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Characterizing Innovation in the Livestock Industry: A Malaysian Case

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ABSTRACT: *Characterizing and quantifying innovations generated in the Malaysian livestock industry is crucial so as to provide an understanding on innovations that has emerged. Given this background, this paper aims to offer a landscape view on the patenting behaviour within the livestock industry. Specifically, it will investigate variation in patenting activities, type of patents filed and granted, technologies or process that are filed for patent and the type of firms that innovate (local vs foreign; commercial vs non-commercial). This study employed the patent landscape methodology, based on technological categories, using the International Patent Classification (IPC) system. Since 1953, a total of 40,180 patent records were filed in Malaysia. These patent records were retrieved from the Thomson Innovation database by Thomson Reuters. Livestock patent search retrieved 3,185 records and all these records were cross-checked with an animal science technical expert to arrive at the final patent documents of 69 (representing 2.22% of livestock patents granted in Malaysia). New inventions are mainly concentrated in two technological categories feed (70%) and animal husbandry (17%) . With an understanding of the current innovations generated in the Malaysian livestock industry, this paper hopes to offer insights on innovation behaviour within this industry.*

Key words: *Innovation, Livestock, Patent, Technology.*

INTRODUCTION

Globally, consumption of meat products has increased over the last decade. This consumption growth is mainly driven by migration of rural population to urban areas. According to the Food and Agricultural Organization (FAO 2009) more than 70% of the world's population is anticipated to be located in urban areas by 2050. Urbanization is associated with increase in wealth and higher purchasing power which leads to greater demand for processed food, meat, dairy, and fish (Godfray et al. 2010)while demand for grains and other staple crops will decline (FAO 2009). The World Health Organization (WHO) has also shared similar findings in 1990. As gross national product of a nation increases, components of that particular nation's population diet tend to shift towards an "affluent" diet that is characterized by protein-rich foods.

The above outlook is already evident in Malaysia. Generally, total meat consumption has increased between 2004 and 2013, by 15kg/capita (Figure 1). Consumption of beef and mutton has remained stable over the ten year period while consumption of pork and poultry has increased. Consumption of chicken has increased by 13kg/capita. According to the Malaysian adults nutrition survey (MANS) carried out between 2002 and 2003, Malaysian adults, between the age of 18 and 59 years, favoured chicken among other meats, and it is consumed twice weekly (Norimah et al. 2008). The MANS also found that chicken is frequently consumed by the urban population and mostly by men. Although production of beef and mutton has increased approximately between two and three folds, Malaysia is still not self sufficient (SS) in beef and mution production as compared to pork and poultry. Population growth has been suggested as one of the contributing factors for not achieving the SS level in beef and mutton. The nation's population has increased by 4.35 million over the last ten years, from 25.37 million (2004) to 29.72 million (2013).

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Table 1
Production, self-sufficient level and consumption of meat in Malaysia

	Production (Mil. Tonnes)		*Self-sufficient Level (%)*		*Consumption (Per Capita) (Kg)*	
Meat	2004	2013	2004	2013	2004	2013
Beef	26,658	53,841	18	30	6	6.3
Mutton	1,320	3,630	9	13	0.5	0.7
Pork	200,180	231,000	100	102	19.7	21.2
Poultry ('000)	928	1,415	108	103	33.6	46.6

Source: DVS, 2015.

The population of Malaysia is projected to increase to 35 million in 2020 (Academy of Sciences Malaysia 2015). Feeding a growing population has translated to a food security challenge. To manage this concern, food productivity has to be increased and agricultural innovation has been proposed to assist in generating new products and/or processes that will enhance the production of livestock and crops.

With the focus on the livestock industry, this paper aims to characterize and quantify innovations generated in this industry so as to provide an understanding on the innovations that has emerged. This paper also aims to provide context on the innovation efforts concerning loss of animal genetic diversity in increasing livestock production to meet food security concerns. For example the locally adapted cattle and goat breeds, Kedah Kelantan and Katjang respectively, are at the verge of extinction in Malaysia. This is generally due to their replacement/substitution with imported breeds such as Brahman (cattle) and Boer (goat). Although productivity of imported breeds is much better than local breeds, the latter offers significant positive genetic traits in adapting to local climatic condition, e.g., tolerance to tropical weather and endemic diseases. If animal genetic resources are not conserved and preserved, local breeds would eventually become extinct, as in the case of the Local Indian Dairy (LID) cattle.

