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An Outlook of Agricultral Biotechnology in Malaysia

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ABSTRACT

Agricultural biotechnology was considered a future technology for many nations, including Malaysia. This technology generates economic value and contributes significantly to the Gross National Products (GNP). The application of biotechnology in agriculture helps enhance the food security and wealth creation through an increase in food production. Modern biotechnology is currently being applied for its potential to produce higher value and yield, and crops that are resistant to pests, diseases, and adverse conditions, as well as improved quality. However, agricultural biotechnology industry faces many issues and challenges that could hinder its progress. The Malaysian government has drafted a long-term strategic plans for the development of the agricultural biotechnology sector. Since the long strategic plan which was started in 2005, will end in 2020, the Malaysian government needs a new way to move forward and set directions. The new direction would lead the industry towards a sustainable agriculture sector in Malaysia.

Keywords : Agricultural biotechnology, strategic plan, agricultural sector, economic value

INTRODUCTION

Biotechnology has been identified as one of the future technologies for every nation as it generates tremendous economic value and make significant contributions to the national Gross National Products (GNP). The contribution of biotechnology to economic growth and improvement of human well-being has been recognized by many countries, including Malaysia. The contribution of biotechnology through the commercialization of products and systems is estimated in the range of one trillion US$, dominated by bio-pharmaceutical industry, by the year 2020.

Malaysia also wanted to take the opportunity from biotechnology, and made significant investments to build capacity for participation in this technology. The Malaysian government has identified biotechnology as one of the strategic sectors that will contribute to the economy. The biotechnology industry contributes around 2.5% of the national gross national product (GNP) in 2010, 4% in 2015 and is expected to increase to more than 5% in 2020. This industry is also expected to offer many new job opportunities for youngsters and school leavers. By the year 2020, the government envisages that the biotechnology sector will produce employment to 280,000 people.

Agricultural biotechnology also plays a crucial role in economic growth and to sustain the competitiveness of agricultural industry. Despite the fact that the application of biotechnology in agriculture has been in practice many years ago, the development of agricultural biotechnology in Malaysia is considered new, when the government started the national biotechnology program in early 1990s. The objectives are to improve the national food security and support the economic growth, as well as to improve the competitiveness of agricultural products in the world markets. In the Malaysian context, the first significant impacts of biotechnology are likely to be in the agriculture sector and this paper will therefore focus on agricultural biotechnology. This paper aims to give an outlook of the development of agricultural biotechnology in Malaysia.

AGRICULTURAL BIOTECHNOLOGY SECTOR

The term "biotechnology" has been generally used to include any technique or process which uses science related to living things such as micro-organisms, animal or plant for solving problems or making products which are useful to mankind (T.C. Seng, 2003). The OECD has defined biotechnology as the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services. In other words, it is not just a science, but it is the application of technology and the business.

Biotechnology has many applications in agriculture, such as for diagnostic, vaccines for animal health, DNA fingerprinting for tracing the plant varieties, animal and plant propagation and genetic modification (GM) to improve plant and animal varieties. The term agricultural biotechnology includes technologies used in agriculture and food for the benefit of mankind (FAO, 2009).

Malaysia has a strong foundation for agricultural biotechnology. Malaysia was recognized as one of the countries with vast biodiversity. Malaysia has the oldest rain forest with more than 15,500 plant species, 300 species of mammals, 150,000 species of invertebrates, 1,200 species of butterflies and 12,000 species of moths. Thus, Malaysia does not want to miss this opportunity, by exploring and using these biodiversity ecosystems. The Malaysian government recognized the agricultural biotechnology as the third engine of growth for Malaysia's economy, after the services and manufacturing sector. At the same time Malaysia also has been recognized as the leading nation for production of palm oil, rubber, paper and tropical timber.

Agricultural biotechnology is envisaged to be a potential tool to ensure food security for the country. The specific focus of agricultural biotechnology in Malaysia is on 1) sustainable production, 2) sustainable management of pest and disease, 3) nutritional security, and 4) quality and safe food. It is also a vehicle for wealth creation. Tissue culture of several industrial crops (oil palm, rubber, rattan, forest trees), together with food crops (rice, banana, sago, herbs and medicinal plants) and ornamental (orchids, pitcher plants) has been successfully carried out. Plant biotechnology has been in practice since 1990s and plant tissue culture was the main research focus at that time. Many experiments on tissue culture crops such as banana, pineapple and papaya were actively pursued. There is ongoing research on genetically modified plants. Several animal recombinant vaccines have been produced to assist the development of animal husbandry. Marker assisted breeding strategies are also being practiced to increase the efficiency of livestock breeding programs.

