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Challenges for Commercialization of University Research for Agricultural Based Invention

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Abstract: This study analyses the challenges for the commercialization of university research for agricultural based invention. It aims at promoting the commercialization of agricultural based research to compete with the existing inventions. From the discussion, it shows that the commercialization of agricultural based invention of university research usually takes a longer time to be marketable, when compared to inventions by agencies such as MARDI and FAMA. The article implies that agricultural based invention of university research should be considered as a significant tool for economic growth. It suggests that a case study and a quantitative analysis will be useful to further formulate propositions and to learn the agricultural based invention of university research.

Key words: Commercialization · University research · Agricultural based invention · University technology transfer · University-industry interactions

INTRODUCTION

The importance of agricultural industry to mega-diversity country such as Malaysia is not contentious. Agriculture industries provide an important contribution to the Malaysia economic development since 1990 and provide many new jobs to the society. After the 1998 financial crisis, there was an increase in agriculture output, underpinned by a meaningful progress in palm oil yield, had contributed towards the positive growth in the economy [1]. Universities also play an important role to develop agriculture inventions that can be transformed to the commercial and feasible product to the market. At present, there is still little research by the research institutions and universities to give foundation to the agriculture industry in commercialization activity and technology transfer.

It is the vision of the present Prime Minister of Malaysia, Dato Sri Najib Tun Abdul Razak that active collaboration between university and industry will have positive impacts on Malaysia. Malaysian universities are currently undergoing Nowadays, Malaysian governments transform tasks of the Malaysian universities from a place to transmit research and education to a place that will contribute generated revenue and furnished to the profitable development. There is a general consensus among policy makers that universities and research institutions are tools for economic growth, via the commercialization of university inventions, including agricultural based ones [2].

It is noted that most universities have adopted a formal mission statement on technology transfer [3]. 'Rather than concentrating on 'blue-skies' research, academics are now increasingly eager to bridge

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the worlds of science and technology, in an entrepreneurial way, by commercializing the technologies that emerge from their research' [2- 4].

According to [5, 4], over the years, universities are increasingly more committed to the society around them in the following areas:

- Teaching: conservation and dissemination of knowledge (from their early days until the late 19th century.)
- Teaching and research. Research was incorporated as another mission of the university in the first academic revolution (from the late 19th century).
- Teaching, research and direct contribution to social and economic development, or the so-called Third Mission. Incorporating the Third Mission as another mission is known as the second academic revolution (from the end of the 20th century).

Over the past decades universities are required to transform themselves from 'ivory towers' to entrepreneurial enterprises [6, 7]. One of the main problems in linking academic research to industry is the tacit nature of knowledge [8]. The roles of scientist are to ensure that their research are relevant to the private sector and effectively transfer their knowledge and finding results [9, 10]. Scientist are measured based on the competences and information embedded in scientist, so that the research result can only to a limited extent be transferred via publication or patents [11]. Commercialization activity and intellectual property are still relatively new researchers and academics.

The research on commercialization of university's research that lead to the academic spin-off that boosting the economic activity [12-14] creating new jobs [15-17] generating new wealth [15-17] that contribute to the economic development [18, 13].

Universities have contributed to society by providing ideas and new knowledge underlying many key innovations- for a sampler see Table 1 [19- 21]. Industry interest on scientific research is well-established [22], but only few studies have discussed the commercialization of agricultural based invention. Most research on university commercialization activities are focused on US and European universities [23], while similar research in other parts of the world is scarce. This research provides a significant contribution to the existing literature in terms of commercialisation of agricultural based university research. This is for the benefit of all Higher Education Institutions and Malaysian Universities, in particular.

