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Technical Efficiency of Beef Cattle Farms in Peninsular Malaysia

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Abstract

Beef cattle farming is a challenging business to operate locally because of its low performance. Different price of beef product around Peninsular Malaysia happens due to the various condition of beef sources in each state in Peninsular Malaysia. This research aims to investigate the technical efficiency of beef cattle farms and its determinants. Farm-level data from 334 beef cattle producers collected from August 2020 to February 2021 were analysed by Data Envelopment Analysis (DEA) for technical efficiency scoring and the determinants discovered by using Tobit Model regression. The results show only 28.78 per cent of the farms operates at a total score of 1.00 while 33.54 per cent of the farms score less than 0.50 in technical efficiency. Technically efficient farms depend on experiences, corporate networking, education, household income and natural breeding technique. The findings help the industry to upgrade the operation standard of the farm in Malaysia by promoting the usage of Artificial Insemination techniques for beef cattle breeding intensively and comprehensively, with the involvement of corporates body to invest in the industry as one of the gestures for supporting the food security agenda of the country. Besides, educated youth might be interested in joining this industry if training incentives are provided, tax reductions for agro-food producers and strong support groups with authority.

Keywords: Technical Efficiency, Beef Cattle Farms, Peninsular Malaysia, Data Envelopment Analysis

Introduction

Cattle industry in Malaysia contributes a significant amount to Malaysian agricultural GDP among the livestock group, yet it faces a low production problem .The imported cattle being slaughter in Malaysia and declared as local beef supply (Ernie et al., 2021) . The challenge

faced by breeders in Malaysia is outsourcing or importing the breed and beef cattle for slaughtering purposes (Mohamed et al., 2013).
As more than half of the Malaysian population consume beef, the price of beef is higher compared to the substitute meats such as fish and chicken meat (Zainalabidin et al., 2016). During the festive seasons, the authority needs to control the ceiling price of beef as fresh meat supplies are limited and the demand spikes tremendously, which lead to higher selling price (Latif & Mamat, 2002). Some of the local beef producers fail to obey the ceiling price as the beef supplies are too limited and they cannot tolerate the market force at that moment. This situation is very severe in certain states that have a small number of cattle population, which consumers have to pay a very high price for the beef.
In Malaysia, cattle population is highly concentrated in the states that have a wider land area. The highest number of cattle populations are in the East Coast region of Malaysia and Johor. These three states, which are Pahang, Terengganu, and Kelantan, cover up to 51 percent of land area in Peninsular Malaysia (66,000 km2 out of 131,732 km2), which becomes an advantage for them to rear more cattle compared to other nine states in Peninsular Malaysia. Amongst the nine states, excluding Pahang, Kelantan, and Terengganu, Johor has a high number of cattle population, especially in Mersing, which is included in the East Coast Economic Region (ECER). With the high concentration of cattle population, the variety of cattle production systems would help the producers or breeders to generate their income in this region; Pahang, Johor, Kelantan, and Terengganu.
Table 1.0 shows the cattle population amongst the fourteen states in Malaysia starting from the highest number, which is the Pahang state, followed by Kelantan and Johor, as well as Terengganu. All these states were covering ECER established in 2007 by the Federal Government of Malaysia. ECER covers the states of Kelantan, Terengganu, and Pahang, as well as the district of Mersing in Johor. Under the cluster of agriculture, cattle industry is one of the emphasised industries to improve its productivity through intensive and extensive rearing systems (ECERDC, 2010). The cattle population in these four states cover 59 percent from the total population of cattle in 2018.

Table 1.0
Malaysian Cattle Population by State from 2013 to 2018

State	2013	2014	2015	2016	2017	2018	Percentage,%
Pahang	**129,394**	**129,255**	**114,239**	**123,679**	**123,299**	**126,084**	
Kelantan	**97,592**	**97,425**	**98,586**	**96,451**	**98,237**	**94,615**	
Johor	**113,864**	**106,085**	**105,810**	**100,798**	**101,967**	**90,667**	**59 %**
Terengganu	**90,351**	**88,317**	**90,480**	**90,304**	**84,427**	**87,792**	
	TOTAL TOP FOUR STATES IN 2018					**399,158**	
Sabah	**67,997**	**68,105**	**70,493**	**73,215**	**73,200**	**71,365**	
Kedah	**69,013**	**68,596**	**78,684**	**71,842**	**56,118**	**46,759**	
Perak	**53,202**	**53,007**	**46,831**	**47,935**	**44,749**	**43,808**	
Selangor	**21,881**	**22,858**	**23,451**	**24,892**	**24,831**	**32,463**	
Negeri Sembilan	**43,783**	**44,574**	**46,388**	**45,959**	**39,614**	**27,356**	**41%**
Melaka	**27,364**	**27,935**	**32,575**	**28,180**	**28,721**	**25,750**	
Sarawak	**15,631**	**15,860**	**10,840**	**10,010**	**10,111**	**16,208**	
Pulau Pinang	**14,320**	**16,091**	**14,766**	**15,187**	**11,642**	**11,642**	
Perlis	**6,614**	**8,225**	**8,645**	**8,802**	**6,713**	**2,058**	
W.P. Kuala Lumpur	**491**	**450**	**550**	**573**	**203**	**119**	
	TOTAL BOTTOM TEN STATES IN 2018					**277,528**	
TOTAL	**751,497**	**746,783**	**742,338**	**737,827**	**703,832**	**676,686**	**100 %**

Source: Department of Veterinary Services (2018)

