

Economic efficiency of beef cattle farms in Peninsular Malaysia

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Abstract. Numbers of beef cattle farmers in Peninsular Malaysia were decreasing from 2016 to 2018 but there were increasing number of beef cattle farms on the years. Beef cattle farming is a costly business to operate locally because of its low performance, strong competitions with other high value agricultural activities, especially palm oil, cheaper prices of imported beef, and price elasticity that leads consumers towards other protein sources substitutes such as fish, poultry, mutton, and pork. The objective of the study is to measure the economic efficiency of beef cattle farms and identifying its determinants. Farm level data from 334 of beef cattle farmers collected in year 2020 were being analysed by Data Envelopment Analysis (DEA) for economic efficiency scoring. The determinants of the efficiency discovered using Tobit Model regression. The results show only 9.28 percent of the farms operate in the full economic efficiency while 44.31 percent of the firms were at the lowest range of economic efficiency score. The economic efficient farms depend on its financial aid, online networking, veterinary networking, job status, and the farm system. Government support by empowerment of smallholders through entrepreneurship skills were one of the suggestions for the industry to sustain economically. The research had justified the economic efficiency of beef cattle farms in Peninsular Malaysia with its determinants.

1. Introduction

The Malaysian beef industry can feed the nation with its huge dependency on imported supplies, which fulfils the concept of food security that mainly focuses on availability, access, stability, and utilization of food. However, greater reliance on imports leading to the reducing food availability domestically and exposing to the risk of hunger whenever the geopolitical tension occurs. Greater reliance on domestically produced food can help to ensure that food supplies do not dwindle when countries' export earnings decline. Countries may face the threat of disrupted trade channels due to war or trade embargoes that can arise from political tensions. In these cases, greater reliance on self-production of food can provide an important supply contingency.

Declining in production could trigger price spike for local beef in meeting the demand of beef products in the country. An increase in price will make the consumers shift to a substitute protein that offers a cheaper price. In this situation, imported beef becomes the main selection, as the price offered is lower than local beef products. Besides, many small-scale cattle farmers are struggling to survive in this industry, as they need to compete with the large-scale farmers, which they have an advantage in price per unit due to economic of scale. Besides, investors are more interested to invest in imported frozen beef and live cattle for slaughter instead of investing in local beef cattle breeding. This is because



the cost for imported beef product gives more advantage to producers and customers. Payable selling price is very important to consumers in spending money for the beef products. The concentrated market of imported beef and live cattle industry could kill the market opportunity for the local beef producers, especially small-scale farmers who hold 90 percent of the cattle population in Malaysia [1]. Increasing demand for live cattle only be seen during the peak of festive months, which is not able to sustain the small farmers' income throughout the years.

Beef cattle rearing is an expensive business to operate locally due to its low performance, strong competitions with other high value agricultural activities, especially palm oil, cheaper prices of imported beef, and the price elasticity that leads consumers towards beef competitors, such as fish, poultry, mutton, and pork. The substitution of beef can be considered as very elastic as fish and chicken are close substitutes to beef [1]. Therefore, the competition of local beef is not only from imported beef, but also from the possibility of substituted by other meat for daily consumption. For a short period, the trade can solve beef scarcity in Malaysia, but not in the long run. The considerations of increasing import billing costs and depressing smallholders' income could highlight these matters as important areas to ponder.

To sustain their businesses, small farmers need to have a consistent income for daily operations of the farms. It will so be hard for the small farmers to maintain their profitability if the consumers tend to choose imported beef due to its cheaper price and all-the-time availability. As commercial beef industry has a high barrier to entry due to the huge capital requirement for importation, as well as farm operation and logistics, it results in the dominance of few importers whose volumes constitute majority of the market. They have the tendency and potential in dictating the market supply and beef price in Malaysia. The less competitive market of imported beef in Malaysia could result in a higher price by monopolists in the future.

One of the aspects that consumers demand was not be fulfilled by imported meat that is freshness. The freshness of the beef is an important consideration from the consumer before purchasing the beef [2]. Not only the taste of beef after cooking, but also its freshness that gives the "healthy image" of the product to the consumers. Some consumers expect the "sweetness" of fresh beef can be tasted in cooking and it plays an important aspect in the beef selection. This illustrates the importance of beef freshness that impacts the purchasing behavior of consumers as they can enjoy the real taste of food.

Majority of the cattle farming involvement are from the smallholders in villages. Most of the smallholders do not have formal education for livestock management, low technical skill operation, and lack of capital for business growth. From the producers' side, the competition between import and local beef would disadvantage them in the long run. As the demand for frozen beef increases, the demand for local fresh beef decreases during non-festive seasons. Furthermore, using more inputs is constrained by the high input prices when most of the animal feeds and high-quality breeds are from imported sources (higher input costs). The price rivalry between commercial beef producers and smallholders has created a larger gap in terms of prices, supplied quantity, and quality. Commercial farms have to be exemplary to smallholders in operating farms. Technical and cost factors would help beef cattle farms to perform efficiently. However, various sizes of farms would use various inputs and sources for their business continuation. The determinants of farms in economic efficiency would be helpful discoveries since each farm has its own sources and capital. There were many attempts to increase the production of beef in Malaysia; from extensive system ranching to intensive feedlot system, which have yielded variable outcomes from the efforts to sustain Malaysian domestic beef industry. Currently, Malaysia largely applies semi-intensive and extensive production systems by smallholders in villages and oil palm plantation settlements [3].