Table 1: Examples of significant inventions/technologies originating at university

Commercialization University Invention
Insulin (U. of Toronto)
Vitamin D fortification (U. of Wisconsin)
Plexiglas (McGill U.)
Penicillin production method (Oxford U.)
Magnetic core memory (MIT)
Polio vaccine (U. of Pittsburgh)
Seat belt (U. of Minnesota)
LCD (Kent State)
CAT Scan (Georgetown U.)
MRI Scan (State U. of NY)
Recombinant DNA technology (Stanford U. and UCSF)
Synthetic Taxol (Florida State. U.)
Digital sound synthesis (Stanford)
"Citation" based (Google) Internet Search Engine(Stanford)

Source: [24].

United Nation have conducted a survey to analyse the potential of the applications using nanotechnology in developing countries and have identified that agricultural productivity and invention as the second most critical area of application for attaining the millennium development goals while energy conversion and storage was ranked 1st and water treatment as the 3rd areas needing focus [25]. The importance of the agriculture invention in providing support to the food industry has not been realized [26]. This study provides an overview about the commercialization activity in Malaysian University and analyses the challenges towards technology transfer of agricultural based invention from university to industry. Two research questions asked are: (i) what are the problems and challenges in the commercialization of agricultural based invention and how to facilitate the process? (ii) How can universities or research institution maintain and develop those capabilities?

Focusing on factors contributing to the success of commercialization of agricultural based invention in Malaysian University, findings from this research is relevant to policy makers and government institution. It can be used to develop an effective commercialization and technology transfer strategy.

Commercialization of university research is still new in Malaysian. Most universities have a Technology Transfer Office (TTO) which is dedicated in the commercialization and coordination of all the different aspects of technology transfer activities, from the development, diffusion and exploitation of patent policies and strategies, to the management of industrial liaisons and licensing activities and the organization of different

forms of support to academic start-ups [27, 28, 29]. At the same time, [30] the decision to disclose a new finding depends upon the patent benefits, framed by the costs of interacting with the university administrators: inconvenient or frustrating interactions may lead to failure to disclose. In particular, many countries and universities have emphasized on the creation of university spin-off firms (USOs) as an important tool for the commercialization of research [3, 31]. The growing interest in USOs among policy makers and the large amount of resources used to support USOs [32] call for more research to better understand how universities can facilitate the creation of new research-based ventures [33].

In Malaysia, there are five research universities (RU) which is Universiti Kebangsaan Malaysia (UKM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Sains Malaysia (USM) and Universiti Teknologi Malaysia (UTM). Technology transfer and commercialization process started in United States when the federal government cut the funding budget for the universities during the Cold War. Then, U.S senate introduced Bayh Dole Act 1980 (also known as the University and Small Business Patent Procedures Act.) This act has removed the barriers of intellectual property ownership and thus, universities can now claim rights towards their invention from federal funding. The Bayh Dole Act 1980 has made many changes that stimulates the commercialization process of US universities. [31].

Previous studies reveal a tendency to use case studies to explain this phenomenon justified by the embryonic nature of the topic field [34] and with the lack of a robust theoretical framework to understand it [35, 36]. Despite the lack of supporting evidence [37], the Bayh-Dole Act of 1980 is often perceived as essential to the growth of university-industry interaction in the US [38]. Research on the importance of different knowledge transfer channels between science and industry suggests that personal interaction of academic scientists and private sector firms is a key element of successful transfer [39, 40, 11].

In Malaysia, most of the research and development (RandD) in agriculture are conducted at University Putra Malaysia (UPM). Established in 1931, UPM has a long history of agricultural research. Undeniably, UPM makes a significant contribution to the society and economic development. [41].

Table 2 above shows some of the agricultural based inventions from UPM. Noted as having commercial value, UPM have commercialized these inventions through licensing agreement, university start-up or joint venture collaboration. This is a normal strategy normally adopted by Malaysian universities. Although there are many potential agricultural based products, the present scenario in terms of commercialization activities made it somewhat difficult for universities to actively involve in commercialization. Farmers are not easily convinced about the need to consider using technology developed by universities. In many instances, they prefer to use technologies developed by research institution. Developing societies will need to develop and implement regulatory measures to manage any environmental, economic, health and social risks associated with genetic engineering [42]. There are also issues in patent and intellectual property that must be properly addresed in the commercialization process. Patent protection and capital investment are necessary components for the effective commercialization of innovations [43].

