STRENGTHENING BIOTECHNOLOGY RESEARCH IN INDONESIA

*S. Sastrapradja & D.S. Sastrapradja**

ABSTRACT

The wave of biotechnology promises has struck not only the developed countries but the developing countries as well. The scientific community in Indonesia is aware of the opportunities and is eager to take an active part in this particular endeavour. Meanwhile resources are required to welcoming the biotechnology era. The need of trained manpower, appropriate infrastructure and equipment, operational and maintenance costs requires serious consideration if a unit or a laboratory is expected to be functional in biotechnology. There is a good opportunity of applying biotechnology in the field of agriculture and industry considering the availability of biological resources in Indonesia. This paper outlines what have been done so far, the difficulties encountered and the efforts made to strengthening biotechnology research in Indonesia.

INTRODUCTION

Among the various techniques applied in biotechnology research and development is fermentation technique. In this particular field Indonesia is considered to be one of the places of traditional fermentation. Tempe (a fermented soybean cake) and oncom (a fermented peanut waste) are popular sources for vegetable protein, which are now available also outside Indonesia.

Another technique in biotechnology which has been in practice for quite some time in Indonesia is tissue culture for micropropagation of orchids. Commercially the technique is economically viable. Though theoretically it can be applied to almost any species of plant, up to this moment only a few gave satisfactory results.

New biotechnology involves, among others, recombinant DNA technique, cell fusion, and immobilized enzymes. With these techniques those biological processes which were impossible to be done before, are nowdays easily achieved in the developed countries. Hybridization between two distantly related taxa is an example of the success in applying cell fusion technique to break a physical barrier.

How the Indonesian scientific community prepare themselves to greet the era of new biotechnology is discussed in this paper. The comparative advantages that we have and the challenges we face in strengthening the existing research capabilities are reviewed. An example is given to illustrate the efforts in developing an institutional building.

* Center for Research in Biotechnology, Indonesian Institute of Sciences, Bogor, Indonesia

The Comparative Advantages

The promises of biotechnology for the development, even for the developing countries, nave been heralded all over the world. The excitement of the scientific community, as well as the decision makers in the developing countries, to receiving the possibility of adopting the new technology has overshadowed the requirements that the technology calls for. There are advantages in the developing countries, however, that are needed for the biotechnology application and not many realize.

Like any other technology, biotechnology is a tool to develop raw materials into products or processes with higher value. Unlike many of the existing technologies, biotechnology requires biological resources in the form of either a microbe, a plant or an animal. Even more, the new biotechnology operates not only at cellular level but at molecular level as well.

With regard to biological resources, Indonesia is considered as one of the richest areas in the world. No less than 30,000 species of plants, 800 mammals, 25,000 insects, and 15,000 fungi and bacteria are reported to occur here. Many of these species have been utilised for food, feed, energy sources, and industrial purposes. Many also are recognized to be harmful because of their role as pests and diseases.

Though the dependence of man to biological resources has been known since the first early history of his existence, only recently the importance of the biological diversity for its sustainable welfare is fully realized (FAO, 1989, UNEP, 1988, Keystone, 1988). Included in this diversity are not only species diversity, but also ecosystems and genetic diversity as well. With biotechnology, their potentials are expected to be unraveled much more rapidly for agriculture, industry, and health.

In the field of agriculture, food production will remain one of the top priorities of action. High yielding varieties of rice for adversed conditions will be enhanced by biotechnology application. Efforts to lessen the dependence on rice has been launched for years through the diversification of food resources. Corn, sweet potato, and cassava as components in mix-farming have not received attention for improvement. They show great genetic variability us enabling one to construct high yielding varieties the way rice varieties have been invented. No doubt biotechnology will speed up their improvement.

The richness of biological diversity offers also the great potentialities of mammals, insects, fungi, and bacteria to be harmful to crops, domesticated animals, and men as well. Right now it is difficult to predict when the outbreak will be and how to control them once they start to be active as pests or diseases. Using techniques developed in biotechnology these problems may be overcome faster than the traditional techniques.

Indonesia is also rich in animal resources as a source of protein. The average protein intake is still low. If animal protein is recommended to be increased both in production and in consumption then poultry and small ruminants are good choices for small scale farmers. However, local chicken and ducks have not been improved, though selected local races have been identified. The same holds true for small ruminants. Feed becomes a problem in the dry season in which foliage feed are barely available especially in the drier regions. Leguminous tress are appreciated as fodder producers and for their nitrogen fixing ability, which in turn improve soil fertility. Biotechnology can play an impor-

tant role in converting biomass into nutritious feed and improving the symbiosis between the legumes trees and the fixing bacteria.