Table 1. Average cost production for beef cattle according to rearing system in Malaysia

| System Details | Feedlot | | Integrated | | Paddock (Free grazing) | |
|-------------------------|-------------|-------------|-------------|------------|------------------------|------------|
| | Smallholder | Commercial | Smallholder | Commercial | Smallholder | Commercial |
| Fixed Cost (RM) | 7300/batch | 19800/batch | 17000/year | 55600/year | 14250/year | 44400/year |
| Variable Cost/head (RM) | 2446 | 2437 | 744/year | 679/year | 1468/year | 1471/year |
| Breakeven point (head) | 29 | 87 | 14 | 43 | 25 | 77 |
| Farm Income/month (RM) | 908 | 7900 | 1950 | 8683 | 858 | 3917 |
| Cattle Price/head (RM) | 2701 | 2664 | 1975 | 1975 | 2050 | 2050 |

Source: MARDI (2012)

In Table 1, it shows the comparison of cost production among the cattle production systems that commonly practiced in Malaysia. From three of the production systems, integrated production system shows the advantages in terms of monthly income and cattle price per head. With the lowest variable cost per year, the integrated production system could have the lowest breakeven point as compared to the feedlot system and paddock system. On the contrary, this system has higher fixed cost per year compared to the paddock system. Feedlot system is the most expensive system, but it can gained profit each of the batch. Usually, there were three batch in each year. Farmers can choose the system according to the capital and sources that they have.

Beef cattle farming needs a wide range of technical skills and physical capital for commercialization. To sustain, beef production requires improving their on-farm efficiency, productivity, and efficient value chain that benefit to their target market specification [4].

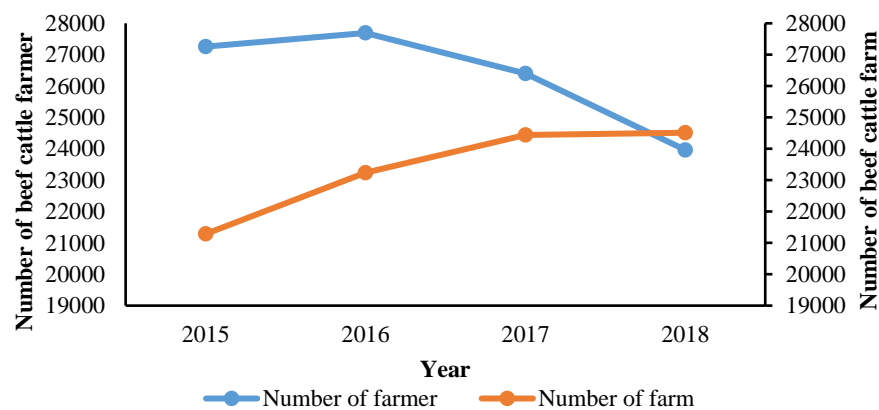


Figure 1. Number of registered beef cattle farm and farmer in Peninsular Malaysia from 2015 to 2018 [25]

Figure 1 shows the trend of registered beef cattle farms and farmers. The pattern shows a mixed trend where the decreasing number of farmers and the increasing trend of farms. Decreasing number of farmers shows the unconditional circumstances of the industry. Meanwhile, the number of farms kept increasing due to the industry merge within time. The possibility behind the trend due to the collaboration of smallholder groups with larger or commercial farms where a farmer registered more than one farm for the business entity, or the unregistered farmers sell or merge the businesses with the bigger scale of registered farms. Merging cattle farms is a good step to save the smallholders' farms, but this might create a new market structure from an oligopolistic market to monopoly market. The situation

influences the price of beef cattle. The decreasing number of beef cattle farmers would explain the sustainability of the business is alarming.

There are significant factors that differentiate between efficient and inefficient cattle farms by using Tobit regression models, where the determinants of efficiency in farms would be controlled breeding method, access to market contract, presence of farm manager, and existence off-farm income [35]. Other than that, farm size, farmer's age, and peri-urban location were also the significant determinants of beef cattle production efficiency. The other determinants such as family labor and agricultural experiences were more important than age, farm size, farmers' education, and member of association in determining the efficiency level among the cash-crop producers in Sarawak [6]. The justification was that farmers who have more experience are valuable as they have hands-on learning, which tend to affect use of inputs more efficiently.

Other than that, feed efficiency of cattle is one of the important determinants in production. The two types of feed that are sufficient for cattle include rough feed and concentration feed. Their costs vary depending on prices, interest rates, and animal performance [7]. Each farm usually allocates certain feed cost or grazing area to maintain feed supply for the cattle such as oil palm plantation that beneficial for lowering the cattle feed cost by using integrated rearing system [8]. Each rearing system has a different accessibility to rough feed and concentrated feed. As for the integrated rearing system, oil palm wastes such as palm fronds and weeds in soil surface are good for cattle daily nutrition. Besides, the feed components are substantial input elements in most of the cattle farm efficiency measurements [5][9] [10] [11] [35].