Specifically in this paper, to measure innovation, patent data is used as proxy. The patenting behaviour across the range of animal species that are important for food and agriculture is also examined. This paper will report variation in patenting activities, type of patents filed and granted, technologies that are filed for patent, type of firms that innovate (local and foreign; commercial and non-commercial), and the productive and emerging fields.

METHODOLOGY

A patent landscape analysis is an analysis of a population of patents and the relationships between those patents and other sets of science and technology (S&T) indicators over a particular time period, technology, or geographic region (Bubela *et al*., 2013). Other commonly employed S&T indicators include scientific articles, clinical or field trials, regulatory approvals, and actors or institutions.

A set of patents can be defined and collected that measures a specific technology or set of technologies while a geographically defined set of patents can measure technological developments across all industries within that geography, including, for example, an entire national economy. Regardless of scale, landscape patent analysis seeks to encompass, as much as possible, an entire population of relevant data rather than a limited random sample drawn from that population. The data can either be visualized graphically or comprise counts of indicators across selected dimensions of time, geography, technology, or economic sector. This study utilized the Thomson Innovation (TI) database, a proprietary database by Thomson Reuters. TI has a comprehensive collection of patent data, including all major patent authorities and nations (Thomson Reuters 2014).

Given our interest in learning the innovation dynamics of Malaysian livestock industry, we sought all patents documents filed in Malaysia with the use of "MY" prefix search over patent document numbers, with no pre-determined time scale. We were interested in obtaining all available granted Malaysian patent documents. The data was then cleaned manually in order to arrive at the final dataset of 40,180 that addressed the research questions of this study. The final data comprised patent documents issued between the years 1953-1985 and 2003-2012. From 1986-2002, Malaysian patent data was not reported in TI. The relevant data fields downloaded from TI

Table 2
Data fields of Malaysian patent documents downloaded from Thomson Innovation

Data Field	*Description*
Publication Number	Follows a type A format (closed series), consist of a two letter country code and a unique number. Example: MY147682A
Title	The title of the invention
Publication Year	The publication year is the granted year of the document
IPC	A set of alphanumeric classification codes setting out the technical content of the document
Assignee (Applicant)	The legal entities seeking patent rights protection

Source: Adapted from Oldham et al. (2014).

consist of publication number, title, publication date, International Patent Classification (IPC) and assignees or applicants. The data fields and description is provided in Table 2.

Using the IPC, we focused on patent classification. We followed closely the approach reported by Singh (2009) in using the categorization assistant tool provided by the World Intellectual Property Organization. This assistant tool classifies patents at IPC class, subclass or main group level. The default classification level is subclass. We queried using keywords "Animal Science", "Livestock" and "Animal" with various combinations. This process resulted in nine sub-classifications:

1. A01D – harvesting, mowing (including knives, cutters etc).
2. A01K – animal husbandry (care of birds, fishes, insects), fishing, rearing or breeding animals, new breeds of animals.
3. A01M – catching, trapping or scaring of animals.
4. A01N – preservation of bodies of humans or animals or plants or parts thereof.
5. A22B – slaughtering.
6. A23K – feeding stuffs specially adapted for animals, methods specially adapted for production.
7. A61D – veterinary instruments, implements, tools or methods.
8. B60P – vehicles adapted for load transportation or to transport, to carry or to comprise special loads or objects.
9. C07D – heterocyclic compounds.

Then, all the IPCs listed under the "Current IPC" field of the 40,180 patent granted documents were broken down into single records. For example, the data string "F01M001300 | H05F000302 | H04W008000" were listed singly by removing the delimiter (|). Subsequently, the 8-digit IPCs were broken down into 4-digit IPCs to in order to categorize them into the nine sub-classifications mentioned above.