In terms of human resources, Indonesia ranks fifth after China, India, USA, USSR. From the point of view of market possibility, the large number of population forms a good market for whatever they need. The import of wheat flour, for example, keeps on increasing. Indonesia does not grow wheat due to its unsuitable environmental condition. So, if biotechnology is able to construct varieties which are adaptable to average Indonesian ecosystems, then the product of biotechnology forms an import substitute. Temperate fruits such as apple, grape, and sunkist orange are liked because of their standard appearance and taste. With proper manipulation Indonesian fruits (rambutan, mangostene, mango, etc.) may be improved to suite consumers' taste, and producers wishes to produce fruit all the year around.

With regard to human health, there are tropical diseases which differ from those commonly found in temperate region. For diagnostic purposes, biotechnology application is no doubt very useful to speed up the processes. Pharmaceutical products will certainly find their market here considering the large number of population though the status of health is improving with time.

Science and Technology for development

Indonesia has established the Guidelines of State Policy of National Development which is known nationally as Garis-garis Besar Haluan Negara (GBHN) since 1968. The general pattern of long-term development covering a period of 25 to 30 years have been drawn and form the basic foundation of the medium-term development plan, which is scheduled five yearly. Emphasis of the development has been given to each medium-term plan. In this way the goals of each period are clearly stated.

The role of Science and Technology as agents for development is fully recognized by the government. Therefore in each term of development plan, the need to advanced science, technology and research is highlighted. It is also realized that the Indonesia society still shows a wide range of characters in applying technologies (Indonesia 1989). For this reason in adopting and developing technologies to be used in unraveling the potentials of the biological diversity, not only technical consideration should be given, but also socio-cultural characters are equally important. It is expected that the application of new technologies or enhancement of traditional techniques will give benefit to low income families as well.

In the past ten years environmental problems have emerged as one of the national concerns. At the same time the natural resources, humid tropical forest in particular, have decreased in quality. These have been identified as a consequence of national development. Research priorities then covers not only subjects in agriculture, industry and economy, but also environmental protection, and rehabilitation of forest areas.

While it is true that appropriate technologies, which are suitable for the present community are considered important, the government is aware of the potential of the advanced technologies for development and wherever possible adopting them. The development of aircraft-industry, for example, illustrates clearly that advanced technology can be adopted to suit the Indonesian need.

The government is also sensitive to new emerging technologies which might be useful

for the national development. For this reason, thought has been given to develop capabilities in adapting biotechnology for various purposes. In the Fifth-five year plan which run from 1989-1994, the will to develop biotechnology is mentioned. It is timely, therefore, to review the national capability for conducting research in biotechnology, so that necessary steps can be taken.

The present research capability in biotechnology

The progress of science and technology in a country depends on the number of its researchers. During the 44 years of independence the government has sent students abroad to be educated at various levels of degree and to be trained in the fields most needed for development. At home, university education provides basic knowledge to those who prefer a career in research. Up to fiscal your 1987/1988, there were 40,372 registered researchers, of whom 1,802 were active in agriculture, 823 in industry and 19,602 in education. was engaged in transportation, energy, and others.

In terms of biotechnology, several fields of specialization are mentioned as important. Microbiology, Biochemistry, genetics, physiology, and biochemical engineering are the fields of specialization identified as prime importance. Moreover, for resource development, genetic resources specialists who know in depth genetic variability of particular species certainly are most useful.

In the above mentioned fields, the number of qualified researches is very limited. Not too many students are interested in majoring in microbiology, genetics, biochemistry, etc. They consider those fields of specialization as unprofitable fields compared to civil engineering, agronomy, pharmacy, etc. Consequently the number of graduates in those fields is low. To encourage those who have indecisive choice when entering university, the goverment provides special scholarships to students who want to major in the mentioned subjects. However, upon graduation they have the freedom to apply for any job they like. At the end, the increase of those joining research activities in the field of biology and the related subjects is very slow.

It is interesting to learn the impression of a group of biotechnology consultants on Indonesian research and development. Upon request of the goverment of Indonesia those consultants came and visited various laboratories which were engaged in the so called biotechnological research. Though there were exceptions, they found that the overall quality of research in biotechnology is not at an international level. This evaluation was given after they thoroughly studied the quality of the research workers, facilities, buildings and equipment, and infrastructure which were available in the country. To understand their evaluation, it is necessary to know where research activities take place and how research institutes are set up to facilitate the activities.