In Indonesia, the artificial insemination (AI) is one of the profitable technologies in beef cattle farming. AI is expected to have a significant role in improving the success of breed in female cattle. Increasing beef production efficiency occurs when the usage of AI technique implemented, and it is an improvement method [12] [13]. AI technique would be profitable to cattle farms if conducted by the experienced AI technician and huge number of cattle are involved in the technique [12]. There was relationship of farm size with technical efficiency of farms but there were non-linear relationship of the size and productivity efficiency where efficiency will fall in the first place, then rise when the size increases [14]. Technically efficient farms usually come from the large-scale operation that have a high income. Demographic factors of the farmers, availability of the feed in the rearing system, the breeding technology such as AI, as well as farm size influencing cattle production efficiency.

The efficiency of cattle farms would depend on the type of rearing system where each rearing has a different efficiency level. The beef cattle farm cost efficiency is different from the nomadic system, agropastoral system, and ranching system, as it depends on the movement of the livestock [15]. Agropastoral incur more veterinary costs compared to nomads. This could be since agropastoral' farms usually stay in the agropastoral compounds, which made them to have relatively less access to subsidized veterinary services than the nomads and ranchers. Agropastoral farms have a similar component to integrated rearing system where the livestock and crops are in the same compounds [16]. This situation is almost like Malaysian's integrated rearing system where they need extra costs for managing the livestock movement in the plantation areas [8].

In northern Ethiopia, the usage of veterinary services, parasite control, and loan utilization were perceived as important strategies to manage risks and operations in their cattle farms [17]. These internal and external factors explaining the consideration of farmers to implement integrated system in Malaysia [18]. These included workers' safety, burdens of the operators, the need for more labors, supplements for cattle were expensive, lack of infrastructure facilities for the integration, lack of training, and breed quality problems.

The objective of paper is to measure the economic efficiency of beef cattle farms and its determinants.

2. Methodology

Measurement of economic efficiency is closely linked to the use of frontier function. There are two efficiency concepts that are related to production system, namely technical efficiency, and allocative efficiency. Technical efficiency in production function formulation is assumed to be addressed and resolved for engineering and managerial aspect and the focus will be on the analysis of allocative efficiency problems. Although the relationship of outputs with inputs is fundamentally physical, production function often uses their monetary values. There is a production process which uses several types of inputs that cannot be aggregated in physical units [19]. Economic efficiency is combination measurement of technical efficiency and allocative efficiency. The output and input perspective will coincide when measuring technical efficiency under constant returns to scale. The allocative and economic efficiency measures, however, are completely different in nature and are not likely to coincide for other reasons than by chance [20].

Economic efficiency will measure the ability of a DMU to produce the current outputs at minimal cost, given its input prices. Looking beyond technical efficiency, the proposed measurement of economic efficiency assumes that prices are fixed and known and maybe different among DMUs.

Suppose that there exist n DMUs, and $c_{ij} \geq 0$ is the cost of the i th input of DMU_j which may vary from one DMU to another. The minimal cost model to produce at least the current output $DMU_0(y_0)$ yields the optimal value of the following $(\sum_{i=1}^m c_{io}x_i^*)$.

$$EE_0 = \frac{1}{\sum_{i=1}^m c_{io}x_{io}} \min \sum_{i=1}^m c_{io}x_i \quad (1)$$

$$s. t. \sum_{j=1}^n \lambda_j x_{ij} \geq x_i; \forall i \quad (2)$$

$$\sum_{j=1}^n \lambda_j y_{rj} \geq y_{r0}; \forall r \quad (3)$$

$$\lambda_j \geq 0; \forall j \quad (4)$$

$$x_i \geq 0; \forall i \quad (5)$$

There is an optimal solution such as (λ^{*t}, x^{*t}) such that all constraints $(\sum_{j=1}^n \lambda_j x_{ij} \leq x_i)$ are binding as the cost of inputs are nonnegative for each DMU. The optimal value of the equation is equal to the equation as follows:

$$EE_0 = \frac{1}{\sum_{i=1}^m c_{io}x_{io}} \min \sum_{i=1}^m c_{io}x_i \quad (6)$$

$$s. t. \sum_{j=1}^n \lambda_j x_{ij} = x_i; \forall i \quad (7)$$

$$\sum_{j=1}^n \lambda_j y_{rj} \geq y_{r0}; \forall r \quad (8)$$

$$\lambda_j \geq 0; \forall j \quad (9)$$

$$x_i \geq 0; \forall i \quad (10)$$

EE_0 is the economic efficiency of DMU_0 and it is clear that $EE_0 \leq 1$.

Also, this economic efficiency measure initially named Farrell-Debreu cost efficiency measure. For this research, the economic efficiency approach was taken from [3] where the dairy farm economic efficiency determines by inputs cost collected from the dairy cattle farms. Therefore, the same approach was conducted for beef cattle farms in this research. The study applied a non-parametric Data Envelopment Analysis (DEA) approach.