Food biotechnology, in general, is also relatively new in Malaysia, although food and food ingredients produced by traditional biotechnology like fermentation technology have brought to market products like soy sauce, yogurt, nata, tempeh, tapai and budu. Food biotechnology has also produced high quality clarified fruit juices. A number of industries producing sweeteners and food additives based on fermentation have been in existence for decades in this country.

Challenges facing the development of agricultural biotechnology sector

The agricultural biotechnology sector in Malaysia faces a number of issues and challenges. Four key challenges are identified and discussed in this section.

R&D capacity

Malaysia still lacks the R&D facilities, commercialization skills, and the entrepreneurial expertise to embark on a full scale biotechnology commercialization. In Malaysia, biotechnology research and development (R&D) on food crops is conducted mainly at the Malaysian Agricultural Research and Development Institute (MARDI), one of the leading government research institutions. The research complements MARDI's active breeding program of local food crops. Research is generally focused on overcoming major limitations in crop production, such as diseases and pests. At the same time, traits to improve quality, such as increasing the shelf-life of fruit or delaying fruit softening, are also being incorporated. The fundamental research, on the other hand, is carried out by public and private universities.

In 2016, Malaysia had only 108,557 research personnel, which is considered very low because they represent 74 researchers per 10,000 workforce. Furthermore, the number of researchers that had a biotechnology academic background is estimated to be less than 0.6%. The graduates with biotechnology academic background are not all effectively employed as bio-technologists. This is because employment opportunities in the biotechnology field are still limited in both public and private

sectors. In the year 2015, less than 500 companies were involved in producing biotechnology products (mainly traditional biotechnology) and even less were in agro-biotechnology.

In overcoming these issues and challenges, the government sets four strategies for agricultural biotechnology R&D that include 1) strengthen knowledge base by developing and acquiring specialized skills workers, 2) enhance agricultural growth by enhancing their value creation, 3) enhance sustainability by embracing green technology and 4) providing support services such as financial and regulatory services.

Malaysia also needs to increase the networking with world-renowned organizations and universities, so that the researchers and scientists can collaborate or join venture in undertaking research and development. At the same time, Malaysia needs innovative entrepreneurs that can adopt the agricultural biotechnology effectively.

Public acceptance of products from modern biotechnology

Public acceptance is important in indicating the potential commercialization of biotechnology products. Public awareness and perception towards the agricultural biotechnology products are also low. In a survey undertaken by the Asian Food Information Center on Malaysians perceptions of GMOs, only about 18% of the respondents were aware of food biotechnology and about 50% did not know about biotechnology. Another survey by the Far Eastern Economic Review however, indicated that 75% of Malaysians are very concerned about genetically modified food. These studies indicate that either the people do not understand what biotechnology is, or the issue of GMO is of concern to many. In another survey of 1,400 Malaysian Muslim respondents around Kuala Lumpur, the capital of Malaysia, conducted by the Institute of Islamic Understanding Malaysia (IKIM), results showed that 66.7 % had heard of biotechnology but only 52.2% declared they know what it is about. The survey also showed that while about 67% could explain genetically modified organism (GMO), genetic engineering and bio-pharmaceuticals, only 40% know what was cloning. A recent survey by the University of Illinois showed that various groups of stakeholders in Malaysia had positive attitude toward biotechnology and believed that the technology would benefit smallholders. This indicates the acceptance level of Malaysians is quite low but promising.

Intellectual Property Rights (IPR) regime

IPR, patents and plant breeders' rights are crucial for development of a vibrant biotechnology sector. A patent is a right granted by the government to inventors to exclude others from imitating, manufacturing, using or selling a specific invention for commercial use during a certain period, usually 17-20 years. The patent holder, in turn, is obliged to disclose the invention to the public. In agriculture, Plant Breeders' Rights (PBR) are rights granted by the government to plant breeders to exclude others from producing or commercializing materials of a specific plant variety for a period of about 15 to 20 years.