Then, nine new dummy variable fields were created in an Excel spreadsheet that also had "Publication Number" and "Current IPC" for each patent. Text filter were used over "Current IPC". Whenever a granted patent's Current IPC field contains the text strings "A01D" or "A01K" or "A01M" or " A01N" or "A22B" or "A23K" or "A61D" or "B60P" or "C07D", that granted patent was assigned "1" in the dummy-variable field. The text filter exercise was repeated for each 4-digit string. The total number of patents that were identified was 3,185 (representing 8% of total patents granted in Malaysia).

Following this process, all 3,185 records were cross-checked with an animal science technical expert to arrive at animal species that are important to food and agriculture in Malaysia. This process resulted in 69 patent documents (representing 2.22% of livestock patents granted in Malaysia).

Further, following the process adopted by Graff et al. (2003) on standardizing each assignee organization's name, the information of an assignee organization in the "Assignee/Applicant" data field was examined and adjusted to reflect a uniform version and had the correct spelling. Then, all documents assigned to smaller entities that were known to be wholly owned by larger entities were aggregated under the names of the respective parent organization's name. Such aggregation was not done for international subsidiaries of multinational corporations: in this case the subsidiary entity listed as assignee was not changed to reflect the parent corporation's name and country (this is a relatively new approach undertaken by the author and team). However, for entities that had been fully acquired, for joint venture that carried a new name, and for entities that changed their name, their names in the dataset were adjusted to reflect the current name of the new entity. Additionally, the records in the assignee data field were cleaned, standardized, categorized as commercial and non-commercial entities and were assigned country identifications.

In the majority of patent records, the data recorded in the "Assignee/Applicant" field included a two-letter country code for each assignee listed, identifying the nation in which that entity is incorporated. However, for those assignee designations that lacked such information, the assignee records were reviewed to identify the home country. As in the step above, this step was carried out manually by reviewing each assignee and determining their country of origin and for subsidiaries, the country in which they are operating.

Then, all of the assignee designations were once again reviewed manually to categorize them according to the type of entity. This typology identified whether the entity belongs to the commercial sector, i.e., if it is a firm or an individual, or if it belongs to the non-commercial sector, i.e., if it is a university, a research institute, or a governmental organization. The primary purpose of this step is to

be able to identify the extent to which non-commercial entities are engaged in patenting. An additional purpose of this step is to be able to identify when inventions arise as the result of collaboration between commercial and non-commercial organizations.[1] Commercial type entities include firms and individual inventors and their primary purpose of establishment is profit oriented. Universities, research institutes and governmental organization were classified under non-commercial entities in which their primary purpose is not profit making.

The original patent data does not indicate whether patent protection remained in force for a given granted patent or whether rights have been subsequently transferred from the original assignee to other assignee(s), whether through licensing, sale or other transactions (Graff et al. 2003). Although licensing has been cited as the most commonly used transaction in the public (i.e., non-commercial) sector, such transactions are not recorded in the patent office data and are generally not publicly accessible (Graff et al. 2003).

In a novel patent landscape analysis, such as this, simple summary statistics can be a very valuable indicator in helping construct and communicate evidence of innovation activities in the Malaysian livestock industry. The analysis for this study was done using Microsoft Access and Excel by using queries, and filters to identify specific data needed to answer each research question.

RESULTS AND DISCUSSION

Type of patents granted

Majority of the patents granted in the Malaysian livestock industry focuses on product-type of invention (Figure 1). In fact, a larger percentage of patents encompass product- and process-type of invention, rather than just process-type invention.

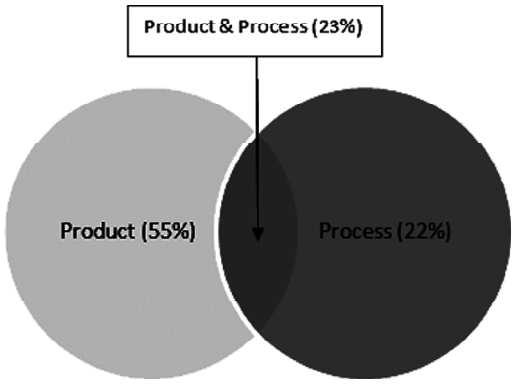


Figure 1: Type of inventions

Concentration of innovation activities

Among the 69 patent documents, majority of the patents (70%) is concentrated in feed-related technology, followed by animal husbandry (17%) (Figure 2). Most patents on feed focus on formulation of feed, i.e., methods, composition, treatment and improvements. As we continue to tweak on processes for the right feed formulation, feed cost will continue to increase. In Malaysia feed cost is the largest contributor to livestock production as almost all feed inputs are imported.

