

Agricultural Biotechnology in Indonesia

Endang Sukara and I.H. Slamet-Loedin¹

Biotechnology has been officially recognized by the government of Indonesia as a strategic technology to help attain sustainable agricultural production since 1988. The National Committee on Biotechnology was established by the Ministry of Science and Technology to prepare and formulate a national biotechnology policy and development program. This program is implemented by several "centers of excellence" and each of these centers is tasked to set up a network of institutions in a particular field. After the economic crisis of 1997, the focus and direction of biotechnology, which remained of high government priority, were adjusted to suit the country's conditions. These priorities included the following: (1) immediate application of existing biotechnology for product manufacture in food production, import substitution, and export opportunities, (2) strategic research program based on competitive advantage of the country, e.g., genetic resources, and (3) increased participation of private companies in establishing significant bio-industries. Biosafety regulations were established in 1997 covering genetic manipulation of microbes, plants, fish, and livestock. These regulations were amended in 1999 to cover plantation and forestry plants and food products the implementation of which involved four ministries (Agriculture, Estate Crops and Forestry, Food, and Health). Guidelines for food safety of GM products have been drafted and are expected to be released this year. Constraints to the development of biotechnology in Indonesia cited were shortage of expertise, limited funding and linkage with the private sector.

Introduction

Recognizing the potential role of biotechnology in maintaining a sustainable agriculture production, Indonesia started to place a high priority on biotechnology since 1988 as one of the strategic technologies. Biotechnology became one of the priorities of the National Science and Technology Development Program. The Ministry of State for Science and Technology established the National Committee on Biotechnology, which is responsible in preparing and formulating a national biotechnology policy and development program to assist national development. The committee also gives guidance and encouragement in the development of bio-industry and its supporting R & D and human resources. The committee also gives directions for the establishment of national, regional, and international network of cooperation on biotechnology, and monitors the implementation of the national policy on biotechnology.

To implement this policy, a program was formulated in 1990. The program includes the production of fine chemicals and pharmaceuticals (antibiotics, amino acids, vitamins); mass production through micro-propagation of industrial, horticultural, and forestry plant species; improvement of food crops quality (in particular rice and soybean); improvement of beef and dairy cattle quality through embryo transfer; and production of various diagnostics and vaccines for human and animal diseases.

The program is implemented by several "centers of excellence", as follows:

¹ R & D Center for Biotechnology, The Indonesian Institute of Sciences (LIPI), Bogor, Indonesia

1. Centers of Excellence on Agricultural Biotechnology I and II, coordinated by the Central Research Institute for Food Crops and R & D Center for Biotechnology – LIPI, respectively, both in Bogor;
2. Center of Excellence on Health Biotechnology, coordinated by the Medical Faculty of the University of Indonesia in Jakarta; and
3. Center of Excellence on Industrial Biotechnology, coordinated by the Agency for Technology Assessment and Application (BPPT) in Jakarta.

These centers are tasked to set up a network of institutions active in its particular field. In addition, the government of Indonesia established an inter-university center on biotechnology in three universities, namely: Bogor Agriculture University in Bogor, with focus on agriculture biotechnology; Bandung Institute of Technology in Bandung, with focus on industrial biotechnology; and Gadjah Mada University in Yogyakarta, with focus on health biotechnology.

To accelerate the implementation of the program, the Government of Indonesia also re-vitalized the National Research Council, which is responsible in setting the biotechnology priority for each fiscal year and inviting scientists from the universities and research institutes, both public and private. A panel of experts was set-up to evaluate proposals and give recommendations to the Council. The Council gives advice to the National Planning Board and the Ministry of Finance to fund the recommended proposal. Administratively, LIPI is assigned to help all of the Competitive Research Grants (RUT) while the Agency for Assessment of the Application of Technology helps all of the Partnership Research Grants (RUK).

The Ministry of State for Science and Technology was restructured to improve its performance. A policy guideline on science and technology, which was made available early this year, is one of its major achievements.

Biotechnology Initiative

For the past six to seven years, the Indonesian Government has consistently provided grants for research activities, including the field of biotechnology, through competitive research grants. Through this particular scheme, research activities increase significantly both in quantity and quality. In addition, through the Department of Education and Culture, the Indonesian Government also provides some additional funding for research for university personnel (Hibah Bersaing, Program Pembinaan Riset and Program URGE).