Challenges 1: Timeliness: A commercialization activity is a long process over time. It requires initial investment before making profit. Initial investments are normally for intellectual property filing, company registration, hiring qualified entrepreneur and marketing of products.

As been mentioned by William R. Brody president of Johns Hopkins University [46]:

‘‘From the university’s perspective, it’s mostly a money-losing operation. The fees that universities get do not cover the expenses involved in licensing and marketing the inventions. That’s because only a very small fraction of licenses actually generate much revenue.

Table 2: Agriculture Invention in Universiti Putra Malaysia (UPM)

Inventions	Description
Humic Substances	Humic Substances is a substances that can entrapped volatile nutrient from vapor to the air
Fabricated Mats From Palm Fronds	Evaporation Reduction Using Palm Fronds
A Process For Producing Biopesticide	The presentation provides a process for producing granulovirus as a biopesticide. Granulovirus comprises of a single protein, granulin, which is embedded in a crystalline protein matrix known as occlusion body.
ICT For Paddy Precision Farming	Utilization of Geographical Information System (GIS) in agricultural is becoming a useful tool for agriculture technology and its adoption can been seen widely in precision farming system

Source: http://www.icc.upm.edu.my/

In the year 2000, universities had about 21,000 active licenses with industry. But only 125 generated more than $1 million in licensing and royalty income. Unless you have a big hit like Gatorade, which came out of the University of Florida, or a drug that the University of Wisconsin had many years ago to prevent blood from clotting, or the recombinant DNA patent that the University of California at San Francisco and Stanford share, the aggregate income does not cover the expenses''.

Accordingly, commercialization of university's research is not necessarily means big money. It is not uncommon for universities to lose money in their quest towards commercialization. It is important for universities to have a proper commercialization strategy and Intellectual Property Policy, thus minimize risk [47]. The following costs and investment listed below can be implemented by the university:

- They can outsource some of the services to reduce the costs.
- Find some sponsor.
- Find co -sourcing, lease courses from or to outside.
- Use open source technology to reduce the costs.
- They can ask government funds for some of the projects.
- The marketing of the programs also should be thinking in advance.

Challenges 2: Incentives and Rewards: Another problem in the commercialization activity is the lack of proper incentives and rewards system. Although there is an ongoing debate about reward and incentive, it is imperative that universities have a proper rewards system. This is consistent with a long research stream on pay and performance [48, 49]. On the other hand, royalties' incentive effect might seem surprising, given the norms of open science and free dissemination of knowledge under which universities are expected to operate [50]. In fact, previous studies on this topic have shown contrasting results [51] suggesting that monetary incentives given to university scientists are negatively related to the number of equity licenses in young ventures and to the number of start-ups; similarly, sharing revenues with scientists' departments is negatively related to the number of incubators. Then, [52] proposed that royalties grant to faculty inventors have positive effect on the number of licenses, while royalties granted to the inventors' departments have a negative effect.

Challenges 3: University-industry Interactions: There were those who warned about undue influence by corporations that provide research funding [53] and potential abuse by faculty and university staff due to conflicts of interest, triggered by the lure of readily available money [54] and conflicts of commitment. Based from the literature there are two form of university technology transfer: patent/technology licensing [55- 57], university spin-offs [58, 59]. The research show that the interactions between university and industry will create and give an important contribution to all the agents involved in it, with all the research university in United States are leading the way. However, the interactions in Malaysia especially in university, still need time to develop and take time to get the result from this. As for agriculture invention, academic researches are not force to collaborate with the industry-practitioners because the university more looking forwards to the publications and teaching. Even though, the academic know about the commercialization activity but they don't have time and knowledge interact with the industry.

