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INDUSTRIAL AGRO-BIOTECHNOLOGY: KNOWLEDGE UPGRADING AS A PREREQUISITE FOR HUMAN RESOURCE DEVELOPMENT

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Abstract

Biotechnology development relates to the quality and skills of human resources. During the Ninth Malaysian Plan 2006-2010, higher education institutions have produced more than 4000 graduates and in service training programs for human resource development and are providing more scholarships to serving officers to pursue post graduate degree in biotechnology. However, gaps still continue to exist between demand for and supply of biotechnology skills and there is an alarming shortage of biotechnology trained manpower. To overcome this vacuum, instant steps must be taken. The biotechnology industry is in a dynamic state of development and companies need to upgrade skill-level standards, in order not to jeopardize their abilities to meet the regulations of the industry. So the need to understand and investigate HRD resources and capacities is a necessity. A regionally focused training strategy to pool resources of firms in biotech clusters and to make the best available training affordable for companies of all sizes is needed to improve the situation. Stronger strategic and operational relationships between the biotechnology industry, research organizations and academic can help fill this gap. Human Recourse Development has the capacity to facilitate industry involvement in skills training and knowledge upgrading for employees to fulfill the human resource needs. This paper intends to provide the HRD and biotechnology companies with information on the present scenario of the Human Resource Development in the Malaysian Biotechnology Industry. This Paper's findings and comments can be used to help the biotechnology companies to improve their employees' skill training and knowledge upgrading.

Key Words: Biotechnology Companies, Human Resource Development, Knowledge Upgrading, Skill Training.

1. Introduction

Human Resource Development (HRD) is the key to the process of economic development. Natural and financial capital is crucial but human capital is the principle for developing these resources (Rivera et al. 2008). For human resources to progress through science and technology, the exploitation of the available resources for more productive activity is a necessity, which can be done by accelerating and updating the knowledge of the involved participants including employees. Close cooperation between the industry and the organizations responsible for science and technology creation. HRD should also facilitate the fullest possible development of skills and knowledge of the labor force relevant to productive activities (Gupta, 1991).

The biotechnology industry is in constant demand for more people and new skills to occupy the jobs that will be created in the near future. To maintain and to keep the existing positions updated some important points must be considered among which are: future directions in the industry, skills and capability requirements, the human resource supply situation, and capability gaps and the capacity to fill them (Paget Consulting Group, 1996).

The goal of this review is to develop recommendations to address the longer-term human resource requirements of the agro-biotechnology industry in Malaysia with regard to skill training and knowledge upgrading of biotechnology employees in agricultural biotechnology companies, using the international experience. Globally, the biotechnology industry is in a dynamic state of development, shaped by four key factors:

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1. The rising need for linking between the research centers, biotechnology companies and the companies that use their results and products.

2. Change in biotechnology research from technology focus to product focus and being multi-disciplinary in nature.

3. The biotechnology companies are moving towards greater specialization.

4. The importance of human resources in the success of biotech companies is increasing.

Governments do their best to help their industries through financial encouragements and other forms of support for research and by creating reassuring regulatory and intellectual property rules (Paget Consulting Group, 1996).

2. Malaysian Scenario

Developing countries in Asia can be categorized in three situations with regard to their industry and human capital: 1). countries with high adult illiteracy rates such as Nepal, Bangladesh, Pakistan, India and Laos. This condition prevents these countries from using their capacity to move up from a low-wage, low-skilled economy to value-added activities. 2). Countries which have experienced high growth rates during the last decade and have high literacy rates, but with low levels of secondary education constraining their ability to move beyond low technology and basic service activities. 3). Countries which have advanced rapidly, are paying particular attention to education and skills and are providing high investments to develop and improve the education and skill training process. However, the industry still suffers from shortages of skilled and/or unskilled workers because of their rapid industrialization. Malaysia is classified among the countries in the third group along with Korea and Singapore (De Silva, 1997). Malaysia has done much effort to cope with this situation and improve it in order to keep up with its rapid movement towards industrialization.