The cattle industry enhancement in ECER covers all three states in the East Coast of Peninsular Malaysia and the district of Mersing in Johor. It was expected that the Federal Land Development Authority (FELDA) to play a leading role in beef cattle development in ECER through improved breeding and nutrition under oil palm cattle integration (Johari and Jasmi, 2009: Najim, Amin, Karimand, & Mei, 2015). By using oil palm cattle integration system, East Coast region has an advantage of land areas compared to southern and northern regions of Peninsular Malaysia. Each of the FELDA settlers provided with ten acres of land by the government developed into oil palm plantation or rubber plantation. Besides, the settlers in FELDA are likely to rear cattle in their plantation to generate a side income as they have a sufficient area for cattle to graze. As palm oil price is fluctuated, rearing cattle in the oil palm plantation is like killing two birds with one stone. Ironically, the number of beef cattle is not increasing and the price of local beef spikes year by year. Most of the oil palm planters focus on the oil palm yield as it is a high value crop that gives high profit. The circumstance does not portray the success of ECER in enhancing cattle industry with the aid of FELDA.
Table 2.0 shows the retail price of local beef in 2019. As we can see, the price is different from one states to another. The cheapest beef found in Kelantan, while the most expensive is beef in Putrajaya. This variety show the source of beef in Malaysia are uneven, depend on the beef sources at the states. Putrajaya is an urban area where the availability of cattle farms are not as much as in Kelantan. This different price of local beef shows beef supply in each states depends on the availability of the sources and the market forces at the place. The price is one of the important aspect of consumer preferences to buy beef in Malaysia before the quality. Many families unable to purchase or consume beef because of the high prices, especially those in the lower economic bracket (Indra et al., 2022).

Apart from price, if the quality is not optimal, the consumer still not buying beef. Quality of beef in Malaysia includes the halal status, fresher than imported beef, its texture, cleanliness, colour and type of cut (Indra et al., 2022).

Table 2.0
Retail Price/Kg of Local Beef in Malaysia for 2019

STATES	**LOCAL BEEF (price/kg)**	
	round meat	**lean meat**
PERLIS	34.00	34.00
KEDAH	33.92	33.56
PULAU PINANG	34.31	34.49
PERAK	31.87	30.42
SELANGOR	35.11	34.58
WPKL	35.75	36.19
PUTRAJAYA	40.12	35.75
NEGERI SEMBILAN	33.68	33.19
MELAKA	32.17	31.25
JOHOR	32.58	32.46
PAHANG	31.60	30.00
TERENGGANU	30.63	30.63
KELANTAN	29.54	29.52
SABAH	27.00	26.50
LABUAN	0.00	0.00
SARAWAK	0.00	0.00

Source: Ministry of Domestic Trade and Consumer Affairs (2019)

Figure 1.0 depicts the trend of registered beef cattle farms and beef cattle producers in Peninsular Malaysia. The pattern shows an inconsistent trend of both producers and farms; where the decreasing number of producers did not affect the increasing trend of farms. Meanwhile, the number of farms kept increasing due to the preparation of accepting imported live cattle during peak festive seasons. The logic behind the trend was due to the merging of smallholder groups into larger farms where a farmer registered more than one farm for his business entity or that the unregistered farmer might sell or merge his businesses into a bigger scale of registered farms. Merging cattle farms was a good step to save the smallholders' operation, but this might construct a new market structure from an oligopolistic producer to monopoly producer. The situation could affect price competitiveness of beef cattle. Another logical explanation of the trend is that there was a possibility of more registered farms shut down as in 2018 while the sustaining producers were expanding their farm capacity.

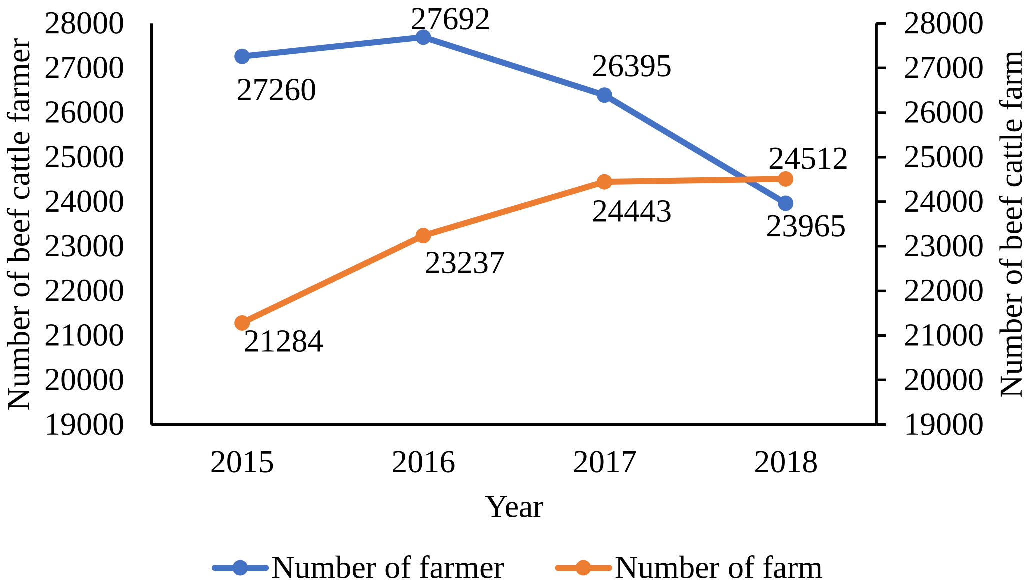

Figure 1.0.Number of Registered Beef cattle Farm and Farmer in Peninsular Malaysia from 2015 to 2018
Source: www.data.gov.my (2022)

The situation showed an increasing number of farms initiated from the intention of producing more money by doing the business in an established and registered entity instead of operating the farm in a small scale or as the side hustle. Meanwhile, the decreasing number of beef cattle producers would explain the loss of the producers' confidence to sustain in the business. The producers' maintaining participation in the beef cattle's operation showed their stronger positioning in the industry as the number of farms was more than the number of producers in 2018.
Each beef cattle farms have different resources. It creates different volume output where lead to different selling price. The management of farms and resources allocation plays its roles to make the farms efficient in its production. The question is what determine farms to become technically efficient? The objective of this research is to investigate the technical efficiency and its determinants of beef cattle farms in Peninsular Malaysia.
Efficiency assessment will contributes to the beef cattle farms' performance information in each states. Identification of efficiency score could help states authority and farms to increase or decrease the operation of farms accordingly. The determinants of farms efficiency can become the main consideration in empowering farms operations in Malaysia. Major beneficiaries of seconds objective are the farms and policy maker. In addition, complementary business such as entrepreneurship consultant, input store and related authority would also gain benefit from the findings. The knowledge of beef cattle industry performance would helps the authority and business provides suitable assistances towards producers.