Technology Transfer Office (TTO) Capabilities: Most of the universities, especially Research University have established TTO office that will provides support to commercialization activity and technology transfer process. These TTO offices are still new and less experience in conducting commercialization process.

Discussion and Implementation: Although it is very difficult to draw generalizations the challenges from observations study, the richness of the case study data and quantitative analysis made it possible for further study to formulate propositions and know the nature of commercialization university inventions. More research using the large samples at other university and research institutions need to conduct to help identify these capabilities and to measure whether they are associated with the technology transfer and commercialization in agricultural inventions. In particular, more longitudinal research is needed to be able to draw conclusions from causal inferences [60]. Our research was only limited based on our observations at the challenges in commercialization university research at Malaysia research university, which is arguably still new in Malaysia research university. We draw our findings based on the initial development in Research University in Malaysia and formulate the links to survival and growths of this institution need further clarification.

It is acknowledged that commercialization university researchers are facing long time to introduce to the market and little attention has focused to the commercialization agriculture invention. The changes in university and not static environment provide learning occurs [61] for the researcher and practitioner to integrate their expertise for the sustainable of the university in the future.

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REFERENCES

1. Bank Negara Malaysia (BNM). 2000. Economic Report 2000. Kuala Lumpur.
2. Phan, P.H. and D.S. Siegel, 2006. The effectiveness of university technology transfer: lessons learned from qualitative and quantitative research in the US and UK. Foundations and Trends in Entrepreneurship, 2: 66-144.
3. Markman, G.P. Gianiodis, P.H. Phan. and D.B. Balkin, 2005. Innovation speed: Transferring university technology to market. Research Policy, 34: 1058-1075.
4. Clark, B.R., 1998. Creating entrepreneurial universities: Organizational pathways of transformation. Pergamon: New York.
5. Shane, S.A., 2004. Academic entrepreneurship: University spinoffs and wealth creation. Cheltenham: Edward Elgar.
6. Etzkowitz, H., 2003. Research groups as 'Quasi-Firms': The invention of the Entrepreneurial University. Research Policy, 32: 109-121.
7. Etzkowitz, H. and L. Leydesdorff, 2000. The dynamics of innovation: From National Systems and ''Mode 2" to a Triple Helix of university-industry-government relations. Research Policy, 29:109-123.
8. Etzkowitz, H., 1998. The norms of entrepreneurial science: Cognitive effects of the new university industry linkages. Research Policy, 27: 823-833.
9. Powers, J. and P. McDougall, 2005. University start-up formation and technology licensing with firms that go public: A resource based view of academic entrepreneurship. J. Business Venturing, 20: 291-311.
10. Pavitt, K., 1988. Uses and abuses of patent statistics. In V. Rann (Edited.), Handbook of Quantitative Studies of Science and Technol., pp: 509-536.
11. Mansfield, E., 1995. Academic research underlying industrial innovation. Review of Economics and Statistics, 77: 55-65.
12. Dietz, J.S. and B. Bozeman, 2005. Academic careers, patents and productivity: industry experience as scientific and technical human capital. Research Policy, 34: 349-367.
13. Agrawal, A. and R. Henderson, 2002. Putting patents in context: Exploring knowledge transfer from MIT. Management Sci., 48: 44-57.
14. Di Gregorio, D. and S. Shane, 2003. Why do some universities generate more start-ups than others? Research Policy, 32: 209-227.
15. Nicolaou, N. and S. Birley, 2003a. Academic networks in a trichotomous categorization of university spinouts. J. Business Venturing, 18: 333-359.
16. Roberts, E.B. and D.E. Malone, 1996. Policies and structures for spinning off new companies from. R and D. Manage., 26: 17-48.
17. Perez Perez, M. and A.M. Sanchez, 2003. The development of university spin-offs: early dynamics of technology transfer and networking. Technovation, 23: 823-831.
18. Steffensen, M., E.M. Rogers and K. Speakman, 2000. Spin-offs from research centers at a research university. J. BusinessVenturing, 15: 93-111.
19. Walter, A., M. Auer and T. Ritter, 2006. The impact of network capabilities and entrepreneurial orientation on university spin-off performance. J. Business Venturing, 21: 541-567.
20. Mian, S.A., 1997. Assessing and managing the university technology business incubator: an integrative framework. J. Business Venturing, 12: 251-285.
21. University of Virginia. 2007. University inventions that changed the world. http://www. uvapf. org/index.cfm/ fuseaction/ viewpage/ page_id/115? CFID=177.
22. Stanford University. 2006. Office of Technology Licensing Annual Report, 2004-2005.
23. Utek Corporation. 2007. http://www. utekcorp. com/documents/ Successful%20 Technology%20 Transfers. pdf.
24. Raphael Klein and Uzi Haan and Albert Goldberg. 2010. "Overcoming obstacles encountered on the way to commercialize university IP," The Journal of Technology Transfer, Springer, 35: 671-679.