The Indonesian Government has also improved research management through a one- gate policy, activated the National Research Council, and established a panel of experts to help the government in selecting proposals for funding through various funding mechanisms (RUT, RUK, RUSNAS, Hibah Bersaing, Risbin etc.)

The major players on biotechnology research activities are universities and R & D Centers of the departmental and non-departmental bodies. In addition, various private companies also conducted biotechnology R&D activities. (Tables 1 to 3).

Table 1. University faculties with major activities in biotechnology in Indonesia.

University	Location	Field of study
Faculty of Pharmacy, University of Airlangga	Surabaya	Plant cell cultures, bio-transformation with plant cells, rat hepatocyte cultures
Food and Nutrition Development Center and Research Center, UGM	Yogyakarta	Bio-preservation, lactic acid bacteria, cell fusion among <i>Aspergillus</i> strains, monoclonal antibodies for aflatoxin
Inter University Center for Biotechnology, UGM	Yogyakarta	Genetic analysis of Waardenburg syndrome, Thalassemia, Dengue viral antigens, diagnostic tools based on PCR, erythromycin and BT toxin production
Inter University Center on Biotechnology, ITB	Bandung	Microbial fermentation, enzyme technology, genetic engineering, biological waste water treatment
School of Medicine, Airlangga University	Surabaya	Reproductive health, infectious diseases, cancer and degenerative diseases, forensic serology
Department of Microbiology UI	Jakarta	Dangue virus diagnostics, Salmonella diagnosis, hepatitis C research
Faculty of Agriculture UGM	Yogyakarta	Baculo virus detection, CVPD-free citrus seedlings, PCR technology, SMZ coat protein genetics for virus-free soybean stocks, food biotechnology
Inter University Center for Biotechnology IPB	Bogor	Improvement of plant productivity by tissue culture, embryo transfer, microbial biotechnology, waste treatment, culture collection

Source: Schmid et al., 1995

Table 2. Research institutes concerned with biotechnology.

Institution	Location/ Supervision	Targets
Indonesian Sugar Research Institute (P3GI)	Pasuruan/ Department of Agriculture	Deranase, xanthan gum, sugarcane breeding, wastewater treatment, genetic engineering techniques
Central Research Institute for Food Crops, Laboratory of Plant Biotechnology	Bogor/ Department of Agriculture	Molecular genetics of rice diseases, cell and tissue culture, nitrogen fixation, bio-fertilizers, bio-conversion
Marihat Research Center	Pematang Siantar/ Department of Agriculture	Tissue culture on cocoa, rattan, vanilla, oil palm etc.
Research Institute for Animal Production (Balitnak)	Ciawi-Bogor/ Department of Agriculture	Feed improvement using fermentation, mannanase, embryo transfer, phytase, cassava-protein
Research Institute for Veterinary Science (Balivet)	Bogor/ Department of Agriculture	Cloning of veterinary toxins, veterinary immunology, monoclonal antibodies
Institute for R & D of Agro-based Industry	Bogor/ Department of Industry	Industrial biotechnology, fermentation of soybean curd whey, food quality control
Center for the	Jakarta/ BPPT	Antibiotics production, plant, dish and livestock

Assessment and Application of Technology (BPPT)		production, vitamin, enzyme and amino acid production
R & D Center for Applied Chemistry – Indonesian Institute of Sciences (LIPI)	Bandung/LIPI	Bio-conversion of solasodine, waste water treatment, fermentation, tempe
R & D Center for Biotechnology – Indonesian Institute of Sciences (LIPI)	Cibinong-Bogor/LIPI	Fermentation and enzyme technology for production of enzymes and biocatalysts, plant biotechnology (genetic analysis and transformation), embryo (production/preservation/manipulation/ transfer technology), aquaculture, natural products
Eijkman Institute for Molecular Biology	Jakarta/Men-Ristek	Mitochondrial DNA mutation in human diseases, aging process, energy-transducing systems, thalassemia, diagnostic kit for Dengue hemorrhagic fever

Source: Schmid et al., 1995

Table 3. Companies active in biotechnology.

