

The Application of Biotechnology in Agriculture Based Product R&D at Government Based Research Institute in Malaysia

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Abstract—The emerging of biotechnology had tremendously added value to the Malaysian Agriculture sector. An in depth case study on R&D conducted at biotechnology unit in a local agriculture research and development institute had indicated that the thrust areas in research were agriculture and industrial biotechnology. The results from the study indicated the extensiveness of biotechnology application undertaken by the unit with sophisticated infrastructure such as laboratories, qualified scientist of different areas in biotechnology. Success stories were included to elaborate the capability of the institute in establishing networking with the industry. In addition, implication to the technology management was also highlighted in the study.

I. INTRODUCTION

The commitment of Malaysian Government in promoting biotechnology is shown through the formulation of National Biotechnology Policy in early 2005. Even though this industry is still new to Malaysia, there are many incentives provided by government to promote the field. Incentives are in the form of R&D grants and other measures introduced to boost the national biotechnology agenda, including RM2.02billion fund under the Ninth Malaysia Plan 2006-2010 (9th Malaysia Plan) announced by the Prime Minister. Of the mentioned amount, industry players can get hold of RM463million set aside for R&D, RM100million for biotechnology acquisition program, RM529 million for business development while RM928million is allocated for biotechnology infrastructure [1]. Since biotechnology acquisition program can be applied widely in industry, it has focused on three thrust areas for the development of its biotechnology scheme- agriculture, healthcare, and industrial biotechnology. While its focus areas are contract manufacturing organization, contract research organization, agriculture biotechnology, bioinformatics, vaccines and others. Despite the commitment shown by the government, there is yet a study on the extent of biotechnology application among public research institute specifically in the agriculture sector.

II. THE STATUS OF AGRICULTURE SECTOR IN MALAYSIA

The Malaysian agricultural sector encounters two major challenges. The first challenge is the issue of national food security or producing sufficient of food for the country and the second challenge is to not only meeting the National Food

Security aim but also producing value added food and food products. To enable the sector to encounter both challenges, biotechnology has been recognized as one of the new high technology that would bring desired changes in the agricultural sector. Biotechnology has proven its capability to transform the agriculture sector through producing value added agricultural products while generating new industries to support the economic growth [2].

The phases of agricultural biotechnology development in Malaysia can be divided into three phases; the period of establishment (1995 and prior), development phase (1995-2000) and advancement phase (beyond 2001). During the establishment phase, basic infrastructure such as establishment of molecular and cellular biology labs with necessary equipment and set up and expertise to undertake R&D biotechnology are set up [2].

The second phase in the development of biotechnology has observed the implementation of the national initiative and agenda on biotechnology such as the establishment of BIOTEK (National Biotechnology Directorate). BIOTEK is to spearhead the development of biotechnology in Malaysia through R&D and commercialization of biotechnology. Finally, the third phase, which involved, the development of biotechnology in the country, is known as BioValley (its function similarly as Silicon Valley with main focus on biotechnology) [2].

The three phases in biotechnology industry developed in Malaysia are gone through by the agriculture based public research institute. However, there is limited study done in observing the development of biotechnology application undertaken at the government based research institute due to the non monetary contribution made by the institution. Hence, the objective of the study is to disseminate the information on the biotechnology program at a government agriculture based research institute by focusing on the R&D success stories.

III. RESEARCH METHODOLOGY

The research strategy undertaken by the study is to conduct an in depth case study on a single case basis. A semi structured interview was conducted at the organization and the subjects in the interview are the scientist and officials at the Biotechnology Unit, who involved in biotechnology R&D project. The data from the interview was transcribed and transferred in tabular form manually before the results were analyzed.

A. Case study Analysis

1) The background of the organization- XC Agritech R&D Institute

XC Agritech was one of the country R&D institute focusing on agriculture products, including poultry products. It was established in 1969. The objective of the institute was to conduct R&D in the agricultural sector. The institute was the country primary agricultural R&D agency. In 2002, it accounted for one third of the country's agricultural researchers (about 410 Full Time employees as researchers) and a quarter of its agriculture spending. XC Agritech was under the supervision of Ministry of Agricultural and Agro based industries and governed by Board of Director representing both public and private interest. The focus of its research was on scientific, technical, economic and sociological issues related to the production, processing, use of crops, agro based food, agriculture products and livestock. The institute had three main branches; Research Technology Transfer, Commercialization, and Operations. The research branch has seven centers focusing on horticulture, rice and industrial crops, food technology, livestock, strategic resources, biotechnology, mechanization, and automation. The technology transfer branch had four centers and two units focusing on the dissemination of the research institute results, while the economy and technology management research centers provided support services. All of the centers were undertaken by 29 regional research stations at every state in Malaysia [1].