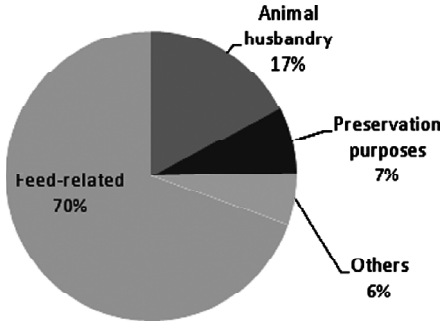


Figure 2: Technological classification of patents

Patent assignees

As mentioned previously, an assignee could be an individual and/or an organization assigned the rights of the patent. All the granted patents in relation to the livestock industry in Malaysia were assigned to just one assignee. However, majority of patents has between 1 and 2 inventors, either residing in their home country or work country (Figure 3).

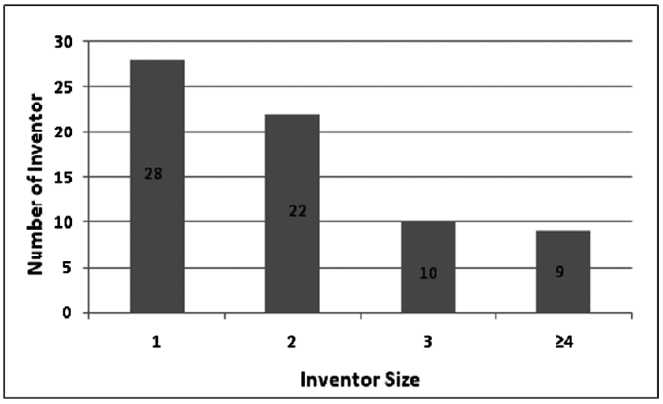
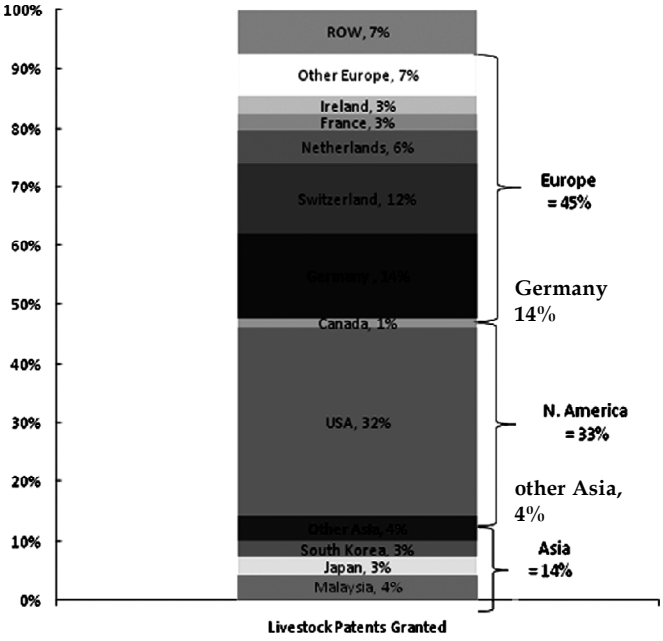


Figure 3: Distribution of number of inventors per patent

Among these assignees, many are based in Asia, Europe and North America (Figure 4). As a region, Europe has the most livestock patents (45%) filed for protection in Malaysia, with Germany and Switzerland collectively dominate 26% of the patents granted. Meanwhile, United States, as a country, has

the largest percentage of livestock patents granted (32%) in Malaysia. Among the Asian countries, Malaysian assignees filed the most patent protection in the livestock industry, suggesting that it is only natural for home-country applicant to seek protection for its invention in its home-country, catering to the local market demand for such innovation coupled with reduced cost of patenting in the home-country as compared to patenting in a foreign jurisdiction.