The DEA method is used to compare the inputs and outputs of similar decision-making units (DMUs) where in this study the DMUs were cattle farms in Malaysia. By using this method, it focused on individual performance observation as represented by the optimization of each DMU. This is different with parametric analysis, which focuses on the average and estimation of parameters. The DEA will focus on analyzing DMUs' performance and efficiency scores, as well as a reference unit for inefficient DMUs, which is provided by DEA. DEA does not require any specific functional form for production function and distributional form for inefficiency terms. For that reason, trade-off between misspecification bias that is usually discovered in SFA and measurement errors in DEA determines the preference of researchers in conducting efficiency analysis [21]. This study focused on input-oriented

as agriculture sector is always based on input-oriented. In efficiency analysis, two components have been put forward as the fundamentals of efficiency comprising of technical (TE) and allocative (AE).

2.1. Data collection

Data collections starts on August 2020 and finished in February 2021. The states involve in this research include Kedah, Pulau Pinang, Perak, Negeri Sembilan, Melaka, Johor, Pahang, Selangor Terengganu, and Kelantan. Distribution of structured questionnaires mainly in Pahang, Kelantan, and Terengganu, with some samples from other states in Peninsular Malaysia. The selection of main sample areas in Terengganu and Pahang because of the cattle availability; high population of cattle in these three states. Descriptive statistics used to describe the features of any data collected and used in research. For this study, the data collected through face-to-face interviews and online form on the distributed questionnaire. There were data replaced by 0.1 as a minimum value for analysis purposes since some farmers submitted no value in questionnaire items. This is the suggested way to make the data readable by DEA application software. Two problems found in the dataset needed special treatment in this research: first, the existence of ratio variables where the value of zero was none of the variables; and second, the treatment of zero data. The property implies that an efficiency measure is not influenced even if the inputs and/or outputs shift toward the same direction by adding or subtracting a specific real number. Therefore, a value of 0.1 was added to any variables that contained a zero value in each DMU [29].

The output and input variables used in the DEA study are shown in Table 2. In total, 334 farms around Peninsular Malaysia were observed. Those with more than four head of cattle were considered for inclusion in the analysis. The number of cattle was important to describe the size of the business and its farm cash flow.

2.2. Data and variables

Variables of the research consists of the input and output component, which aimed for DEA analysis method. The analysis consists of the variables as in Table 2. For the output, usage of average carcass production value in states currency (Ringgit Malaysia) applied [22]. Input of the analysis includes the price value of labor, number of cattle, commercial feed, land, roughage, veterinary services, health and farm maintenances and unit of machinery [23][22].

Table 2. Variables for data envelopment analysis of economic efficiency

| Output | Input | Input unit | Input price |
|---------------------------------------|--------------------|---------------------|-------------|
| Average carcass production (Kilogram) | Labour | Person | RM/year |
| | Breeder | Head | RM/year |
| | Bull | Head | RM/year |
| | Commercial Feed | Kilogram | RM/year |
| | Land | Acre | RM/year |
| | Roughage | Kilogram | RM/year |
| | Veterinary Service | Per service | RM/year |
| | Health maintenance | Per product/service | RM/year |
| | Farm maintenance | Per product/service | RM/year |
| | Machinery | unit | RM/year |

2.3. Tobit Regression Model

There would be a second analysis for the efficiency model. Second analysis was to identify the determinants of efficiency among the farms. To analyze the attributes of socio-economic, demography, and institutional features, second stage analysis is needed. Tobit regression was introduced involving a censored regression model of the economy and was first analyzed in the econometric literature [24]. The efficiency index; bound between 1 and 0 derived for data envelopment analysis. Therefore, it is significant to use as the analysis to identify the determinants of technical efficiency and cost or economics efficiency among farmers.

Tobit regression could be written as follows,

$$y_t^* = x_t' \beta_0 + \epsilon_t, \quad t = 1, 2, 3, \dots, n \quad (11)$$

$$y_t = y_t^* \text{ if } y_t^* > c; \text{ and } y_t = c \quad (12)$$

where, y_t is a DEA efficiency index was used as a dependent variable, $\epsilon_t|x_t$ is $N(0, \sigma_0^2)$ and $\{y_t, x_t\}$ ($t = 1, 2, \dots, n$) is vector of independent variables related to farm-specific attributes, value of c is known. y_t^* was a latent variable. β was an unknown parameter vector associated with the farm-specific attributes and ϵ was an independently distributed error term that was assumed to be normally distributed with zero mean and constant variance, σ^2 . Farm level economic efficiency scores are used in the regression model to show the relationship between the measurement of the efficiency and characteristics of farmers.

3. Results and Discussion

Peninsular Malaysia had 24,512 units of registered beef cattle farms at the time of the survey (DATA, 2020). The demographic of respondents shown in Table 3.