Regulatory framework for commercializing GM products

Although Malaysia has guidelines for research on GMOs, the Biosafety Bill which would allow commercialization of GM products is yet to be passed by Parliament. This is the single most important bottleneck to investment by the big players in agricultural biotechnology as there is no mechanism to approve GM plants for potential use in producing bio-fuels, bio-plastics and bio-pharmaceuticals. To some extent, the large investments in R&D may generate a pipeline which becomes “constipated” because no product can be commercialized or released beyond the R&D phase. It would be illogical to expect any private company to share its IP and do joint ventures in Malaysia as any due diligence analysis would reveal this as a key stumbling block in obtaining “freedom to operate”.

In spite of the above challenges, which must be viewed as only temporary roadblocks, there are great opportunities to venture in biotechnology in Malaysia, especially in agri-biotechnology. One such opportunity is the production of halal foods (food processing according to Islamic law). The market potential for halal food is very huge. The global market value for halal food was estimated around US$2.3 trillion according to data in 2010 publication. Malaysia can tap this market by being the halal hub for the Muslim market. There is great opportunity to explore this market and the use of biotechnology techniques and practices can advance the manufacturing of food products. The potential halal food products can be produced by using biotechnology practices are natural food or food ingredients, modified palm oil and feed or feed supplements from herbs. These include the production, bio-generation and modification of foods and bio-ingredients. Malaysia has the second highest per

capita income in the ASEAN region. In 2018, the Gross National Income (GNI) per capita registered RM43,086 or approximately US$10,043. At the same time, domestic expenditure is expected to grow by 4.6%. These indicators show good domestic market potential for biotechnology products including agro-based biotechnology products. These include health-care products, pharmaceuticals, cosmetics and toiletries, food products and ornamental plants. It is estimated that the total domestic market value for biotechnology products in Malaysia is around RM 90.5 billion or US$21.55 billion, and continue to increase at an average rate of 15% annually.

The Malaysian biotech industry is dominated by small to medium sized companies. Only a few larger companies are involved in biotechnology, and most of them focus on plant tissue culture. Currently, there are about 282 companies registered with the Malaysian Biotechnology Directorate under the Ministry of Science, Technology and Innovation. Of these, 162 companies are involved in the agricultural sector, 77 operated in Bio-medical and 43 companies in Bio-industrial (Teo and Tat, 2019). There is still great potential for SMEs and large scale firms to explore in this industry. The newness of this industry is also an advantage because as the early comers, a company has the opportunity to spearhead the business.

Biotechnology policy

The biotechnology sector is relatively new in Malaysia, although the development of biotechnology as a source of economic growth has been championed since the 1990s. Biotechnology has been identified as a new engine of growth for Malaysia. The country's rich flora and fauna are seen to provide potentially rich reservoirs of natural resources for health-care application, agriculture food production and solutions for a clean environment. Malaysia announced its first National Biotechnology Policy on 28 April 2005, and support for the development of this sector was further strengthened under the Malaysia;s Development Plans. The National Biotechnology Policy specifies nine policy thrusts, as follows:

Thrust 1 : Agriculture Biotechnology Development
Thrust 2: Health-care Biotechnology Development
Thrust 3 : Industrial Biotechnology Development
Thrust 4 : R&D and Technology Acquisition
Thrust 5 : Human Capital Development
Thrust 6 : Financial infrastructure Development
Thrust 7 : Legislative and regulatory Framework development
Thrust 8 : Strategic Positioning, and
Thrust 9 : Government Commitment.

The philosophy of the policy

The National Biotechnology Policy envisions that biotechnology will be a new engine for Malaysia, enhancing the nation's prosperity and well-being. To succeed, the Policy aims to build a conducive environment for R&D and industry development whilst leveraging on the country's existing areas of strength**.**

The National Biotechnology Policy underpinned by nine policy thrust:

Thrust 1 : Agriculture Biotechnology Development
Transform and enhance the value creation of the agricultural sector through biotechnology.

Thrust 2: Health-care Biotechnology Development
Capitalize on the strength of biodiversity to commercialize discoveries in natural products as well as position Malaysia in the bio-generics market.

Thrust 3 : Industrial Biotechnology Development
Ensure growth opportunities in the application of advanced bio-processing and bio-manufacturing technologies.