The Ninth Malaysia Plan, 2006-2010 outlines the government's policy and plans for the biotechnology activities. A facilitating institutional, regulatory and financial framework is established to sponsor biotechnology as a major motivation of sustained economic development. Human capital development efforts are being intensified to meet the industry's skill needs and nurture entrepreneurship. To achieve this aim 'BioNexus' is adopted as a leverage on the strengths of existing institutions along with parallel developments in industries.

In order to regulate the operation of the nation's biotechnology initiatives and provide an opportunity to ensure inter-ministerial coordination The Biotechnology Implementation Council was set up which is in close enterprise with the relevant ministries and stakeholders. The Ministry of Higher Education is responsible for ensuring an adequate and qualified supply of human resource in biotechnology and biotechnology related fields.

Malaysia has participated in several international conventions and protocols on the development of the biotechnology industry to ensure a regulatory environment in developing the biotechnology industry and the public safety. Among these the Convention on Biological Diversity , the Cartagena Protocol on Biosafety in 2003 , the promulgation of the Control of Drugs and Cosmetics Regulation in 1984, In 2002 the Pharmaceutical Inspection Cooperation Scheme (PICS) can be named.

To provide the talent and experience required in the biotechnology and biotechnology related fields the institutions of higher education are envisaged to produce more than 4,000 graduates with Bachelors, Masters and Ph.D. degrees, covering a wide range of biotechnology specializations but despite efforts in manpower development, gaps continue to persist between demand for and supply of biotechnology skills. The human resource development programs are being modified and new ones introduced to meet the skill requirements. To create greater collaboration between the research institutions, universities and the industry, measures are being taken to create highly dynamic and motivated R&D personnel. On the other hand the issue of brain drain is addressed and work is done to attract overseas talent by reviewing the remuneration and reward system.

During the Plan period, measures were taken to provide the necessary technological infrastructure and facilities to support biotechnology-related activities. Amongst others, three special laboratories were set up, covering agro-biotechnology at the Malaysian Agricultural Research and Development Institute (MARDI), genomics and molecular biology at the *Universiti Kebangsaan*

Malaysia (UKM) as well as pharmaceuticals and nutraceuticals at the *Universiti Putra Malaysia* (UPM). The center provides services related to standardization and quality control of natural products. As part of efforts to develop a Malaysian biotechnology community, the National Biotechnology and Bioinformatics Network (NBBNet) was set up in 2001. It was initiated to promote closer collaboration and networking among research institutions, universities and industry. It also hosted databases and information on local genetic resources and major R&D activities (Ninth Malaysia Plan, 2006-2010).

HRD has been considered as an important factor influencing the process of the fast industrialization in Malaysia. Some of the policies taken to improve and enrich the training based HRD activities in industry are presented here based on the Malaysia's Science and Technology Policy for the 21st Century (2009).

1. Malaysia expanding Human Resource Development (HRD) Fund to: improve Human Resources Development and to achieve nationwide human resource goals, providing more post-doctoral fellowships, initiate brain pool programs by means of association with renowned researchers, and establish, in collaboration with industry, distinguished visiting scientist programs in universities.

2. Reinforcing and intensifying Teaching Company Scheme and other student attachment programs to build long-term relationships for technology transfer and training between university and industry.

3. Working to improve the career visions and flexibility of scientists and research workers.

4. Revising the Skills Development Fund to finance industry-training program to be cooperatively managed by the private sector and the Government, with manufacturing industries contributing one percent of their total payroll to the Fund.

5. Allowing the industry to share their needs with the higher education centers and invite them to contribute to course design and curriculum assessment in institutions of higher learning and industrial training institutes to ensure that Malaysian graduates acquire training and skills that are fully relevant to national needs, particularly with respect to the choice of elective subjects and post-graduate programs and fields of research.

6. Providing connections for industrial training between industry and educational centers.

7. Reinforcing the part of institutions in advanced technology research and innovation that can be attained by: providing special development budget distributions in areas related to new technologies, and increasing the industry coordination of post-graduate courses.

3. Biotechnology and Training from a Global View

Learning from the experiences of the rich economies and the more recently industrialized countries that sustained investment in human capital is very important for competitiveness and growth. The technology transfer and industrialization in developing countries is due to rapid change with globalization, increased investment and trade, and the spread of technology. Without correct human capital economic, trade and investment policies will fail towards lead to improvement. Since the time taken for investment in human capital to bear fruit is relatively long, the planning period also, has to be necessarily long and timely. But the good point is that unlike most other resources, human capital does not waste or diminish in value through use; on the contrary its value enhances (De Silva, 1997).