Table 3. Demographic of respondents

| Demographic | Criteria | n | % |
|------------------------------|------------------------|-----|------|
| Age | ≤18 | 2 | 0.6 |
| | 19-40 | 163 | 48.8 |
| | 41-60 | 159 | 47.6 |
| | ≥ 61 | 10 | 3.0 |
| Gender | Male | 326 | 97.6 |
| | Female | 8 | 2.4 |
| Marital Status | Married | 276 | 82.6 |
| | Unmarried | 58 | 17.4 |
| Experiences (year) | 3-5 | 194 | 58.1 |
| | 6-10 | 72 | 21.6 |
| | 11-20 | 56 | 16.8 |
| | 21-30 | 11 | 3.3 |
| | 31-40 | 1 | 0.3 |
| Education | UPSR-Primary School | 17 | 5.1 |
| | PMR-Junior High School | 33 | 9.9 |
| | SPM/STPM- High School | 155 | 46.4 |
| | College graduates | 124 | 37.1 |
| | No education | 5 | 1.5 |
| Yearly household income (RM) | ≤10000 | 25 | 7.5 |
| | 10001-20000 | 150 | 44.9 |
| | 20001-30000 | 89 | 26.6 |
| | 30001-40000 | 27 | 8.1 |
| | 40001-50000 | 11 | 3.3 |
| | ≥ 50001 | 32 | 9.6 |
| Survey platform | Online | 50 | 15 |
| | Offline | 284 | 85.0 |

Most of the respondent age between 19 to 40 years old. This is the age of working adults. Male farmers dominate the sample by 97.6 percent. Surprisingly, most of the respondent have a little experience as 58.1 percent of the respondent have 3 to 5 years of experiences in cattle farming. Most of the respondent are high school leaver (46.4 percent) and college graduates (37.1 percent). The respondents mostly at the low income ranging from RM 10,001 to RM 20,000 per year.

Table 4 shows farms' characteristic. The most participants came from Kelantan (28.7 percent) and Terengganu (27.8 percent), followed by Kedah (16.5 percent), and Pahang (9.9 percent). Only a farmer in Selangor responded to the questionnaire. Less than 10 head of cattle (51.2 percent) are the majority amount of cattle amongst the farms. Most responsive farms were semi-intensive farms (71.6 percent), followed by intensive farms. Only few farms (5.7 percent) received financial aid.

Table 4. Farm characteristics

| Characteristics | Criteria | n | % |
|---|--|-----|-------|
| Farm origin (state) | Kelantan | 96 | 28.7 |
| | Terengganu | 93 | 27.8 |
| | Kedah | 55 | 16.5 |
| | Pahang | 33 | 9.9 |
| | Pulau Pinang | 31 | 9.3 |
| | Johor | 10 | 3.0 |
| | Negeri Sembilan | 8 | 2.4 |
| | Perak | 4 | 1.2 |
| | Melaka | 3 | 0.9 |
| | Selangor | 1 | 0.3 |
| Number of cattle (head) | 4-10 | 171 | 51.2 |
| | 11-30 | 107 | 32.0 |
| | 31-50 | 23 | 6.9 |
| | 51-100 | 8 | 2.4 |
| | ≥100 | 25 | 7.5 |
| Farm system | Intensive | 95 | 28.4 |
| | Non-intensive | 239 | 71.6 |
| Received financial aid | Yes | 19 | 5.7 |
| | No | 315 | 94.3 |
| Membership in any cattle association | Yes | 60 | 18.0 |
| | No | 274 | 82.0 |
| Social media networking | Yes | 176 | 52.7 |
| | No | 158 | 47.3 |
| Artificial Insemination | Yes | 230 | 68.9 |
| | No | 104 | 31.1 |
| Veterinary networking | Yes | 133 | 39.8 |
| | No | 201 | 60.2 |
| Domestic farm labor | Yes | 207 | 62.0 |
| | No | 127 | 38.0 |
| Commercial networking (supermarket, corporate and etc.) | Yes | 19 | 5.7 |
| | No | 315 | 94.3 |
| Farm profit per year (RM) | ≤1000 | 23 | 6.9 |
| | 1001-10000 | 133 | 39.8 |
| | 10001-20000 | 129 | 38.6 |
| | 20001-50000 | 30 | 9.0 |
| | 50001-100000 | 10 | 3.0 |
| | 100001-1000000 | 7 | 2.1 |
| | ≥ 1000001 | 2 | 0.6 |
| Land Ownership | Rent | 107 | 32.0 |
| | Owned | 189 | 56.6 |
| | Others (special project, lease and etc.) | 38 | 11.4 |
| Cattle breed (head) | Local breed | 100 | 29.9 |
| | Imported breed | 60 | 18.0 |
| | Both imported and local breed | 174 | 52.1 |
| Business size/herd size | Commercial | 33 | 9.88 |
| | Smallholder / Pre commercial | 301 | 90.12 |

Online platforms (52.7 percent) had become the networking selection platforms of farmers but only 18 percent of the farmers had joined the association. Plus, 39.8 percent of them had engaged in networking with veterinary bodies. There were only 5.7 percent of the farmers had engaged with distribution agency and platforms such as supermarkets, cooperatives, and statutory bodies for the commercial and distribution chain purposes.