Literature Review
Efficiency can be defined by dissociating what comes from technical origin due to a bad choice, in terms of input combination compared to the price of the inputs (Ouattara, 2012).

It is related on how well a goal is accomplished by considering the amount of resources used and the wastes that are created. In the simplest word, efficiency is doing things right.

Technical efficiency was defined by Koopsman (1951) as "If a producer needs to decrease one of the outputs or increase one of the inputs in order to increase its output, the situation is technical efficient". It can be analysed by using input-oriented approach and output-oriented approach (Tutulmaz, 2014). From the output perspective, technical efficiency measures the potential increase in output, keeping the inputs constant. Two common methods to measure efficiency in the firm level are Data Envelopment Method (DEA) and Stochastic Frontier Analysis (SFA) Mathematical programming approach, which is also known as Data Envelopment Analysis (DEA), was originated by Charnes, Cooper, and Rhodes (1978). Meanwhile, the econometric approach, namely Stochastic Frontier Analysis (SFA) was originated by Aigner et al. (1977), Battese and Corra (1977), as well as Meeusen and Van den Broek (1977). Besides these two methods, there are other methods to measure efficiency, such as Thick Frontier Approach (TFA) and Distribution Free Approach (DFA) for parametric approach. Another non-parametric approach besides DEA is Free Disposable Hull (FDH).

DEA is advantageous at times because it 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 (Erkoc, 2012). This study focused on output-oriented because beef producers are assumed to have more control over their outputs than most of their inputs (i.e., land, capital, and labour are quasi-fixed in practice) (Martinez and Thorne, 2019).

Technical efficiency focuses more on managerial decisions of the farms rather than regulatory decisions. Technical efficiency of beef cattle farms should be up to Scale 1 or 100 percent efficient for the constant return to scale. For Malaysia's beef cattle efficiency, Serin et al (2008) had found the average computed technical efficiency of individual cattle farm unit for targeted area of concentration (TAC) in Johor, which was 0.683 with the range between 0.4 to 0.8. The technical efficiency of integrated rearing system in Johor had been improved by the score between 0.958 to 1.0 with the average score of 0.997 (Gabdo et al., 2014). This shows the technical efficiency of cattle farm in Johor was high in score.

The technical efficiency of beef cattle farms in Kenya demonstrated the same range as Malaysia's beef cattle farms where they had an average technical efficiency level of 0.69. Regardless of their production system, the farms had been analysed to be using an available technology sub optimally (David et al., 2014). Meanwhile, the three type of rearing system in Nigeria have their score of 0.59, 0.69 and 0.83 for the nomadic pastoralists, agropastoralists and ranchers system (Nwigwe et al., 2016). In the West Java Province, the beef cattle farm efficiency shows the score of 0.77 which also fall under the range of score in Malaysia (Isyanto et al., 2013). Yet, the situation was different in Central Java where technical efficiency of beef cattle farms was less than 0.5 which could be considered as not efficient (Ekowati et al., 2018). In summary, the score of technical efficiency that most beef cattle farms could achieve was more than 0.50. Regardless of the farm type, technical efficiency of the farms considered efficient in most countries. This circumstance illustrated the commitment of the farms in their technical aspect for their business survival.

The input of technical efficiency found in many literatures. The prominent input for technical efficiency of cattle farm land ,labour and capital (Jamison & Moock, 1984; Dakpo et al., 2019). Some literature provides in detail the input use in the farms. The input list include concentrated feed (kg), roughage feed (kg), veterinary services and cost, worm medicine(dose), vitamins (dose), fuel (litre), farm size (acre), herd size (head), energy cost and other variable cost (Gul et al., 2018 : Wantasen et al., 2022 : Hansson & Öhlmér, 2008; Nwigwe et al., 2016; Madau et al., 2017; Palacpac & Valiente, 2023).

Output of the cattle farm efficiency includes milk and beef yield. Most of the literature provides milk yield as output (Gul et al., 2018; Hansson & Öhlmér, 2008; Madau et al., 2017; Palacpac & Valiente, 2023). Meanwhile, this research focus on the beef productivity. Most of the research focus on the financial value of the beef cattle in currency such as revenue and sales (Hansson, 2008; Wantasen et al., 2022; Dakpo et al., 2019). Few of the literature had highlight the beef cattle in volume of kilogram as output (Wantasen et al., 2022).

Determinants of efficiency for the farms are varies. Many aspects can be the determinants of the farms, including cost aspect, biological aspect, social aspect, demographic aspect and others. According to Chamhuri et al (2014), Tobit model is suitable to identify the determinants of producers and farms through the farm-specific characteristics over the efficiency score. Farm specific characteristic such as variables are age, education level, family labour, year of agricultural experience, association participation and farm size are among the determinants that influence the efficiency of farms (Chamhuri et al., 2014). Other than that, the specific determinant such as social networking and extension service plays important roles to adoption of technology and lead to farm efficiency. This happen when social networks are rich in content, including learning, interaction, reciprocity and trust (Wang et al., 2020).