Godkin (2008) argues that organizational knowledge is a context-specific and dynamic process. It issues from social interactions between individuals and the corresponding network of relationships inside and outside of organizations. It is difficult, however, to erect the organizational architecture (Kay, 1993) and structure necessary to support those networks and relationships. Networks give the opportunity of handling various sources of information and a broader learning interface than hierarchies do. John Kay (1993) argued that strategies have to be used to help a company to obtain a competitive advantage over the other companies. He identified four distinctive capabilities: Architecture, Reputation, Innovation and Strategic Assets.

Biotech firms and companies are already a major employer of highly educated and skilled work force but the need for more experts to fill the future positions will be required to direct the financing and growth needed to support the transition to commercialization and sustain longer-term success for the

companies (Paget Consulting Group, 1996). On the other hand, the rapid progress of science and technology makes the in service education and updating the employees' capabilities a necessity.

The human resource requirements of firms at different stages of development are different and can be summarized as:

1. The need for management and specialized expertise to accelerate the transition from research and development to commercialization.

2. Adequate resources to gear up for manufacturing and the transition to commercialization.

3. A more efficient and hospitable regulatory environment for moving biotech products from the research stage to the market; and public awareness of and knowledge about the industry (Paget Consulting Group, 1996).

The need to improve the capacity for science and technology has long been emphasized for developing countries. Technology means a way of doing things, more specifically, a way of increasing human capability to perform an activity (Gupta, 1991). Biotechnology is known as a dynamic technology which is the center of transformation in many areas of the economy, including agriculture and food, pharmaceuticals, and environmental management. Research and Development, together with science and technology education and training are, thus, essential components of the development process. The education system is the main source to prepare scientific and technical labor at the graduate, post-graduate, and doctoral levels. Therefore the academic training should be sensitive to the changing technologies, patterns of industrialization and the demands of the labor market (Gupta, 1991).

Universities must realize this demand for post-doctoral fellows, post-graduates, university graduates and technicians. The capability gap is related more to the specialized needs of developing fields of biotechnology such as the need for people with multidisciplinary backgrounds combining several scientific specialties. Multiple scientific fields require large capacity pools. An important challenge of the training programs needed for biotech companies then is to create an effective interface across disciplines (Bhan, 2008). The expanded and more effective working cooperation between business and the educational system at all levels is inevitable.

In order to fill this gap, closer collaboration between biotechnology companies and universities and research centers must be assumed. More effective cooperation can be achieved through ensuring R&D programs of these research institutes and universities more specialized to encounter the needs of biotechnology companies. An emphasis on innovation and elevation capacities of these research institutes and universities to allow the provision of more effective advisory services and commercialization of more research findings can contribute to the growth of the industry (Smallbone et al. 2001).

Besides, universities are not able to provide all the specialized skills that biotechnology companies will need as they move toward full commercialization. These skills must be acquired through experience. Some of these specialized skills requirements can be found through enrollment from firms in other industries. However, the future of the biotechnology industry is subjected to better training within the industry to build the functions that are significant for commercial accomplishments (Paget Consulting Group, 1996).

This issue goes beyond the need to upgrade the skills of the current workforce. It is also necessary to equip future human capital with the necessary education which makes them able to be trained and adopted to the over changing skills requirements. Many Asian countries assume that such problems must be sorted out by governments, because it is the responsibility of governments to provide education and training. This assumption is no longer valid and employers influence policy, environment and the education bias. High levels of education by itself do not guarantee economic growth, so employers need to have an impact on education policies and systems to sponsor the achievement of knowledge and skills related to business needs and the ability to use this knowledge and skill. This process has been successful implemented in developed countries like New Zealand, Sweden and USA (De Silva, 1997).