Company	Location	Ownership	Products
Perum Bio Farma	Bandung	State Enterprise	Vaccines, sera, diagnostics
PT Kalbe Farma	Jakarta	Indonesian	Pharmaceuticals, diagnostics
PT Meiji Indonesia Pharmaceutical Industries	Jakarta	Japanese	Antibiotics
PT Rhone-Poulenc Indonesia Pharma	Jakarta	French	Pharmaceuticals, vaccines
PT Sandoz Biochemie Farma Indonesia	Jakarta	Swiss	Antibiotics
Pusat Veterinaria Farma	Surabaya	State enterprise	Vaccines, antigens
PT Sasa Inti	Probolinggo	Indonesian	Glutamic acid
PT Ajinomoto	Mojokerto	Japanese	Glutamic acid
PT Miwon Indonesia	Gresik	Korean	Glutamic acid
PT Indo Acidatama	Surakarta	Indonesia	Ethanol
Perusahaan Daerah Aneka Kimia	Surabaya	State Enterprise	Ethanol
Rhizogin Indonesia	Jakarta/Bogor	Indonesian	Rhizobium starter cultures

Source: Schmid et al., 1995

New direction on biotechnology policy

Even after the economic crisis hit Indonesia in 1997, biotechnology remained a main priority in Indonesia. The focus and direction were adjusted to the existing economic conditions. The first priority in biotechnology is to immediately apply an existing biotechnology process for product(s) manufacture to respond to the needs of the people, especially in food production, production of traditional medicine, and added-value of agricultural products for import substitution and export opportunities. The

second priority is strategic research, which will respond to the rapid development of biotechnology for long-term investment and will improve national capabilities in the field of biotechnology.

To implement the above strategic development in biotechnology, the national program needs to do the following:

1. **Immediate application of an existing technology.** The use of national capability and facilities for the production of health products and diagnostics kit, including diagnostics kit for hepatitis B and C, dengue and other diseases common to tropical countries, is important. The application of transfer of cattle embryo to increase and improve cattle population to respond to the increasing demand for meat and milk, and improvement of the production of staple foods including rice and soybeans are of great importance to the country.
2. **Strategic research.** A strategic research program to position Indonesia at the edge of global market is important for the country's future. Such program should be based on competitive advantage of the country, such as genetic resources, drug discovery projects, genetic improvement of agriculture commodities (e.g., food crops, horticulture, fruits, animal husbandry etc.), marine biotechnology, environment biotechnology (e.g., bio-remediation) and manufacturing vehicle technology (e.g., unconventional approaches to production processes).
3. **Increase participation of private companies.** Indonesia will not be able to significantly achieve bio-industry development without the participation of the private sector. As a new emerging technology, biotechnology is categorized as a high-risk business. To invite venture capital for the development of industries based on biotechnology findings require excellent entrepreneurs and managers.
4. **Human resource development.** The major constraint in biotechnology development is the limited number of qualified researchers in the country. The commitment of the Indonesian Government to provide facilities and funding and continuous development in human resources is of utmost important.

Future of Indonesian biotechnology development

Indonesia, the largest archipelago in the world, lay on the tropical zone between two continents, Australia and Asia. Indonesia comprises 17,508 islands, which vary in sizes and shapes. The land type also varies from flat, hilly to the mountainous. There are at least 47 different ecosystems. About 17 percent of all living creatures in the world are found in Indonesia, including 10 percent of all flowering plants, 12 percent of mammals, and 25 percent of reptiles. The microbial diversity is tremendous and no one could estimate the actual numbers. The richness of biological diversity is a competitive advantage for the country. Such biodiversity needs to be preserved; its utilization should be considered important.

With its mega-biodiversity, Indonesia should be the richest in terms of genetic resources. With the advancement of biological sciences, particularly in the fields of molecular biology and molecular genetics, the potential gene(s) from the biological

resources could be studied, isolated, amplified, preserved, and utilized. The utilization of gene(s) through advance biotechnology has great potential for Indonesian agriculture (production of food), industry (added- value of agricultural products), health (traditional medicine and drug development), and environment (improved quality of environment). Biotechnology, therefore, will be important to the future economic development of Indonesia.