*ROW- Rest of The World

Figure 4: Assignee countries

Distribution of patent assignment

Each assignee entity was classified according to organizational type, commercial and non-commercial.

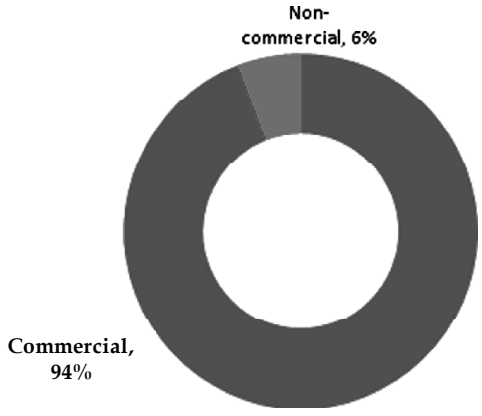


Figure 5: Distribution of commercial and non-commercial patent assigned to Malaysian patent granted assignees in the livestock industry

Commercial type entities include firms and individual inventors, and their primary purpose are profit oriented. Academic establishments, research institutes and government organization are classified under non-commercial entities in which their primary purpose is not profit making. The commercial sector dominates the distribution of Malaysian granted patent assignee share (Figure 5).

In absolute numbers, out of 69 Malaysian patents granted in the livestock industry, commercial sector own 65 while non-commercial sector own 4 (Table 3). This finding suggests that for every 16 patents granted to the commercial sector, only 1 is granted to the non-commercial sector. Within the commercial sector, firms are found to be actively involved in patenting activities as compared to individual inventors. The high percentage of patent ownership share assigned to firms is not surprising since there are a large number of them in Malaysia (Ghapar et al. 2013). Comparatively, the number of patent documents assigned to commercial entities is greater in Malaysia as compared to US or Europe. In US, over half of the innovations in the pipeline are generated by private sector and in Europe, over a third (Graff et al. 2009). Patent filing by the non-commercial sector in Malaysia (i.e., research institutions and universities) is generally lower than their counterparts in the developed nation. The increase in patent filings of academic inventions in European universities was driven by biotechnology revolution and the Bayh-Dole Act-like regulations which were aimed at encouraging patenting in academic institutions (Powell and Owen-Smith 1998, Mowery et al. 2001, Geuna & Nesta 2006). In the US, the rampant growth of patenting activities and licensing of public funded research has been regarded as a new model of academic research, one that fosters economic and social returns from universities (Sampat 2006). In Malaysia, commercialization of public

Table 3
Number of Malaysian granted patent documents assigned in the livestock industry

Organization	*Number of MY patent documents*	*Percentage of total*
Commercial		
Firm	63	91%
Individual Inventor	2	3%
Subtotal	*65*	94%
Noncommercial		
Research Institution	3	4%
University	1	1%
Subtotal	*4*	6%
Total	***69***	100%

research began with the implementation of the Sixth Malaysia Plan (1991-1995). The Malaysian government emphasized that public R&D programs should be more market oriented and exploit the commercialization process of research and technology (Govindaraju 2010). To do so, government of Malaysia provided avenues for universities and research institutes to own inventions.

Major animal patents

The patent search for this study was also extended to cover major animals that are important to food and agriculture in Malaysia, i.e., poultry, cattle and goat. Among the 69 livestock patents granted in Malaysia, 11 patents returned "poultry" in their titles. Two patents returned "cow" and "goat", respectively.

The larger amount of patents granted to poultry can be attributed to market forces and economic value the poultry sub-sector brings to the livestock industry. The non-ruminant sub-sector is valued at above RM 12 billion compared to just over a billion for the ruminant sub-sector. As mentioned earlier, Malaysians generally prefer chicken as compared to beef and mutton. In response to higher demand for chicken meat, commercial and non-commercial players have beefed up effort in enhancing the poultry production efficiency (Figure 6). The strong partnership between these players has brought major structural changes to the poultry sub-sector, where large-scale, vertically integrated broiler operations contract grow-out operations to smaller farmers.