4. HRD Strategies

In Asian countries, priorities in HRD have to be set to fulfill the special needs of the Asian developing countries due to their highly growing population and rapid industrialization. HRD includes three basic strategies: 1). developing human resources through education and training, 2). deploying

human resources, and 3). providing the incentives to ensure that they are productively deployed (Horwitz, 1999). The process of development can be enhanced by achieving innovations, discoveries and improvements in productivity from science and technology contributions. Emerging an approach for human resource development for scientific and technological manpower for achieving development needs an understanding of the skill and training implications at the different phases of the procedure of innovation, transfer of technology, and technological change. In a company or firm, suitable training programs are required to develop the necessary knowledge and skills (Gupta, 1991).

Human capital and human resource development are essential for development. Human capital which is the source of skills and technical knowledge embodied in workforce is vital for using and developing natural and financial capital. According to the Task Force on the Future of American Innovation (2005), the international position of a country in science and technology shows its competitive advantage on the global stage Knowledge. In a knowledge economy, resources such as skills, expertise, and intellectual insight are often more critical than other capitals such as land and labor and even investment. This is particularly true for agriculture. Greater commercialization of agricultural systems creates a need for more capacity on the part of the agriculture workforce in the 21st century. Agricultural education systems including extension, formal education and in-service training call for inclusive consideration in order to prepare the agricultural workforce to encounter new challenges (Rivera et al. 2008).

Bhan (2008) has provided some practical ways to make Human Resource Development cope with the emerging needs and demands. The Malaysian situation with regard to each classification is presented here.

1. **Human Resource Need assessment:** In Malaysia as stated in Haslinda Abdullah (2009) the training needs assessment in manufacturing companies is done informally using observations. Although the Malaysian HRD practitioners recognize the importance of an effective needs assessment in planning HRD activities, still there is a lack of effective resources with this regard.

2. **Technician training programs:** Technician training programs in biotechnology and biotechnology related fields are provided through institutions of higher education are which are supposed to produce more than 4,000 graduates with Bachelors, Masters and Ph.D. degrees. This number of trained technicians covers a wide range of biotechnology specializations but despite efforts in work force development, gaps continue to persist between demand for and supply of biotechnology skills (Ninth Malaysia Plan, 2006-2010).

3. **Strengthening teaching at university level by stronger linkage with R&D:**

Strengthening R&D in life sciences and biotechnology in the universities and other teaching institutes may be accorded high priority. In order to improve the quality of education and to provide acquaintance to innovative technologies for students in different levels, this should be considered as an important issue (Dzulkifli Abdul Razak 2010).

4. **Lateral mobility of scientific personnel:** Commercialization of the research can be improved by allowing university and institute scientists to work in industries.

5. **Dual/adjunct faculty positions:** Researchers working in university/research institutions may be allowed to hold positions in the industry and vice-versa.

6. **Institute Innovation grants:** the Ministry of Science, Technology and Innovation (MOSTI) is responsible for controlling and encouraging the production and adoption of agricultural biotechnology innovations. This encouragement is provided through loans and grants to the academic research centers as the producers and the biotechnology companies as the adopters of the innovations.

7. **Enabling working conditions for scientists to undertake industry oriented research:** Augmenting the number of Ph.D. programs in biotechnology is critical in order to educate academic leaders to sustained innovation. This attempt can include the formulating of undergraduate and post-graduate curricula, attracting talent to life and biotechnology programs and improving the working conditions industry oriented researchers.

8. **Arresting and reversing brain drain:** Malaysia is working on the issue of the brain drain and trying to reverse the situation by offering facilities, better career perspectives and tax incentives to highly skilled emigrant professionals to persuade them to return. Thousands of trained Malaysians work in Singapore, Britain, the USA, Australia and elsewhere. The incentives are aimed at Malaysians with doctorates and other higher qualifications.

5. Characteristics of Malaysian agro-Biotechnology Companies

The details of the agro-biotechnology companies including information on trained employees, source of skills, company orientation, MOSTI support, relative biotechnology activities and innovation-related activities were collected via a questionnaire. The data collection was done by means of a self-administered questionnaire which was devised by the researcher. The questions and their content were developed based on the literature review and the local and social situation to ensure validity. The adopted questions were modified to match the research context.