Government support policy remains but funding is limited. For the next five years, the development of infrastructure in universities, public research institutes, and non-public research institutes will be slowed down, if not stopped. The only advantage of the past 10 years experience is that it has been possible for Indonesia to identify the strength of its biotechnology capability. Various strong research groups within the country have been and are being formed. This is one area which could lead to the rapid development of collaboration with the international scientific community and attract funding from various international funding agencies.

In the future, the need for a new vision in biotechnology development and utilization, entrepreneurship, venture capital/bank, and research quality for industrial development will be tremendous.

Biosafety regulation

Biosafety regulations has been established in Indonesia since 1997, as embodied in the Ministerial Decree on Genetically Engineered Biotechnology Product, which was put in place by the Minister of Agriculture. To implement the decree, a committee for biosafety was formed in 1997. The committee is supported by a technical team consisting of experts in plant biotechnology representing different national institutes and universities. The technical team formulated a series of guidelines for the release of genetically-engineered organism. This series of guidelines includes general and specific guidelines for genetically engineered plants, microbes, and animals.

The 1997 decree did not cover plantation and forestry plants and food products. To fulfill the need for wide coverage regulation, the decree was revised in 1999 by the collective decree of four ministries, namely: Ministry of Agriculture, Ministry of Estate Crops and Forestry, Ministry of Food, and Ministry of Health. The committee and technical team members were also expanded, representing different parties. The guidelines of food safety of genetic modified organisms (GMO) products have been drafted and will be released within this year.

However, at present, Indonesia has not yet released any transgenic material. Six applications from Monsanto and Pioneer have been reviewed. The Bt corn, and Bt cotton from Monsanto and the Roundup Ready soybean, corn and cotton have gone through the biosafety committee and are currently under the review process of the plant variety release committee.

Intellectual Property Rights

Indonesia enacted a patent law in 1989, which was enforced in 1991. Under this law, no patent could be granted for any process for production of food, drinks for human

and animal consumption, and new plant, and animal or their product. This patent law was revised in 1997 in accordance with the WTO regulations, which allowed patenting of the abovementioned items.

Constraints

The development of biotechnology in Indonesia is hindered by several factors. Capacity building of manpower with specific expertise is very important. At present, in each institute, the critical mass for any particular subject has not yet been achieved. The activities are very much individual and scattered. Therefore, a national center for biotechnology may offer a good alternative to build networking among the experts in the field since the consortium of biotechnology as a voluntary body has not really achieved its objective.

Another set back is that the interest of private sectors to fund research in this field is still very limited, perhaps because it requires a high investment. However, a number of private industries have shown some interest. At present, most funding comes from the government, but the recent economic crisis forced a cut in funding, which has resulted in the termination of several projects.

The development of regional and international linkages is very important in achieving similar goals together.

Bibliography

- Collective Decree of Ministry of Agriculture, Ministry of Estate Crops and Forestry, Ministry of Health, Ministry of Food No. 998. 1999. 1/Kpts/OT.210/9/99, 790.a/Kpts-IX/1999; 1145A/MenKes/SKB/IX/199; 015A/Nmeneg PHOR/09/1999
- Falconi, C. A. 1999. Agricultural Biotechnology Research Capacity in Four Developing Countries. ISNAR Briefing Paper 42.
- Herman, M. 2000. Genetically Engineered Plant and Biosafety Regulation in Indonesia. *Journal Agribio*. (In press).
- Ministerial Decree Forms Department of Agriculture. 1997. No. 856/Kpts/HK 330/9/1997
- Prone, M. S., E. Sukara and S. Nuswantara. 1993. Development of Biotechnology in Indonesia. *Kursus Sesko ABRI, Bandung* (Indonesian)
- Roesma, J. 1997. Development and application of biotechnology as a priority in Indonesia. *Proceedings of the Industrial enzyme and Biotechnology Workshop. Agency for the Assessment and Application of Technology (BPPT), Jakarta.*
- Sauna, S. 1995. Biotechnology in the Member States of ASEAN. 409-417.
- Schmid, R. D., B. Chung, A. J. Jones, S. Saono, J. Scriven, and J. H. J. Tsai. 1995. *Biotechnology in the Asian-Pacific Region*. VCH, Weinheim, Germany.