In Indonesia, the artificial insemination (AI) has become one of the profitability in beef cattle farming. AI is a modified technology expected to have a significant role in improving the success of breed in female cattle. As mentioned in Sugiarto, Wakhidati, Einstein, & Mulyadi, (2019), The usage of AI technique has been proven as an improvement method of beef cattle breeding to increase beef production efficiency (Trenkle & Willham, 1977). Despite of higher cost, AI technique would be profitable to cattle farms if the experienced producers and a large number of cattle are involved in the technique (Sugiarto et al., 2019). Meanwhile, Bhat (2014) estimated the relationship of farm size with technical efficiency of farms. There were non-linear relationship of farm size and productivity efficiency where efficiency will fall in the first place, then rise when the size increases. Large farms tend to have a higher net farm income and are technically efficient compared to other small farm size categories. Therefore, cattle production efficiency may depend on demographic factors of the producers, availability of the feed in the rearing system, the breeding technology such as AI, as well as farm size.

According to Temoso et al (2016), herd size is one of the important determinant of livestock performance in farms. This factor associated with the economies of scale where production costs tend to decline with herd size which indicate the existence of economies of scale and large herds tend to be more drought resilient than small herds (Temoso et al., 2016). Another literature by Temoso et al (2023) include the determinants of herd size, age of farm owner, education of owner, mortality rate, gender of farm owner, proportion of crossbreed in farms, the off-farm income and number of advisory centre for determine the efficiency of beef cattle farm specifically.

Beef cattle farm efficiency determinants get various highlight from Indonesia literature. Farm scale, forage, concentrated,health, and labour of the beef farm are not efficiently applied in beef cattle farms of Grobogan region. The inefficiency of the input usage due to the low qualification or not in standard specification (Ekowati et al., 2018). Isyanto et al (2013) found the beef cattle fattening efficiency determined by the involvement of family labour and concentrated feed while education, experience, number of cattle ownership, and credit had significant effect on the level of technical inefficiency with age and family size had no significant effect. Wantasen et al (2022) suggest the beef cattle farm would increasing their business scale (more efficient) with the inclusion of family labour and expectation to increase income. It shows, then, that the lesser total raised cattle, lower education, smaller annual income and business risk, the higher the opportunity to improve the business scale of beef cattle farms in North Sulawesi . Indonesian literature of beef cattle shows different region have different condition and determinants to keep the beef production sustain efficiently.

Methodology

Technical efficiency in production function formulation assumed to address and resolve for engineering and managerial problems. Technical efficiency defined via three forms of efficiency, which were technical efficiency (TE), pure technical efficiency (PTE), and scale efficiency (SE). Data envelopment analysis (DEA) measures efficiency relative to a deterministic of non- parametric frontier (Charnes et al., 1978). Farrell (1957) illustrated his ideas with an application to U.S. agriculture, using cross-sectional data to compare the efficiency of producing units. The drawback of a cross-sectional analysis is that it provides only a snapshot of a process, but this is the need of this research. Many other literature use the same theoretical approach of efficiency measurement for capturing the cross-sectional event in the farms operation (Heinrichs et al., 2013; Johansson, 2005; Gul et al., 2018; Hansson, 2008; Palacpac & Valiente, 2023) .

TE measured by which DMUs evaluated for their performance relative to other DMUs. However, the value influenced by SE, which quantified the effect of the presence of Variable Return-to-Scale (VRS) in DMUs. PTE was a TE that had the effects of removed SE. The relationship of the technical efficiency components was as follows:

$$TE = PTE \times SE \qquad (1)$$

The choice of input or output DEA model depends on the quantities of inputs or outputs that are available in DMUs. Since livestock farms had more control over outputs than inputs, this research was much more suitable for applying output-oriented DEA (Temoso et al., 2023). As the profitability depends on the efficiency of the operations and the output are usually more predictable, an output-oriented analysis was more suitable for a cattle farm analysis compared to an input-oriented analysis (Martinez and Thorne, 2019).

The output-oriented DEA model under assumption of Constant Return to Scale (CRS) and VRS used to estimate the overall TE and SE of the beef cattle farm. Therefore, this study applied the output oriented DEA-CRS model for estimation of cattle farm and assume that (k= 1,…,K) DMU's, operating in a technology subset T denotes by $x = (x_1, \ldots, x_N) \in \mathfrak{R}^{N+}$ vector of inputs produce a nonnegative vector of output vector $y = (y_1, \ldots, y_N) \in \mathfrak{R}^{M+}$. The TE of the k-th DMU is measure by which the k-th DMUs are evaluated for its performance of other DMU's as in equation below based on research of Abed & Acosta (2018):

$$\mathrm{TE_k} = \frac{\lambda_1 y_{1k} + \lambda_2 y_{2k} +,\ldots,+ \lambda_M y_{Mk} = \sum_{m=1}^{M} \lambda_m y_{mk}}{v_1 x_{1k} + v_2 x_{2k} +,\ldots,+ v_N x_{Mk} = \sum_{n=1}^{N} v_n x_{nk}} \qquad (2)$$

Where, TE_k is technical efficiency score given to the k-th DMU, and v and λ denote input and output weights.

The equation was transformed into linear equation as below :

$$DEA\,(x, y) = Min\emptyset_k^{CRS} \Big| [\emptyset_k^{CRS} \geq 0] \qquad (3)$$

$$\text{s.t} \sum_{k=1}^{K} \pi k y_k^m - s_m^+ = y_0^m, m = 1, \ldots, M \qquad (4)$$

$$\sum_{k=1}^{K} \alpha k x_k^n - s_m^- = x_0^n \ \ , n = 1, \ldots N \qquad (5)$$