The validity of the questionnaire was ascertained by a panel of experts and through a pilot test. A pilot test was carried out to determine the validity and reliability of the questionnaire. The pilot test was conducted in ten Malaysian biotechnology companies.

The reliability was measured by using the Cronbach's alpha internal consistency (Ary et al. 2006). The reliability coefficient for this questionnaire as a whole was equal to .90. The questionnaire was distributed to all the 51 agro-biotechnology companies active in Malaysia and 46 companies returned the completed questionnaire. Therefore, response rate was 90.19% (N=46). The data presented in Table 1 and Table 2, which is given in the form of frequencies and percentages, summarizes this data. The calculations for Mean and Std. Deviation are also provided.

Table 1 summarizes the information on the number of personnel trained in biotechnology, working with each company. It shows that 26.1% (N=12) of the companies had less than 10 trained personnel, 43.5% (N=20) had between10-15 trained personnel, 17.4% (N=8) with 16-20 trained workers and 13% (N=6) were large companies with more than 20 trained personnel. It also shows the source of skills obtained by the company personnel. It is noted that 82.6% (N=38) of the companies employ university graduates, 13.0% (N=6) have personnel who gained their skills from job experience and only 4.3% (N=2) provided training for their personnel. The data also displays that 47.8% (N=22) of the companies are government-linked, 32.6% (N=15) are private companies and 19.6% (N=9) are international companies. The majority of the companies i.e. 67.4% (N=31) used the loans and grants provided by MOSTI to support their biotechnology activities. Biotechnology information provided by MOSTI was used by 19.6% (N=9) of the companies while 13.0% (N=6) used the R&D and commercialization support from MOSTI. As the scope of this study was agricultural biotechnology innovations, the target population involved only those companies working in this field. Among the 46 companies engaged in this study, 69.6% (N=32) were involved in GM agricultural biotechnology, 19.6% (N=9) were Non-GM agricultural biotechnology companies and 10.9% (N=5) were working in the industrial processing field.

Table 1: Characteristic of Companies' Biotechnology Activities

Variables	Frequency	Percent
Train Personnel		
Less than 10	12	26.1
10-15	20	43.5
16-20	8	17.4
More tan 20	6	13
Total	46	100
Source of skill:		
University educated	38	82.6
Job experience	6	13

Company trained	2	4.3
Total	46	100.0
Nature of company:		
International Company	9	19.6
Government-linked company	22	47.8
Private company	15	32.6
Total	46	100.0
Type of MOSTI Support:		
R&D and commercialization support	6	13.0
Biotechnology Information	9	19.6
Loans & Grants	31	67.4
Total	46	100.0
Biotechnology activities:		
Non-GM agricultural biotechnology	9	19.6
GM agricultural biotechnology	32	69.6
Industrial processing	5	10.9
Total	46	100.0

The technological innovation-related activities practiced by the participant companies include financing, development, evaluation, dissemination, introduction/selling, training, use and purchase which are illustrated in Table 2. The percentages for each type of activity were 15.2% (N=7), 21.7% (N=10), 8.7% (N=4), 10.9% (N=5), 19.6% (N=9), 8.7% (N=4), 10.9% (N=5), 4.3% (N=2) respectively.

Table 2: Kind of Innovation by Biotechnology Companies in Malaysia

	Frequency	Percent
Technology financing	7	15.2
Technology development	10	21.7
Technology evaluation	4	8.7
Technology dissemination	5	10.9
Technology introduction / Selling	9	19.6
Technology training	4	8.7
Technology use	5	10.9
Technology purchase (local/international)	2	4.3
Total	46	100.0

The questionnaire also included some questions on the nature of knowledge updating activities in these companies the results of which are presented here. More than 50% of the active companies have personnel who are educated in Malaysian universities. The process of knowledge updating and personnel training is done through various channels as follows: 84.8 % of these companies use journal articles, 32.6% have direct access to universities and higher education institutes, 80.5% attend conference, workshop, seminars, and 90.8% use internet as a source of knowledge.