There are 62 percent of the farms were using free domestic labor to run their daily operations. They are the family members of the farm owners and were not paid fixed wages. Smallholder farms in Kelantan and Terengganu usually involves their family members as unpaid labor. The commercial farms such as Ladang Risda Livestock Tersat, Terengganu and Kris Agritech, Johor, which were being managed by professional farm operators are vice versa. They tend to manage large scale operation with greater profit. Most of the farms are making profit less than RM10,000 per year (39.8 percent), although 0.6 percent were able to make more than RM1 million yearly. Unpaid labor from family members is a solution to reduce operational costs since the annual profit of most farms was less than RM10,000. Most farmers owned the land to conduct their cattle rearing operations (56.6 percent). Fixed costs can be reduced if the farming activities conducted on the owners' land plus agricultural activities is an asset and should be a good investment. The farmers can modify the farms facilities according to their current necessity.

Many of the farm rear imported and local cattle breeds (52.1 percent) altogether. Only 18 percent reared purely imported breeds, while the remaining 29.9 percent kept only local breeds. Local breeds, such as the Kedah-Kelantan breed, have the advantages of being highly resistant to many diseases, fully adapted to Malaysia's conditions, and suitable to be fed with low-quality feeds [27]. Keeping both breeds open the potential to obtain crossbreed cattle, which are heavier, mature earlier, produce more milk, wean heavier calves, and yet to consume more energy. They are more efficient than purebred cattle, despite their greater predicted feed intake [26].

90.12 percent of the data came from smallholder farms and 9.88 percent came from commercial farms. This percentage closely matches the cattle population distribution in Peninsular Malaysia that 90 percent of Malaysia's ruminant population were in the hands of smallholders [1]. Commercial farms are the farms that have 50 or more head of cattle at one time, while smallholder farms have less than 50 head of cattle [28]. Non-intensive farms dominated the sample population by 71.6 percent. Example of non-intensive systems are the traditional extensive systems and rotational grazing systems in oil palm plantations. Non-intensive systems tend to be cheaper where the cattle are free to walk around as in their natural habitat. The other 28.4 percent farmers employed intensive farm systems, which require high maintenance costs. From the random sampling of beef cattle farmers, an intensive farm system is not an outstanding choice as non-intensive systems are more affordable for smallholders.

The evidence showed the means of the farms' breeders and bulls were over fifteen and four, respectively. The minimum number of breeders and bulls was close to zero for both since some farms kept only bulls (male) and others kept only breeder (female) cows.

Table 5. Descriptive statistics of beef cattle farms

| Output Variable | Obs | Mean | Median | Std. Dev. | Min | Max |
|---------------------------|-----|-----------|----------|-----------|---------|------------|
| Potential carcass (kg) | 334 | 3724.63 | 330.00 | 20539.20 | 55.00 | 256153.30 |
| Revenue (RM) | 334 | 80400.18 | 11200.00 | 410755.70 | 1800.00 | 6000000.00 |
| Input Variable | Obs | Mean | | Std. Dev | Min | Max |
| Labour (person) | 334 | 1.42 | 1.00 | 1.47 | 1 | 20.00 |
| Labour wages (RM) | 334 | 11796.41 | 4800.00 | 34625.97 | 100 | 384000.00 |
| No. of breeder (head) | 334 | 15.57 | 2.00 | 40.45 | 0.1 | 419.10 |
| Breeder cost (RM) | 334 | 57010.63 | 20000.00 | 139760.40 | 0.1 | 1424600.10 |
| No. of bull (head) | 334 | 4.74 | 5.00 | 9.86 | 0.1 | 101.1 |
| Bull cost (RM) | 334 | 19278.45 | 9500.00 | 47285.2 | 0.1 | 700000.10 |
| Commercial feed (kg) | 333 | 14513.51 | 2.00 | 44957.66 | 0.1 | 480000.10 |
| Feed cost (RM) | 334 | 13469.10 | 4410.00 | 39509.87 | 0.1 | 408000.10 |
| Land area (acre) | 334 | 62.95 | 3000.00 | 417.78 | 0.1 | 4732.10 |
| Land cost (RM) | 334 | 112348.30 | 9600.00 | 733694.00 | 0.1 | 1.28e+07 |
| Roughage (kg) | 334 | 132651.60 | 13070.00 | 550957.8 | 100 | 6141125.10 |
| Roughage (RM) | 334 | 51376.33 | 500.00 | 704785.4 | 0.05 | 1.28e+07 |
| Veterinary service (unit) | 334 | 12.86 | 3.00 | 60.72 | 0.1 | 627.10 |
| Veterinary service (RM) | 334 | 561.95 | 205.00 | 1600.89 | 0.1 | 21060.10 |
| Health service (unit) | 334 | 36.05 | 3.00 | 195.58 | 0.1 | 3000.10 |
| Health cost (RM) | 334 | 655.02 | 200.00 | 3079.88 | 0.1 | 48000.10 |
| Maintenance (unit) | 334 | 3.87 | 5.00 | 19.50 | 0.1 | 351.10 |

| | | | | | | |
|-----------------------|-----|----------|---------|-----------|-----|------------|
| Maintenance cost (RM) | 334 | 4118.75 | 400.00 | 19647.58 | 0.1 | 206200.10 |
| Machinery (unit) | 334 | 2.30 | 2.00 | 1.91 | 0.1 | 20.10 |
| Machinery cost (RM) | 334 | 24551.11 | 2000.00 | 124469.30 | 0.1 | 2060000.10 |