$$\pi k, \alpha k, s_m^+, s_m^- \geq 0 \qquad (6)$$

where $\emptyset_k^{CRS}$ is Farrell TE of the k-th DMU under CRS; y_0^m and x_0^n represents the output and inputs of the consideration; $s_m^|$ and s_n^- denote as output and input slacks. For instance, if $\emptyset_k^{CRS} = 1$ and slacks = 0 ($s_m^|$ = 0;Ą m and s_n^- =0;Ąn), the DMU was on the predictable frontier and is technically efficient. Technical efficiency also referred to as radial efficiency. Technical efficient DMUs classified in two types, namely strong efficient DMUs and weak efficient DMUs. In evaluating DMUo, which was a technical efficient DMU, if all slacks $s_m^|$ and s_n^- (i = 1, ..., m, r = 1, ..., s) equalled zero in all possible optimal solutions then DMUo is called a strong efficient DMU otherwise, was called a weak efficient DMU (Mirdehghan, 2015). However, estimating CRS is suitable when all DMU's operate in an ideal scale, which was not probable with constrains such as financial problem, market competition and government regulation. Therefore, CRS TE scores decomposed into pure technical efficiency (PTE) and scale efficiency (SE) components by solving a variable return to scale (VRS) DEA model which have additional convexity constraint $\sum_{k=1}^{K} v_k = 1$. In Banker, Charnes and Cooper (1984), the model of VRS for estimating technical inefficiencies and scale inefficiency as follows:

$$DEA\ (x, y) = Min\emptyset_k^{VRS} \Big| [\emptyset_k^{VRS} \geq 0] \qquad (7)$$

$$\text{s.t} \sum_{k=1}^{K} \pi k y_k^m - s_m^+ = y_0^m, m = 1, \ldots., M \qquad (8)$$

$$\sum_{k=1}^{K} \alpha k x_k^n - s_m^- = x_0^n \ , n = 1, \ldots N \qquad (9)$$

$$\pi k, \alpha k, s_m^+, s_m^- \geq 0 \qquad (10)$$

Where, $\emptyset_k^{VRS}$ was Farrell PTE of the k-th DMU under variable returns to scale. The VRS approach forms a convex monotone hull of interesting planes that envelope the data points more strongly than CRS conical hull and thus the score of PTE is greater than or equal to TE score under CRS. Since the convexity restriction is not imposed in the CRS case, a DMU may be benchmark against a DMU that substantially binger or smaller than it. Therefore, scale efficiency (SE) is introduced to measure the size of DMUs in order to achieve the optimal size and indicates some part of inefficiency that caused by inappropriate size of DMU. The scale efficiency that able to show the relationship of the k-th DMU are as follows:

$$SE_k = \frac{Technical\ Efficiency\ (TE)}{Pure\ Technical\ Efficiency\ (PTE)} = \frac{CRS}{VRS} \qquad (11)$$

When $SE_k = 1$ indicated that scale efficiency or constant return to scale, while if $SE_k < 1$, it indicates the scale is inefficient.

Data

Data collection for the efficiency of farms occur on August 2020 until February 2021. The states involves in this research include Kedah, Pulau Pinang, Perak, Negeri Sembilan, Melaka, Johor, Pahang, Selangor Terengganu and Kelantan. We are succeed to collect from ten states in Peninsular Malaysia out of twelve. Structured questionnaires distributed to cattle farms, mainly in Pahang, Kelantan, and Terengganu, with some samples from other states in Peninsular Malaysia. The selection of main sample areas was due to the high population of cattle in these three states, which covered 59 percent of the total cattle population in Malaysia.

Variables

Variables used in the research consists the component of input and output, which aimed for analysis by using DEA method. Table 3.0 explain the variables involve in the analysis. For the output, usage of average carcass production value in states currency (Ringgit Malaysia) applied as in research of (Ludena et al., 2005). Input of the analysis includes number of labour, number of cattle, commercial feed, land, roughage, veterinary services, health and farm maintenances and unit of machinery.

Table 3.0
Variables for Technical Efficiency

Output	Input	Input unit	Literature
Average carcass production, kg/year (Wantasen et al., 2022)	Labour	Person	(Gul et al., 2018; Wantasen, Umboh, & Jein, 2022; Hansson & Öhlmér, 2008; Nwigwe et al., 2016; Madau et al., 2017; Palacpac & Valiente, 2023).
	Breeder	Head	
	Bull	Head	
	Commercial Feed	Kilogram	
	Land	Acre	
	Roughage	Kilogram	
	Veterinary Services	Per service	
	Health maintenance	Per product/service	
	Farm maintenance	Per product/service	
	Machinery	unit	

Tobit Regression Model
Censored regression needed in the second stage analysis; to analyse the role of socio-economic, demography, and institutional attributes in explaining technical and economic efficiencies in cattle production. Tobit regression was introduced by Tobin (1958), involving a censored regression model of the economy and was first analysed in the econometric literature (Lubis et al., 2014). The efficiency index was derived from a data envelopment analysis, which was bound between 0 and 1 value. Thus, it is suitable for use as a simulation analysis to identify the determinants of technical efficiency and cost or economics efficiency among producers. Tobit regression written as follows,

$$y_t^* = x_t' \beta_0 + \epsilon_{t,} \; t = 1,2,3, \dots \dots, n \qquad (12)$$

$$y_t = y_t^* \; if \; y_t^* > c \; ; and \; y_t = c \qquad (13)$$

where, y_t is a DEA efficiency index was used as a dependent variable, $\epsilon_t | x_t$ is N(0,σ_0^2) and {y_t,x_t}(t = 1,2,...,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 technical and economic efficiency scores used in the regression model to show the relationship between the measurement of the efficiency and the characteristics of producers. Table 4.0 displays the variables used in the questionnaires that distributed to the beef cattle producers around Peninsular Malaysia. An expected sign showed the relationship of the variables towards dependent variables; technical efficiency, and economic efficiency. For the dummy variables, related literature provided in explaning the usage of variables in Tobit regression. The variables represent the features of the farms visited that become the determinants of the farms efficiency score.