MOSTI and Extension services provide facilities and consultations to agro-biotechnology companies. The collected data through the questionnaire revealed that 23.9% of these companies do not use extension and education activities while 52.2% agree strongly that they benefit from these activities. As for the importance of R&D, it should be mentioned that 19.6 % of the companies do not use R&D activities at all and 52.2% use them in a weak uncertain way, only 28.3% admit using R&D activities to improve their knowledge on biotechnology innovations. Collaboration with other companies is rather high with 82.6% stating that they use this collaboration to update their knowledge. Unfortunately 30.4% do not use the facilities provided by Malaysian Technology Development Corporation (MTDC) 84.7% do not receive financial support from MTDC and only 15.2% use this facility.

The cooperation with MOSTI can be stronger since 19.6% of these companies do not collaborate with universities and MOSTI and although 50% have some cooperation, only 30.4% have active strong collaboration. Using Grants and funds are popular by more than 90% of the companies, emphasizing the importance of this factor which can be used as a leverage force to direct the companies to the knowledge sources and gain feedback form these companies to support the innovative activities. As for technology transfer, Personnel training is used by only 2.2% of the agro-biotechnology companies as a channel of technology transfer. 43.5 % of these companies directly use MTDC as a channel of technology transfer, 34.4% somewhat use this channel and 21.7% do not use this channel at all.

6. Recommendations

The data collected from the Malaysian agro-biotechnology companies reveals that the cooperation with universities, MOSTI and MTDC is rather weak. MOSTI and MTDC provide many beneficial facilities with regard to knowledge and technology transfer but a large number of these companies neglect these services. As presented by the data only half of the companies use MOSTI facilities and the services of MTDC are used by only 15% of the companies (these are the services provided by MOSTI and MTDC apart from loans and grants, which are quite popular). The direct collaboration with universities is used by only 32.6% of the companies, while this collaboration can be used as a rich source of knowledge for the companies and on the other hand, the researchers can use the feedback from the companies to improve and apply their innovations

Cooperation at various levels and between different organizations can be the key to progress with regard to training and skill development. A locally focused training strategy to pool resources of companies in biotech clusters and to make the best available training affordable for companies of all sizes is useful. It is important to build stronger relationships between the biotechnology industry and academic and research organizations. Cooperation between the industry and the government can be helpful to improve personnel in the regulatory and intellectual property areas to cut the costs and increase the efficiency of these processes (Paget Consulting Group, 1996).

Strengthening the relationships among biotechnology companies, MOSTI and the universities and institutions of higher education can be recommended to enhance the knowledge updating process in the companies and provide sufficient feedback for the researchers.

Rivera and Alex (2008) state that carefully diagnosed, systematically implemented policies for capacity development in the agriculture workforce, and their implementation by agricultural institutions, both public and private, including bilateral and nongovernmental organizations, promise a more educated and skilled workforce that is capable of increasing the production and development of food security as well as high quality and specialized products competitive in international markets. Based on this idea Malaysian public and private institutions need to coordinate to diffuse innovations for agricultural productivity, and in general, to advance people-centered, production-oriented, environmentally sensitive agricultural education, knowledge transfer, training and development programs. This new complexity requires new knowledge and skills. The levels of knowledge, skills, abilities, and aspirations of a nation

will increasingly dictate the rate and degree to which a country can use its material, geographical, institutional, and cultural resources.

Human resource development must meet the demands of the current knowledge imperative, and fulfill the task of making knowledge work productively. As suggested above, this task can be accomplished in part by developing an interrelated educational network that responds to contemporary efforts at reform. However, the greater part of the task resides with policy makers, institutions, and individuals committed to the modernization of the agricultural workforce (Rivera et al. 2008).

Conclusion

Human resource development must meet the demands of the current knowledge imperative, and fulfill the task of making knowledge work productively. The HRD department in the Biotechnology companies can improve skill training and knowledge upgrading of biotechnology employees by active cooperation with other companies, educational/research centers, universities and the government. In order to achieve practical training affordable for all companies it is very useful to establish a locally focused training strategy to pool resources of companies in biotech clusters. Foreign investment can be considered as another option to improve the situation of training new and in service personnel for biotechnology companies in Malaysia.

The government can use the provided grants and loans facilities, which are very popular among the agro-biotechnology companies, as a control factor to lead and encourage the companies to use the knowledge and technology transfer services. This will be beneficial for the companies, the research centers and the nation in general.

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