2) The Biotechnology Unit

Since the focus was in biotechnology, the biotechnology Unit was chosen as the single case for the study. The Biotechnology unit was headed by one Head of Department and a number of researchers, who worked in various R&D projects. Scientists or researchers in the unit came from various field of biotechnology including molecular biology, genetic engineering, diagnostics, bioreactor technology, and biosafety. The goal of the unit was to generate new leads in state of the art technologies for the agriculture sector. The unit had three thrust areas in biotechnology known as;

1. research in biotechnology inclusive of improvement of plant, animal, and microorganism through tissue, cell and gene. Manipulations and propagation and conservation of elite plant, development and application of bioprocess and others
2. research in molecular bio and genetic engineering- focusing on developing new crop varieties that difficult to be produced through conventional way
3. Bioprocess- focuses on the use of biological materials such as microorganism and enzymes
4. Biodiagnostics and biosafety- focusing on the production and development of locally made diagnostics apparatus agriculture, food and environment.

Obviously, the focuses of Biotech unit were on agriculture and industrial biotechnology.

The biotechnology unit also had developed some technologies as well as research output such as;

1. tissue culture techniques for orchids, banana
2. reproductive biotech techniques in cattle
3. producing enzymes for medical and industrial biotechnology and more to mention.

Thus, most of the biotechnology R&D output was mainly for agriculture and industrial biotechnology application [3]. To comprehend how the unit function, the unit of analysis would be project based. To name a few biotechnology projects, we have selected two projects for illustration in this case study.

3) Success stories of the Biotechnology Unit

The success stories on technology developed by the institute can be learnt through the illustration on the projects undertaken by the unit.

Project 1- Bioprocess

The LTK Omega-3 enriched egg was the result of the R&D by the unit aimed at producing a nutritionally enhanced premium egg product which was a good source of additionally fatty acid, Omega 3 and Vitamin E. Through extensive R&D and advanced feed formulation by the unit, an all vegetarian (no animal fats, meat or fish by-products) and antibiotics-free layer chicken feed for the production of Omega-3 eggs was developed. Commercial production of Omega-3 eggs had started under a licensing arrangement with a Malaysian producer. These eggs contained up to 5 times more Omega-3 polyunsaturated fatty acids and up to 4 times more Vitamin E than regular eggs. The Omega-3 eggs had the similar look, great taste, storage quality and cooking versatility as regular eggs.

This was an example of a commercial arrangement which had been done via the licensing mode. Licensing arrangements had been found to be a suitable commercialization route by a number of R&D establishments and universities in USA, European countries and Australia. In this case the technology (poultry feed formula to produce Omega-3 content in eggs and production process) was leased to the commercial company in lieu of royalty of a royalty pay off to the institute or the marketing arm of the institute was the largest layer farm company in the country. In addition, continued technology support was provided to the company [4].

Currently, the company produced 90,000 eggs daily for Omega-3 (out of a total of 1 million eggs total production). Sold under the LTK Omega plus brand name, this represented an estimated turnover of RM6million a year. There could be a potential market of RM30million a year. With this breakthrough, 4 or 5 other 'me too' products had also appeared in the market indicating the country as a whole had benefited from the commercialization of the Omega-3 egg formula [4].

The significance of this commercialization project was shown, in spite of a glut in production or negative growth of the egg market, it was quite possible, through the intervention of the technology, to create a differentiated product which can have its own market niche. The proprietary process was kept as confidential information by the purchaser.

Project 2- Molecular Biology and Genetic Engineering

Project 2 aim was to improve the paddy yield level. Yield levels amongst the paddy farmers were range widely between 3.5 metric ton per hectare and 9 metric ton per hectare. This difference in yield levels illustrated variability in the cultural practices amongst farmer for example, seed selection, husbandry, and farming methods. While location and agro climate were significant factors, beginning with the right seeds was a mandatory step. The technology commercialized was varieties of rice seedlings such as MR185, MR211, MR84 and others. In addition to the seedlings, the unit also developed quality rice seed production processes [4].