The variables for Tobit Regression would be as follows
Table 4.0
Variables for Tobit Regression

VARIABLES	UNIT	EXPECTED SIGN
Technical efficiency	Index	Positive
Cost or economic efficiency	Index	Positive
Experiences	Years	Positive
Household Income	RM	Positive
VARIABLES	**DUMMY CATEGORICAL**	**LITERATURE**
Gender	1 male, 0 female	(Temoso et al., 2023)
Cooperate networking	1 involve, 0 not involve	(Cofré-Bravo, Klerkx, & Engler, 2019)
Financial aid	1 received, 0 not received	(Suhartini, Gunawan, Sinuraya, & Ilham, 2021)
Family labour	1 involve, 0 not involve	(Gul et al., 2018)
Association membership	1 involve, 0 not involve	(Chamhuri et al., 2014)
Online networking	1 involve, 0 not involve	(Cofré-Bravo et al., 2019)
Veterinary networking	1 involve, 0 not involve	(Muhamad & Man, 2014)
Education	1 graduates, 0 non graduates	(Gul et al., 2018)
Farming job status	1 full time , 0 part time	(Song, Robinson, & Bardsley, 2022)
Type of breed	1 import, 0 local	(Temoso et al., 2023)
Artificial Insemination	1 involve, not involve	(Gul et al., 2018)
Herd size	1 commercial, 0 smallholder	(Gul et al., 2018)
Farm system	1 non-intensive, 0 intensive	(Qushim, Gillespie, Bhandari, & Scaglia, 2018) (Sukhairi & Rasat (2014)

Results and Discussions

In this research, the respondents' demographic information was important when explaining the sample. The sample collected from beef cattle producers around Peninsular Malaysia. Farms with more of four head of cattle and involved in livestock farming for more than two years were eligible to participate in the survey. The interviews conducted structurally and

made understandable to producers through various channels. This included appoint local people as enumerators, online forms, youth associations, corporate entities, and social media. In total, 334 respondents took part in the survey. The data collection started in August 2020 and finished in February 2021. The farms were selected with clustering technique ; rear minimum four heads of cattle with more than two years operation from smallholder and commercial operations, depending on their commitment and responses to this research.
At the beginning, the survey conducted online using a form for the participants to complete. Collecting the responses took around a month and only 30 feedback samples obtained out of 70 producers contacted for pilot test, which is not included in the sample count. The main barrier when using this method was that not all the beef cattle producers were technology-savvy. Therefore, the approach changed from August 2020, and face-to-face interviews then conducted simultaneously with online distribution survey by the researcher and enumerators. According to the data from an official government website, Peninsular Malaysia had 24,512 units of registered beef cattle farms at the time of the survey. For the data collection, six enumerators appointed. They assigned to conduct face-to-face interviews with beef producers in their local region. This approach seemed more convenient for the producers because some were illiterate and needed guidance on responding to the survey.
Through the face-to-face interviews, 284 producers responded to the questionnaire. The total number of distributed questionnaires came to 500 sets, but some producers refused to answer due to the time needed to answer all the questions, and/or they were not interested in a non-profit conversation (they expecting the sales oriented discussion only). Other than the enumerators, the researcher also travel to certain states to obtain a variety of feedback from different areas of Peninsular Malaysia.
The 334 completed questionnaires was confident to represent the beef cattle farms in Peninsular Malaysia. Due to the Movement Control Order (MCO), some states were unreachable and no enumerators came from these states.

The demographic details of the respondents were as follows:

Table 5.0
Demographic of Respondent

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	17	5.1
	PMR	33	9.9
	SPM/STPM	155	46.4
	Institutional 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

To meet objective, primary data collected from beef cattle producers around Peninsular Malaysia. The largest group were aged between 19 to 40 years old (48.8 percent), followed by those aged 41 to 60 years old (47.6 percent). Only 0.6 percent of the survey respondents were below the age of 18; they had finished school and immediately become involved in cattle rearing. Most respondents were in the active employment (19 to 40 years old) or pre-retirement (41 to 60 years old) age groups.

Only 2.4 percent of the respondents involved in this survey were female since cattle rearing is a physically intensive task. Of the 334 respondents, 82.6 percent were married, which usually made them responsible for generating their household income. Meanwhile, 79.6 percent of the respondents had less than 10 years of experience, 16.8 percent had 11 to 20 years of experience, and only a small number had more than 20 years of experience (3.6 percent). The majority of the respondents had finished high school (46.4 percent) or graduated from a higher education institution (37.1 percent). The respondents tended to have a low household income as 44.9 percent earned less than RM20,000 per year. In summary, the demographic information shows that the majority of the respondents (52.4

percent) had a low household income (less than RM20,000 per year) and lacked experience (58.1 percent had less than five years of cattle farming experience).
The details of the farms involved in this research are as follows

Table 6.0
Farm Characteristic

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

The features of the farms involved in this research shown in Table 6.0. The most responsive participants came from Kelantan (28.7 percent), followed by Terengganu (27.8 percent), Kedah (16.5 percent), and Pahang (9.9 percent). Only one farmer in Selangor responded to the questionnaire. Generally, less than 10 head of cattle reared on each farm (51.2 percent). The types of farms that responded most frequently to the questionnaire were semi-intensive farms (71.6 percent), followed by intensive farms. Few farms (5.7 percent) received financial aid. There is no participant from Perlis.

Most producers had a connection with other producers through online platforms (52.7 percent) but only 18 percent of the producers had joined the established association and 39.8 percent had engaged in networking with veterinary bodies. For commercial and distribution chain purposes, only 5.7 percent of the producers had engaged with distribution bodies such as supermarkets, cooperatives, and statutory bodies.