25. Rothaermel, F.T. S.D. Agung and L. Jiang, 2007. University entrepreneurship: A Taxonomy of the literature. Industrial and Corporate Change, 16: 691-791.
26. Libaers, D., 2009. Industry relationships of DoD-funded academics and institutional changes in the US University system. J. Technology Transfer, 34: 474-489.
27. Sastry, R.K., N.H. Rao, R. Cahoon and T. Tucker. 2007. Can nanotechnology provide the innovations for a second green revolution in Indian agriculture. Proceedings of the NSF Nanoscale Science and Engineering Grantees Conference, Dec. 3-6, Cornell University, Ithaca, New York, USA, pp: 1-4.
28. Joseph, T. and M. Morrison. 2006. Nanotechnology in agriculture and food. Institute of Nanotechnology, Report, Nanoforum Organization, European Nanotechnology Gateway. http://www. nanoforum. org/dateien/temp/ nanotechnology%20 in% 20 agriculture %20 and %20food.pdf
29. Jensen, R. and M. Thursby, 2001. Proofs and prototypes for sale: the licensing of university inventions. American Economic Rev., 91: 240-259.
30. Louis, K., M. anderson, L. Jones, D. Blumenthal and E.G. Campbell, 2001. Entrepreneurship, secrecy and productivity: a comparison of clinical and non-clinical life sciences faculty. J. Technology Transfer, 26: 233-245.
31. Rasmussen, E., 2008. Government instruments to support the commercialization of university research: lessons from Canada. Technovation, 28: 506-517.
32. Owen-smith, J. and W.W. Powell, 2001. To Patent or Not: Faculty Decisions and Institutional Success at Technology Transfer. J. Technology Transfer, 26: 1-2.
33. Wright, M., B. Clarysse, P. Mustar and A. Lockett, 2007. Academic Entrepreneurship in Europe. Edward Elgar, Cheltenham.
34. Lockett, A. and M. Wright, 2005. Resources, capabilities, risk capital and the creation of university spin-out companies. Research Policy, 34: 1043-1057.
35. Markman, G.D., D.S. Siegel and M. Wright, 2008. Research and technology commercialization. J. Management Studies, 45: 1401-1423.
36. Gartner, W. and S. Birley, 2002. Introduction to the special issue on qualitative methods in entrepreneurship research. J. Business Venturing, 17: 387-395.
37. Guerrero, M., D. Urbano and D. Kirby, 2006. A literature review on entrepreneurial universities: An institutional approach. Working Paper Series, 06/8. Business Economics Department. Autonomous University of Barcelona.
38. Guerrero, M., 2008. The creation and development of entrepreneurial universities in Spain: An institutional approach, PhD dissertation. Barcelona: Autonomous University of Barcelona.
39. Mowery, D.C., R.R. Nelson, B.N. Sampat and A.A. Ziedonis, 2004. Ivory Tower and Industrial Innovation: University-industry Technology Transfer before and after the Bayh-Dole Act in the United States. Stanford University Press, Stanford, CA.,
40. Jaffe, A.B., 2000. The US patent system in transition: policy innovation and the innovation process. Research Policy, 29: 531-557.
41. Cohen, W.M., R.R. Nelson and J.P. Walsh, 2002. Links and Impacts: The Influence of Public Research on Industrial R and D. Management Sci., 48: 1-23.
42. Cohen, W.M., R. Florida, L. Randazzese and J. Walsh, 1998. Industry and the academy: uneasy partners in the cause of technological advance. In: Noll, R.G. (Ed.), Challenge to the Research University. Brookings Institution, Washington, D.C., pp: 171-200.
43. Geuna, A., 1998. The internationalization of European universities: A return to medieval roots. Minerva XXXVI, 3: 253-270.
44. Colyvas, J., *et al.* 2002. How do university inventions get into practice? Management Sci., 48: 61-72.
45. AUTM, 2005. U.S. licensing survey: FY 2004. Northbrook, IL: The Association of University Technology Managers.
46. Holstein, W.J., 2006. Putting bright ideas to work off campus. The New York Times. 5 November.
47. Lorenzo, G., 2002. Summary of Proceedings from the Virtual High School Summer Institute,
48. Gomez-Mejia, L.R. and D.B. Balkin, 1992. Determinants of faculty pay: an agency theory perspective. Academy of Management J., 35: 921-955.
49. Makri, M., P.J. Lane and L.R. Gomez-Mejia, 2006. CEO incentives, innovation and performance in technology-intensive firms: a reconciliation of outcome and behaviour-based incentive schemes. Strategic Management J., 27: 1057-1080.