In project 2, the mode of commercialization was different to Project 1. Commercialization of the technology was done through a joint venture with Padi Beras Nasional Bhd (Bernas), a national paddy production authority. The project demonstrated Bernas intention to go beyond its current forte of rice trading to upstream activities. In this regards, Bernas saw the commercial potential in the production and marketing of quality seeds. The company had been operating since 1997 over more than 8 planting seasons. It produced over 8,000 metrics ton or 20% of the national demand representing a total turnover of more than RM12million a year. With the nation's desire to increase agricultural productivity, increasing rice yield was the major agenda. The need for quality rice seeds was therefore expected to increase. The company had been granted ISO certification for processing, illustrating the progress in the production/business system technology developed by the unit. It had provided employment for 60 full time workers and contract farming over 3000 hectares. The significance of the project was that rice seed production was commercially viable. Regarding patents or IPR issue, it was not applicable for variety as plant breeder right or similar protection was not imposed in Malaysia. Proprietary production process was kept by Bernas XC Agritech Sdn Bhd [4].

IV. DISCUSSION ON THE LESSON LEARNED IN MANAGING THE BIOTECHNOLOGY PROJECTS

The establishment of public research institute focusing in agriculture sector has developed the status of local agricultural from merely focusing on the rice and industrial crops to a much more value added agro products through biotechnology application. Even though the goal of the research institute is to ensure R&D undertaken enable local farmers to upgrade their agro product quality in terms of seedling, fruits, crops and others, the institute also extends its

services to private sector through transferring the agriculture technology such as automation to the private sector. The capacity of the institute is strengthened through years of experiences in conducting R&D in agriculture starting from the first phase until at present. The popularity of this institute can be observed during its early independence years and today it regain the popularity due to the full support to the agriculture sector by the government especially in addressing the issue of national food security. Through the capability of the research institute, the dependency on foreign imported crops and foods can be reduced gradually and improved the local crops and food production in order to meet customers demand.

The institute is dynamic as its function in conducting agriculture R&D changes in accordance with the development of agricultural field in the world. The establishment of the biotechnology unit is an example of commitment shown by the research institute to upgrade agriculture sector. It has been the backbone of the institute. As outlined by the government, the thrust areas of R&D in Biotechnology unit are aligned to the areas promoted by government. Moreover, the level of R&D capabilities of its scientist is comparable to the international standard since most of its researchers attain doctoral degree in various areas of biotechnology. The extent of biotechnology application in the unit is more on agriculture and industrial biotechnology compared to healthcare.

There are about 45 researchers or scientists and 17 technicians since most of the scientists or researchers have attained doctorate in the related biotechnology field such as genetic engineering and molecular biology. In addition to the technical staff, the biotechnology unit also has about 10 laboratories to run experiments at one time. Referring to the two successful projects illustrated in this study, the unit undertook any R&D projects based upon market demand, private sector requests, the government instruction as well as the top management of the institute and the researchers' initiatives. The research done is to support and help local entrepreneurs in marketing the agricultural products of global standard, where the institute adopts the incubator-incubate program.

V. TECHNOLOGY MANAGEMENT IMPLICATION

The biotechnology unit takes into consideration market factor in developing the agricultural technology even though its main responsibility is for public benefits. The process development and production of a new discovery of biotechnology based product are significantly more complex [5]. The focus of the basic research in biotechnology is geared toward the problems of finding and cloning molecules [6]. Both of the projects have shown that public research institute cannot stand alone in ensuring that its technology to be diffused successfully. Linkages with private companies would help the technology not to left on the shelf but most importantly, public could benefit from the technology transfer

from the research institute to the private companies. Forms of collaboration with the private companies can be in licensing term or establishing a joint venture company. This is one way to ensure a win-win situation between the technology developer and the buyer as well as strengthened by the marketing arm of XC Agritech, known as Agritech Sales.

In terms of the biotechnology application by the unit, it is quite extensive as it does not only concentrating on the fruits or crops but also animal. The scope of the R&D activities varies from tissue, gene and microorganism manipulation, crops varieties as described in project 2, conversion of raw materials to value added food and non food product to developing diagnostic apparatus such as biosensor to assess the genetically modified food products. In short, the research institute is aware of the importance of biotechnology in upgrading the local agriculture products.

VI. CONCLUSION

Being the leading PRI in agriculture sector, the research institute has extended its function from focusing merely on crops and plantation to value added agro products using biotechnology. The thrust areas in the biotechnology unit are aligned with government emphasis, which are agriculture and industrial biotechnology. With the support of its highly

qualified scientists and researchers, the biotechnology unit has shown its progress in the area of plant, animal, micro-organisms improvement through tissue to biodiagnostics and biosafety apparatus used in the agriculture, food, and environment. The R&D conducted by the unit has its own success stories especially two of its project are successfully commercialized and accepted by the industry as well as public.

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