Overall, 62 percent of the farms were using unpaid domestic labor in their daily operations. Unpaid domestic laborers were often the family members of the farm owners and not paid fixed wages. Smallholder farms in Kelantan and Terengganu usually used unpaid domestic labor. Different conditions found with commercial farms such as Ladang Risda Livestock Tersat, Terengganu and Kris Agritech, Johor, which managed by professional farm operators. Most farms made a profit of less than RM10,000 per year (39.8 percent), although 0.6 percent were able to make a yearly profit of more than RM1 million. Unpaid labour from family members was one of the ways to reduce operational costs since the annual profit of most farms was less than RM10,000. Most producers owned the land on which they conducted their cattle rearing operations (56.6 percent). Cattle farming activities are easier to conduct on the owner's land as this can reduce the fixed costs, while land for agricultural activities is an asset and should be a good investment. The land owned by cattle producers can be upgrade with additional facilities, such as personal forage areas, ponds, and farm shelters. The cattle producers who own the land have the advantage of being able to modify the farm facilities according to the requirements of the herd.

Many of the farms kept mixed imported and local cattle breeds (52.1 percent). Only 18 percent reared purely imported breeds, while the remaining 29.9 percent kept only local breeds on their farms. 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 (Islam et al., 2021). Meanwhile, the advantage of farms keeping a mix of imported and local breeds is the potential to obtain crossbreed cattle, which are heavier at maturity, mature earlier, produce more milk, wean heavier calves, and predicted to consume more energy. Thus, they are more efficient than purebred cattle, despite their greater predicted feed intake (Mendonça et al., 2019).

In terms of the proportion of data, 90.12 percent came from smallholder farms and 9.88 percent came from commercial farms. This percentage closely matches the cattle population distribution in Peninsular Malaysia mentioned by Zainalabidin et al (2013),who found that 90 percent of Malaysia's ruminant population were in the hands of smallholders. Commercial farms have 50 or more head of cattle at one time, while smallholder farms have less than 50 head of cattle (Serin et al., 2012).

Non-intensive farms dominated the sample population (71.6 percent). Non-intensive systems include traditional extensive systems and rotational grazing systems in oil palm plantations. Non-intensive systems are cheaper and the animals are free to walk around according to their nature and habits. Many producers applied non-intensive systems because they are cheaper and more convenient for cattle movement. Meanwhile, the other 28.4 percent employed intensive farm systems, which require high maintenance costs. From the sampling of beef cattle producers, it was hard to find any who used an intensive farm system as non-intensive systems are more affordable for smallholders.

The technical efficiency in each state analyzed for management scoring purposes. Each state analyzed separately and comparisons were made between the farms in each state. For example, the beef cattle farms in Kelantan compared only to other farms in Kelantan. Therefore, the state's efficiency score obtained by comparing only the farms operating in Kelantan.

Table 7.0
Technical Efficiency Mean Score within States in Peninsular Malaysia

State	**Constant Return to Scale**	**Variable Return to Scale**	**Scale Efficiency**	**Full efficient farm contributor according to business size ,%**		**Percentage of full efficient cattle farm by states (%)**
Kedah	0.798	0.873	0.899	smallholder	100.00	29.20
				commercial	0.00	
Negeri Sembilan	0.860	1.000	0.860	smallholder	20.00	6.25
				commercial	80.00	
Johor	0.807	0.924	0.856	smallholder	33.30	6.25
				commercial	66.70	
Melaka	0.835	1.000	0.835	smallholder	66.70	2.10
				commercial	33.30	
Perak	0.819	1.000	0.819	smallholder	66.67	3.10
				commercial	33.33	
Pulau Pinang	0.688	0.917	0.753	smallholder	100.00	12.50
				commercial	0.00	
Terengganu	0.453	0.741	0.620	smallholder	53.33	15.60
				commercial	46.67	
Kelantan	0.467	0.777	0.610	smallholder	100.00	17.70
				commercial	0.00	
Pahang	0.400	0.956	0.417	smallholder	42.86	7.30
				commercial	57.14	

Technical efficiency describes how the extent of a farm can reduce the input but still remain within the variable returns to scale frontier. This means how each farm in each state utilized their input. Table 7.0 shows the technical mean scores for the beef cattle farms in each state in Peninsular Malaysia. The state-level evaluation is relevant since each state in the country has different sources of inputs and a different implementation of the extension services offered by the state authority. The farms achieving a score of 1.000 operated under full efficiency. Based on the data, Kedah had the highest percentage of fully efficient farms of all the states; all of these were smallholder farms. This followed by Kelantan, with 17.71 percent of the farms operating at full efficiency and, again, all were smallholder farms. Terengganu had an almost balanced proportion of fully efficient farms, with smallholder farms comprising 53.33 percent of this number. Commercial farms comprised 46.67 percent of the fully efficient farms in Terengganu, while 15.63 percent of the farms in this state were fully efficient, based on the collected survey. The same applied to Pahang, where both smallholder and commercial farms found to operate under full efficiency but the contribution of commercial farms was greater (57.14 percent). However, the state only accounted for 7.30 percent of the fully efficient farms in the overall sample. Melaka was shown to have the fewest fully efficient farms since the number of samples from this state was also low. Smallholder farms dominated in the states of Kedah, Melaka, Perak, Pulau Pinang, Terengganu, and Kelantan in terms of operating at full efficiency. Meanwhile, fully efficient commercial farms were prominent in the states of Negeri Sembilan, Johor, and Pahang, where the efficiency levels of these farms were higher than those of the smallholder farms.

The highest scale efficiency score was for the beef farms in Kedah (0.899), followed by those in Negeri Sembilan (0.860). The lowest mean scores obtained by Kelantan (0.610) and Pahang (0.417). Pahang and Kelantan are two states with high cattle populations than Kedah and Negeri Sembilan, but both Kelantan and Pahang scored the worst for scale efficiency. Although Kelantan had a low scale efficiency mean score when comparing the states, it contributed the second-highest percentage of full efficiency scores (17.70 percent) when compared overall with other states (after Kedah, which scored 29.90 percent). This occurred because the beef cattle farms in Kelantan varied in size, with many input and output option, mostly amongst the smallholders. There are only 9 states recorded in the analysis as the Selangor states only have one representative and it cannot be compare to other farms in Selangor.

