R&D in biotechnology under AFMA, introduction of foreign technologies, including genes that offer unique advantages, may have great potential for the country. For example, the sugar industry had been declining because of competition with high fructose syrup and other sugar substitutes. There are opportunities to use sugarcane, a highly efficient plant to produce high-value products such as oral vaccines, biodegradable plastics, and other products.

Joint R&D Collaboration

Collaboration between Philippine and overseas researchers is one opportunity that is now well in place. Many researchers actively collaborate with researchers from Australia, Canada, USA, Japan, South Korea, and countries of the European Union.

Constraints

Although the R&D opportunities are evident, there are some additional constraints that need to be addressed.

Difficulty in Accessing New Technologies

Development of the local biotechnology industry has been hampered because of the inability of researchers to access state-of-the-art technologies. Researchers are therefore repeating work done elsewhere rather than being able to adopt current technologies.

Antibiotechnology Groups

Some NGOs and individuals in academe and government services do not support biotechnology. These groups are well organized and well funded, and are highly successful in promoting anti-biotechnology sentiments in the country. They are also instrumental in convincing legislators to enact resolutions imposing moratoria on research and commercialization of GIOs. While they focus on GIO products produced and brought into the country by multinational companies, they also affect the R&D of local researchers.

Biosafety Guidelines

The present set of biosafety guidelines is one of the strictest in the world. The guidelines were originally patterned after those first used in the United States, Australia, and Japan during the early 1980s. Since then, all these countries have relaxed most of their guidelines as a result of new technical data and familiarity in dealing with new products. However, the Philippines did not relax its guidelines.

Commercial Release

New genetically improved products cannot be commercialized in the country because the regulatory bodies cannot issue the required permits or licenses. The regulations allow only limited field trials of genetically improved organisms. The regulatory bodies lack the proper guidelines and institutional support to regulate the new products. This is a major constraint because any potentially useful new product cannot be commercialized after the field trials.

How CGIAR Centers Can Help

The CGIAR centers can play a larger role in assisting national centers develop their R&D capabilities in biotechnology. Some activities that CGIAR centers can undertake include:

Germplasm Exchange

Most CGIAR centers hold extensive collections of germplasm, the starting point for selection, breeding, and genetic manipulation. The centers are in a position to share or exchange this germplasm with local researchers or institutes.

Joint Collaborative R&D

Centers should encourage more joint collaborative research with local institutes and share their financial and human resources and infrastructure with less well-endowed local research institutes. Centers are also in a position to assist through training, workshops, and scholarships, human resources development.

Regulatory Arrangements

Centers should help countries develop their biosafety protocols and competence in risk assessment and management of biotechnology products. Centers may also be able to assist countries in developing regulatory mechanisms and institutional capabilities for the commercialization of biotechnology products.

Advocacy

CGIAR Centers should be more proactive in promoting popular awareness and acceptance of the products of modern biotechnology.

Conclusion

Researchers, policymakers, industry people, and the CGIAR system must address the challenges, opportunities, and constraints that face R&D in

biotechnology at this critical time of increasing population, globalization, trade liberalization, concerns with biosafety, regulation, and intellectual property. All countries share these same challenges, opportunities, and constraints although at different levels.

The above challenges, opportunities, and constraints can be addressed by CGIAR centers at the international level and by national R&D centers at a country level, with harmonized activities at internatiobnal, regional and country levels.

For developing countries, the small farmers and fisherfolks should be the main beneficiaries of biotechnology R&D. Biotechnology will only prosper if the private sector actively participates in the R&D aspect as well as in the commercialization stage.