Thrust 4 : R&D and Technology Acquisition
Establish Center of excellence, in existing or new institutions to bring together multidisciplinary research teams in co-ordinated research and commercialization initiatives. Accelerate technology development via strategic acquisitions

Thrust 5 : Human Capital Development
Build the nation's biotechnology human resource capability in line with market needs through special schemes, programs and training.

Thrust 6 : Financial infrastructure Development
Apply competitive "lab to market" funding and incentives to promote committed participation by academia, the private sector as well as government-linked companies. Implement sufficient exit mechanisms for investments in biotechnology.

Thrust 7 : Legislative and regulatory Framework development
Create an enabling environment through continuous reviews of the country's regulatory framework and procedures in line with global standards and best practices. Develop a strong intellectual property protection regime to support R&D and commercialization efforts.

Thrust 8 : Strategic Positioning
Establish a global marketing strategy to build brand recognition for Malaysian biotechnology and benchmark progress. Establish Malaysia as a center for contract research organizations and contract manufacturing organizations.

Thrust 9 : Government Commitment
Establish a dedicated and professional implementation agency overseeing the development of Malaysia's biotechnology industry, under the aegis of the prime Minister and relevant government ministries.

The implementation of the National Biotechnology Policy encompasses three main phases:

Phase 1 (2005 – 2010) : Capacity building
Activities in this phase involve:
i. Establishment of advisory and implementation Councils
ii. Establishment of Malaysian Biotechnology Corporation
iii. Education and training of knowledge workers
iv. Development of legal and IP framework Business development through accelerator program
v. Build Malaysian branding
vi. Initial job and industry creation in agricultural biotechnology, health-care biotech, industrial biotech and bio-informatics

Phase 2 (2011-2015) : Science to business
Activities in this phase include:
i. Develop expertise in drug discovery and development based on natural resources
ii. New products development
iii. Technology acquisition
iv. Intensify investment promotion
v. Intensify spinning-off of companies
vi. Strengthen branding
vii. Develop capability in technology licensing
viii. Knowledge-intensive job creation.

Phase 3 (2016-2020): Global presence
The activities include:
i. Consolidate strengths and capabilities in technology development
ii. Further develop expertise and strength in drug discovery and development
iii. Strengthen innovation and technology licensing
iv. Promote global Malaysian companies. It is intended that by 2020 Malaysia will be a global player in biotechnology and will generate at least 20 global Malaysian companies.

Summary of targets of the National Biotechnology Policy

	Phase 1	Phase II	Phase III	Total

	(2005-2010)	(2010-2015)	(2016-2020)	
Policy statements	Capacity building	Creating business out of Science	Turning Malaysia into global player	Biotechnology for wealth creation and social well-being
Creation of employment	40,000	80,000	160,000	280,000
Establishment of companies	25	25	50	100
Contribution to GDP (%)	2.5	4.0	5.0	5.0
Compounded Annual Growth (%)	32.8	21.7	14.7	23.7

Source : The National Biotechnology Policy

In implementing this policy, biotechnology was spread out using the concept of a "Bio-Nexus Network." In general, the research, development and commercialization of agricultural biotechnology products are carried out by government research institutions under the Ministry of Agriculture and Agrobased Industry, Ministry of Science, Technology and Innovation (MOSTI). Ministry of Natural Resources and Environment (NRE) and Ministry of Higher Education (MoHe) that covers all public universities. At the same time the industry development services are carried out by the Malaysian Bioeconomy Corporation that facilitate biotech companies, implement government policies and initiatives, commercialization of biotechnology products. The Technology Park Malaysia provides services to biotechnology companies that are clustered together within a Science Park. The Technology Park also provides incubator and an enterprise complex that supports the development of biotechnology products and its marketing. The Malaysian Industrial Development Authority on the other hand, is tasked to directly promote the biotechnology policy initiatives at the international level.

Funding for the new biotechnology sector in Malaysia revolves around both public and private. There are a range of grant schemes available which has a fund allocation to biotechnology and these are administrated by governmental bodies such as the National Biotechnology Division (NBD), Malaysian Technology Development Corporation (MTDC) and others. The purpose of the grants appears to be in support of R&D activities and the commercialization of research findings in specific areas that are of national importance to the Malaysian industry. These bodies each have different objective, sector and activity focus. The criteria for eligibility and fund size vary with the type of scheme and the project under consideration. Grants are eligible for anyone who qualifies within the set criteria but would normally require some collaboration with public research institutes or universities.