The average carcass mass produced by the beef farms was 3,724.63 kg per year, with a standard deviation of 20,539.20, which shows the variability between the farms. The revenue data were skewed to the right since the mean (RM 80,400.00) was greater than the median (RM11,200.00). The average wages for labor amounted to RM11,796.41 per year and each farm had, on average, only one hired worker. The average number of breeders was 15 head while four bulls on a farm was common. Some farms had no bulls since they used AI breeding methods. Meanwhile, other farms had no breeder or female cows as they were not breeders but more seasonal cattle sellers, selling bull and male cows for slaughtering purposes during festivals. The bull data were skewed to the left. In terms of land area and maintenance, the data were also skewed to the left as the mean values for both these features (62.95 acres and 3.87 units) were smaller than the median (3,000 acres and 5.00 units); the data for the remaining variables were skewed to the right.

The data had a minimum number of 0.1, which was the treatment given to any zero value. Farmers may not have provided certain input units and input costs as they used an alternative or had another input option for their own cattle farm. For analysis purposes, a zero-value needed to shift to a value of 0.1 so that the data would be readable by the analysis software.

3.1. *Economic efficiency of beef cattle farms by states in Peninsular Malaysia*

Table 6 shows the distribution of the economic efficiency scores of the beef cattle farms, according to the state-by-state evaluation. Most farms (44.31 percent) were in the lowest range of economic efficiency scores (0.00-0.09). Meanwhile, 9.28 percent of the farms attained full economic efficiency scores.

Table 6. Frequency distribution of economic efficiency score

| Efficiency Scores | Economic efficiency distribution | Economic efficiency, % |
|-------------------|----------------------------------|------------------------|
| 1.00 | 31 | 9.28 |
| 0.90-0.99 | 4 | 1.20 |
| 0.80-0.89 | 13 | 3.90 |
| 0.70-0.79 | 22 | 6.57 |
| 0.60-0.69 | 27 | 8.08 |
| 0.50-0.59 | 14 | 4.19 |
| 0.40-0.49 | 17 | 5.09 |
| 0.30-0.39 | 13 | 3.89 |
| 0.20-0.29 | 21 | 6.29 |
| 0.10-0.19 | 24 | 7.20 |
| 0.00-0.09 | 148 | 44.31 |
| Observation | 334 | |
| Mean | 0.33461 | |
| Minimum | 0.001 | |
| Maximum | 1.00 | |
| SD | 0.34980 | |

3.2. *Determinants of economic efficiency of farms*

The factors that contributed to the economic efficiency of farms revealed in this subsection. Economic efficiency is important for the farms to sustain their business operations. Technical (scale) efficiency is important when arranging the physical needs of farms, while economic efficiency is crucial to the financial sustainability of the business.

Table 7 shows the descriptive statistics for the variables used to analyze the determinants of economic efficiency for the beef cattle farms in each state. The mean (0.33461) of the farms' economic efficiency was less than the standard deviation (0.3498). The data seemed to spread slightly from the standard deviation value.

Table 7. Descriptive statistics of variables for economic efficiency of beef cattle farms

| Variables (units) | Mean | Min | Max | SE |
|-------------------------|---------------------|-----------|------------|----------|
| Farms CE (%) | 0.33461 | 0.001 | 1.000 | 0.3498 |
| Household income (RM) | 37975.26 | 1800.00 | 400000 | 46190.81 |
| Experiences (Years) | 9.4536 | 1 | 40 | 7.5774 |
| Dummy Variables | Category | Frequency | Percent, % | |
| Financial aid | No (0) | 315 | 94.30 | |
| | Yes (1) | 19 | 5.70 | |
| Association membership | No (0) | 274 | 82.00 | |
| | Yes (1) | 60 | 18.00 | |
| Social media networking | No (0) | 158 | 47.30 | |
| | Yes(1) | 176 | 52.70 | |
| Veterinary networking | No (0) | 201 | 60.18 | |
| | Yes(1) | 133 | 39.82 | |
| Corporate networking | No (0) | 315 | 94.31 | |
| | Yes(1) | 19 | 5.69 | |
| Education | Non graduates (0) | 210 | 62.87 | |
| | Graduates (1) | 124 | 37.13 | |
| Gender | Female (0) | 8 | 2.40 | |
| | Male (1) | 326 | 97.60 | |
| Job in farm status | Part time (0) | 197 | 58.98 | |
| | Full Time (1) | 137 | 41.02 | |
| Type of breed | Local (0) | 111 | 33.23 | |
| | Imported (1) | 223 | 66.77 | |
| AI implementation | Non-implementer (0) | 104 | 31.14 | |
| | Implementer (1) | 230 | 68.86 | |
| Farm size | Smallholder (0) | 301 | 90.12 | |
| | Commercial (1) | 33 | 9.88 | |
| Farm system | Intensive (0) | 95 | 28.44 | |
| | Non-intensive (1) | 239 | 71.56 | |
| Domestic labour | No (0) | 127 | 38.02 | |
| | Yes(1) | 207 | 61.98 | |

The analysis in Table 8 shows that, at the state level; the beef cattle farms' economic efficiency was influenced by financial aid, online networking, veterinary networking, education, job status, and the farm system.