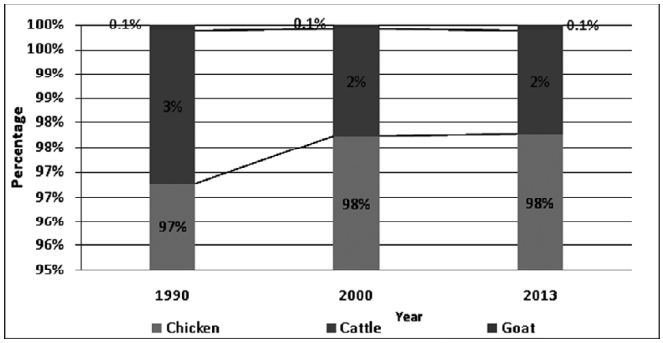


Figure 6: Comparison of meat production in Malaysia between 1990, 2000 and 2013

Animal genetic diversity

New breed requires a large pool of gene. Hence, access to a nation's genetic materials is necessary to ensure that livestock germplasm is not lost due to the utilisation of modern improved breeds.

In Malaysia, a patent is denied if the invention involves animal varieties or essentially biological processes for the production of animals, other than man-made living micro- organisms, micro-biological processes and the products of such micro-organism processes. Patenting of life-forms is expressively provided for Article 27.3 of the Trade Related Aspect of Intellectual Property Rights (TRIPS) Agreement. The TRIPS Agreement is one of the three main pillars of World Trade Organization (WTO), in which Malaysia is a member. To-date, TRIPS is the most comprehensive multilateral agreement on intellectual property. The placement of intellectual property in WTO means that non-compliant WTO members would face trade sanctions if they do not adhere to its rules. With clear regulations on non-patenting of life-forms, it is only natural that patenting in the livestock industry within the Malaysia is focused on technologies, new methods or new processes rather than on new breeds. As such, this limits the assessment on patents granted pertaining to the loss of genetic diversity within the Malaysian livestock industry, as what this paper initially intended to measure.

CONCLUSION

The livestock innovation activities in Malaysia are mainly driven by foreign commercial sector focusing on product type inventions. The Malaysian government encourages collaboration between commercial and non-commercial sectors, however, innovation activities on the ground does not seem to indicate so. Although large amount of patenting activities are concentrated in feed-related technologies, feed continues to be the largest single cost item for livestock production in Malaysia, inevitably burdening livestock farmers. Patent filings on feed-related technologies are mainly dominated by foreign firms. Broadening the current scope of incentive mechanisms to locals (i.e., commercial and non-commercial sectors) in generating, transferring and commercializing feed-related technologies can be one way of tackling the high feed cost. These incentive mechanisms can include intellectual property rights, technology commercialization policies and programs, technology transfer programs, agribusiness incubators and accelerators, commercial-non-commercial partnerships, research rewards and prizes, advance market commitments, tax breaks and public subsidies for research, and other such mechanisms.

While intellectual property has been suggested to drive innovation and assist in enhancing the efficiency of an industry, the poultry sub-sector in Malaysia demonstrates otherwise. It is the most efficient sub-sector within the livestock industry, however, patents

concerning poultry are rather limited, suggesting that patent filing is not a pre-requisite for a sub-sector to thrive. Hence, this is where probably other incentive mechanisms come into play. Ultimately, government policies and funding opportunities need to be target-oriented, i.e., enhance livestock productivity and reduce feed cost.

The findings of this study are limited to patent search carried out on patent document titles rather than on abstracts and claims due to data availability in TI.

NOTE

1. Often, policymakers and scholars would categorize such efforts as "public-private partnerships." However, due to the legal nature of some Malaysian firms as state owned enterprises, some confusion may arise with such terminology. It was therefore decided to categorize all assignee entities as either "commercial" or "non-commercial" rather than "private" or "public" and thus be able to identify the results of collaboration between commercial and non-commercial entities separately from their legal nature.

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