50. Agrawal, A., 2006. Engaging the inventor: exploring licensing strategies for university inventions and the role of latent knowledge. Strategic Management J., 27: 63-79.
51. Markman, G.D., P.T. Gianiodis, P.H. Phan and D.B. Balkin, 2004. Entrepreneurship from the Ivory Tower: do incentive systems matter?. J. Technology Transfer, 29: 353-364.
52. Friedman, J. and J. Silberman, 2003. University Technology Transfer: Do Incentives, Management and Location Matter. J. Technology Transfer, 28: 81-85.
53. Thursby, J.G. and S. Kemp, 1998. University technology transfer: a DEA analysis. In: Kantarelis, D. (Ed.), Business and Economics for the 21st Century, vol. 2. Business and Economics Society International, Worcester, M.A., pp: 303-311.
54. Shane, S., 2002. Selling university technology: patterns from MIT. Management Sci., 48: 122-137.
55. Carlsson, B. and A.C. Fridh, 2002. Technology transfer in United States universities. J. Evolutionary Economics, 12: 199-232.
56. Franklin, S., M. Wright and A. Lockett, 2001. Academic and surrogate entrepreneurs in university spin-out companies. J. Technology Transfer, 26: 127-141.
57. Lockett, A., M. Wright and S. Franklin, 2003. Technology transfer and universities' spin-out strategies. Small Business Economics, 20: 185-201.
58. Noble, D., 1977. America by design: Science, technology and the rise of corporate capitalism. Oxford: Oxford University Press.
59. Matkin, G., 1997. University technology transfer and the problems of conflict of interest. 96. In Y. S. Lee (Ed.), Technology transfer and public policy. Quorum Books.
60. Narayanan, V.K., Y. Yang and S.A. Zahra, 2009. Corporate venturing and value creation: a review and proposed framework. Research Policy, 38: 58-76.
61. Moray, N. and B. Clarysse, 2005. Institutional change and resource endowments to science-based entrepreneurial firms. Research Policy, 34: 1010-1027.