Table 8. Tobit Regression Analysis of the determinants of economic efficiency of beef cattle farms

| Variables | Coefficient | SE | Z-statistic | P |
|-------------------------|-------------|--|-------------|----------|
| Gender | 0.07434 | 0.11749 | 0.63 | 0.527 |
| Experiences | 0.00298 | 0.00306 | 0.97 | 0.331 |
| Corporate networking | -0.00262 | 0.09407 | -0.03 | 0.978 |
| Financial aid | 0.21939 | 0.08847 | 2.48 | 0.014** |
| Association membership | -0.01120 | 0.06119 | -0.18 | 0.855 |
| Social media networking | -0.22862 | 0.04640 | -4.93 | 0.000*** |
| Veterinary networking | 0.10527 | 0.05321 | 1.98 | 0.049** |
| Education | 0.14903 | 0.04064 | 3.67 | 0.000*** |
| Household income | -3.94e-07 | 5.15e-07 | -0.76 | 0.445 |
| Job in farm status | -0.08870 | 0.04334 | -2.04 | 0.042** |
| Type of breed | 0.05298 | 0.04260 | 1.24 | 0.215 |
| AI implementation | 0.06075 | 0.04230 | 1.44 | 0.152 |
| Farm size | 0.01993 | 0.07648 | 0.26 | 0.795 |
| Farm system | -0.22165 | 0.04646 | -4.77 | 0.000*** |
| Domestic labour | 0.02887 | 0.04102 | 0.70 | 0.482 |
| Constant | 0.27866 | 0.12413 | 2.24 | 0.025** |
| Sigma | 0.31855 | 0.01334 | | |
| Observation summary: | 0 | Left-censored observations | | |
| | 303 | Uncensored observations | | |
| | 31 | Right-censored observations at AE >= 1 | | |

Financial aid played an important role in helping the beef cattle farms to achieve a higher economic efficiency score. They have economic efficiency advantage up to 22 percent compare to other farms who has not access to the financial aid. This determinant proven where the funding access facility of the breeders will influence their ability to obtain more profits because the fund will be used to provide the production factors required [30]. Farmers with financial aids tend to be more efficient and motivated to improve the current operation of their farms as the inputs required provided and facilitated.

Meanwhile, farms using social media networking scored -0.22862 less for economic efficiency than those not engaged in social media networking. Social media networking play important role in advertising and spread the information regarding to the outbreak disease and its management. Information dissemination would benefit the farmers through the networking as they can reduce the risk of animal diseases and it would be reducing the culling cost of the animal [31].

Veterinary networking was found to be positively significant in helping the beef cattle farmers to achieve higher economic efficiency scores. This related to the aspect of the biosecurity of the farms where they can have cooperative discussion and shared discussion making [32]. The excellent biosecurity farms will produce more yield and reducing the loss incurred because of infection and diseases. Some of the farmers' suggestions were related to veterinary networking, as respondent number 290 mentioned: "I hope the authority could support the rural farms" connectivity (with) the veterinary officer." Respondent number 292 echoed this view: "I wish the authority (would help) small farms in rural areas, especially regarding technical advice." Rural farms urgently need government support to grow their operations.

Education also played a significant role in contributing to an economically efficient farm. Graduate farmers had an advantage of up to 15 percent over non-graduate farmers in terms of a farm's economic efficiency. This factor influenced their decision making regarding to the farm's operation and other required skills which involving the economic decision of the farms.

In terms of job status, part-time farmers tended to contribute 8 percent more to the economic efficiency of the farms, compared to full-time farmers. These results same as scale efficiency where the part timer farmers are more efficient [33].

For the farm system, the intensive system contributed more than 22 percent to the economic efficiency score, compared to the non-intensive system. This was far from the expected result as intensive systems are costly for farmers due to the limited use of land, which has high rental or purchasing costs. But most of the farmers tend to practice the traditional system or non-intensive system as it is more beneficial to them [34]. Therefore, the strategy to promoting intensive system in cattle farming should be develop as it is proven economically efficient in this research.

4. Conclusion

The economic efficiency of the farms across Peninsular Malaysia influenced by financial aid, online networking, veterinary networking, job status, and the farm system. Policy implementation should be focused on helping smallholders to master the beef cattle supply chain management. Most of the beef cattle farms in the research were responsible for cattle from an early age until slaughtering age. The authorities should provide an extension service for farmers to gain access of the beef supply chain from the early stages of cattle breeding until the end consumer. Smallholders would gain an advantage if they performed a specialty at each of the beef supply chain. This type of knowledge aid would create more competition in the beef cattle market. Farmers would become more particular about cattle breeding since they would have to provide end-products to users, such as beef patties, steaks, and homemade meatballs. The economic inefficiency of beef cattle farms could be reduced with increased input subsidies and the value added of marketing skills training for smallholders, who could then venture into high-end products. It is suggested to promotes the intensive system approach to the smallholder since it is proven to be more economic efficient as compared to the extensive system.

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