The existing Researh Institutes

Research activities related to biotechnology are conducted in several biology laboratories of several agencies and ministeries. Basically there are 4 types of research units depending on their main function. The first group consists of those under the universities whose main function is for education. Though there are many who disagree with the idea, the university laboratories were at time expected to concentrate their efforts in basic research. Even if there is a development effort, the

percentage of this should be much smaller than the former. The second group consists of the laboratories under the non-depart- mental agencies. To those group belong the Indonesian Institute of Sciences and the Agency for the Assessment and Application of Technology. Researchers in this group should be oriented more to the application of science. In the Indonesian Institute of Sciences, the proportion of basic research to the applied research is larger than that of the Agency for Assistant and Application of Technology. The third group are laboratories under the Departments such as the Department of Agriculture, the Department of Health and the Department of Industry. In each department there is an agency for Research and Development. These agencies are charged to do research and development on the subjects of their respective mandate. The last group are those of the private sector. Those laboratories have specific function, i.e., to support production of goods. Ideally the four groups of research laboratories should work in a system so that a flow of results are to be expected.

With the above set-up, several things are noticable. Manpower for research is distributed thinly. The same holds true for equipment, budget and chemicals. Moreover, institutional building is hard to achieve. In exercising biotechnology activities which require not only qualified trained manpower, but also sophisticated equipment and novel chemicals, each laboratory does its utmost to cope with these problems.

Most of the research institutes are government owned. For this reason, there is a political will to pull together all the research potentials in biotechnology. The State Minister of Research and Technology has established a committee which is in charge of formulating a cooperation among reseach institutes. Meanwhile with the help of the World Bank, Inter Universities Centers has been established. The centers for biotechnology are located in Bogor (Bogor Agriculture Institute), Bandung (Bandung Institute of Technology) and Yogyakarta (University Gajah Mada), with a specialization of agriculture, industrial chemistry, and medical biotechnology respectively. The government of Italy supports the biotechnology establishment in Serpong in which the Agency for the Assessment and application of Technology is residing.

Establishing a biotechnology institute : A case study

The Indonesian Institute of Sciences was established in 1967. Under this institute were research institutes which could be grouped into natural sciences, technology and social sciences. A reorganization of the Indonesian Institute of Sciences was felt necessary to cope with new developments in Science and Technology. Therefore, in January 1986, research institutes under LIPI were reorganized. At the same time, a new institute dealing with biotechnology was set-up.

Most of the research workers appointed to staff the newly established center are there because of their choice. They are trained microbiologists, zoologists and botanists who have a reputation in their fields of specialization. Along with them are junior scientists who were newly graduated from the universities in Indonesia. Most of them were majoring in biology or agriculture. A few have new biotechnology background. The latter were educated and trained in the field of industrial microbiology and embryo transfer. With the existing staff the first order or priority to be taken by the institute was to reorient them toward the new task. Reorientation was done,

among others, through visits to the developed laboratories engaging research in biotechnology. Japanese Society for Promotion of Science has been generous in providing grants for our reorientation program. In this way there is a change of mental attitude of our staff and their knowledge is broadened.

To be able to construct a sound research program, the institute should have in its hand equipment and budget. Unfortunately however, the birth of the institute coincided with the decline of the oil price. Being the goverment owned institute, of course, its whole budget comes from the government. In this situation, only a fraction of equipment requested were obtained. Further more, the operational budget is too small to enable the institute to plan something worth recognizing. To lighten up the spirit of its staff, however, small projects in their interests covering tissue culture for micropagation, enzyme isolation and bioconversion have been initiated. The results of these activities have indeed provide confidence to the staff. At the same time, it was proved that with all the limitations still something could be achieved.

The strength of the institute lies on its staff who known the biological diversity quite well. With this knowledge and strong conviction, slowly but surely the institution is building its capability to pave the road to modern biotechnology. It is true that the skill in DNA-recombinant techniques, or in protoplasm fusion has not been acquired, but given the opportunity and the right equipment, these techniques would be mastered in due time.

The challenges ahead

The road to master the techniques in new biotechnology is still a long way to go. The government has allocated special funds to educate and train manpower abroad. Meanwhile, through the Inter Universities Centers in Biotechnology (Yogyakarta, Bandung and Bogor) courses are offered for those who want to study at home. In developing the capability, it becomes apparent that basic sciences such as chemistry, physics and biology are primarily important for the development of biotechnology in which one works at cellular and molecular level. Therefore, efforts to strengthening the capability should not be restricted to the university graduates and students of the university, but at high school level improvement needs to be done as well.

Biotechnology is a tool which is admired because of its efficiency and its great potentials. We have talked since early eighties of the potentials. Unless the scientific community in Indonesia is able to show that biotechnology could be applied soon to produce goods or processes as it has been advertised, the government is going to loose patience. The challenge then is how to convince the government that building the human capability in biotechnology is a long process. There should be commitments from both the government and the scientific community. Neither one can act alone.

Moreover, cooperation among scientists in the scientific community is a must if the process should be accelerated in pace. Establishing an industry for biotechnology might be relatively easy. The biodiversity is here to be utilised for agriculture, health and pharmaceutical industry. But, to be able to play an active role in the industry, we need to have a power to deal with whoever intends to set up the industry here. And that power is human capability, without which we will just be at the receiving end.