To further spur growth and development of the biotechnology industry, the Malaysian government has offered attractive investment incentives to local and foreign-owned companies. Some of the incentives are as follows:

1. For High Technology Companies - Pioneer status with full tax exemption of statutory income for five years, or an investment tax allowance of 60% on qualifying capital expenditure for five years to be offset against 100% of the statutory income.
2. Strategic projects – Pioneering status with a full tax exemption of 100% of statutory income for 10 years; or investment tax allowance of 100% on qualifying capital expenditure for five years can be offset against 100% of the statutory income.
3. Incentives for R&D
4. Incentives for software development
5. Pre-packaged incentives – customized package that covers both tax and non-tax incentives
6. Incentives for export, and
7. General incentives – industrial building allowance, infrastructure allowance, import duty exemptions for raw material components, equipment and machinery.

In general, the policy framework for R&D, and for investment appears in place for a fledgling biotechnology sector to develop in Malaysia.

Way forwards

The main challenges faced by Malaysian agriculture are shortage of suitable land for agriculture, low productivity, high production cost, and shortage of labor (Rozhan & Daud, 2005). These supply side factors have severely constrained Malaysia in food production. As a result, in 2017 Malaysia imports more than RM51.3 billion (US$12.21 billion) of food as compared to RM31. 8 billion (US$7.57 billion) of exports. Most of the foods imported are temperate fruits and grains (soy beans, corn and milk-based products). The Malaysian National Agriculture Policy 3 (NAP3) and the action plans have outlined important elements that aim to transform agricultural sector in Malaysia. The main goal is to enhance food security and wealth created through increased food production. One of the strategies described in NAP3 is the utilization of high technologies, including biotechnology. The agricultural sector is aimed to be a dynamic, modern, and highly commercial sector with high returns, through new agricultural practices that are agro-biotechnology based. In this respect, strategic initiatives are now in place to enable biotechnology to play a core role to advance the agricultural sector. The industries targeted for improvement include palm oil, rice, cocoa, fruits, flowers, ornamental, vegetables and herbal and medicinal industries as well as agro-based downstream industries.

The biotechnology industry in Malaysia consists of companies specializing in biotechnology, bio-pharmaceuticals, bio-informatics and agricultural biotechnology. These companies focus on a range of products such as tissue culture, diagnostics, vaccine production, blood bank collection. Companies involved in agricultural biotech are mainly plantation (palm oil), herbal based, and aquaculture companies.

The Malaysian government recognizes that biotechnology processes such as genetic engineering have the potential to increase production and productivity in the agricultural sector. This is indicated by the fact that Malaysia is among several ASEAN countries that have approved the use of GM food crops as human food and animal feed. Malaysia has successfully conducted field trials of GMOs and has its guidelines for the release of GMOs. GMO release into the environment is currently restricted to research fields. At present GM activities and products in Malaysia are governed by guidelines formulated by the Genetic Modification Advisory Committee (GMAC). This Committee produced a guideline entitled "The National Guidelines of Release of Genetically Modified Organisms(GMO) into the environment." Under these guidelines, commercialization of biotech crops involves steps which require GMAC approval for all field evaluations. At the same time, Malaysia also set up a National Bio-safety Central Body that is responsible for monitoring biotechnology activities in Malaysia.

The application of biotechnology is believed to sustain the agriculture for the benefit of the people. The biotechnology will enhance environmental quality, make the most efficient use of non-renewable resources and on farm resources, sustain the economic viability of farm operations and enhance the quality of life for farmers and society as a whole. For example, the introduction of biotechnology control has change in the amount of insecticides and herbicides applied to the biotech crops relative to conventionally grown plants. The biotech crops also reduce the global greenhouse gas (GHG) emissions.

CONCLUSION

Biotechnology has made significant contributions to advances science and technology as well as to agriculture industries. It is said to be the technology of the 21st century and will continue to drive economic and social development. Biotechnology is envisaged to become the main driving force needed to transform Malaysian agriculture by redefining the value creation potential of agriculture. Furthermore, biotechnology is expected to expand societal well-being and wealth creation by unlocking the value of the Malaysia's natural resources and human capital talents. In considering the challenges and opportunities, Malaysia can consider biotechnology as an appropriate vehicle that can deliver economic gains. It is hoped that Malaysia can gain its competitiveness in agriculture sector through the application of biotechnology.

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