To summarize the state technical efficiency scores, Table 8.0 shows the distribution of the scores where the mean score was higher than the standard deviation. This was due to the low disperse value of the data around, compared to the mean. A low standard deviation means the data clustered around the mean. The fully efficient farms in each state counted, resulting in 96 in total.

Table 8.0
Frequency Distribution of Technical Efficiency

Efficiency Scores	Technical efficiency distribution	Technical efficiency, %
1.00	96	28.74
0.90-0.99	36	10.78
0.80-0.89	33	9.87
0.70-0.79	18	5.39
0.60-0.69	19	5.69
0.50-0.59	20	5.99
0.40-0.49	19	5.69
0.30-0.39	20	5.99
0.20-0.29	40	11.98
0.10-0.19	20	5.99
0.00-0.09	13	3.89
Observation	334	
Mean	0.67207	
Minimum	0.036	
Maximum	1.000	
SD	0.32382	

As the table indicates, most farms operated at a fully efficient scale (28.74 percent). However, 11.98 percent scored between 0.29 and 0.20 for technical efficiency. Farms performing below 0.50 considered to be in an alarming situation compared to other farms that scored almost or exactly 1.00. It can be conclude that producers in Peninsular Malaysia are struggle in managing the beef cattle farms.

Determinants of Technical Scale Efficiency in State Level Farms

Tobit regression conducted to discover the determinants of technical efficiency. The descriptive statistics for the data used are as follows:

Table 9.0
Descriptive Statistics of Variables for Technical Efficiency of Beef Cattle Farms

Variables (units)	Mean	Min	Max	SE
Farms TE (%)	0.6721	0.036	1.00	0.3238
Household income (RM)	29,882.92	300	500,000	39,154.34
Experiences (Years)	7.6407	1	40	6.4707

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
Online 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
Family labour	No (0)	127	38.02
	Yes(1)	207	61.98

Table 9.0 shows the variables involved in the Tobit model regression, including the selected demographic, socioeconomic, and institutional variables. The technical efficiency (TE) of the farms had a mean value of 0.6721 and a lower standard deviation of 0.3238. The data clustered around the mean and were normal. The mean of the producers' cattle farming experience was 7.6 years, with the standard deviation of 6.4707 also considered normal as the mean was greater than its standard deviation. Meanwhile, for annual household income, the data were skewed as the mean (RM 29,882.92) was lower than the standard deviation (RM 39,154.34).

The scores from the previous DEA analysis were used as the dependent variables in the Tobit regression analysis, which was conducted to determine the factors or determinants of technical (scale) efficiency, based on each beef cattle farm's technical (scale) efficiency score. The evaluation of the scores based on each state-level evaluation.
Tobit regression analysis was suitable for the regression as it is used to describe the relationship between a non-negative dependent variable (technical (scale) efficiency score) and one or independent variables (the demographic items used). Generally, the Tobit models assume a latent continuous variable, which not observed over its entire range. This can happen due to truncation or censoring. When truncation occurs, individuals on a certain range of the variable are not included in the dataset. In the data, only individuals taking values on the variable in a restricted range observed; individuals out of that range were excluded from the dataset or in fact did not exist (in this research, the efficiency score ranged from 0 to 1).

Table 10.0
Tobit Regression Analysis of the Determinants of Technical Efficiency

Variables	Coefficient	SE	Z-statistic	P
Gender	-0.03845	0.15025	-0.26	0.782
Experiences	0.00940	0.00403	2.33	0.021**
Corporate networking	0.26756	0.13230	2.02	0.044**
Financial aid	0.18198	0.11777	1.55	0.123
Association membership	0.08925	0.08005	1.11	0.266
Online networking	-0.14907	0.05959	-2.50	0.013**
Veterinary networking	0.07168	0.06921	1.04	0.301
Education	0.09806	0.05230	1.88	0.062*
Household income (Off-farm)	1.36000	7.02000	1.94	0.053*
Job in farm status	0.08830	0.05562	1.59	0.113
Type of breed	-0.04470	0.05441	-0.82	0.412
AI implementation	-0.11089	0.05417	-2.05	0.041**
Farm size	0.06435	0.10405	0.62	0.537
Farm system	-0.00700	0.05911	-0.12	0.906
Domestic labour	-0.00132	0.05284	-0.02	0.980
Constant	0.71436	0.15812	4.52	0.000
Sigma	0.03914	0.01909		
Observation summary:	0	Left-censored observation		
	238	Uncensored observation		
	96	Right-censored observation at TE >=1		

Note: ***,**,* = significance level at 1%,5%,and 10%
Table 10.0 shows the determinants affecting the TE scores of the beef cattle farms in Peninsular Malaysia. Experience, corporate networking, education, and household income had a positive impact on technical efficiency scores. Experience is an endogenous factor, as generally proven in various studies (Chamhuri et al., 2014; Qushim et al., 2018; Sugiarto et al., 2019; Ekowati et al., 2018). Meanwhile, social media networking and AI implementation had a significant and negative impact on the technical efficiency of the farms. Experience contributed positively and significantly to cattle farm efficiency. This result was consistent

with the findings of Qushim et al (2018) that producers' experience is a driver of technical efficiency in cattle farm operations.

Corporate networking significantly affects the technical efficiency of the beef cattle farms in Peninsular Malaysia. Besides this, online networking resulted in a significantly negative trend. The importance of networking for producers was explained by Cofré-Bravo et al (2019), who found that producers had different types of social capital, based on linking, bridging, and bonding ties. The motives for corporate networking positively influenced the cattle producers since this type of networking occurred for bridging and linking purposes. Through connections with corporate entities, producers gained access to financial services, extension services, technological investment, and other benefits (Cofré-Bravo et al., 2019). In the Malaysian context, weak networking among cattle farming players is a major concern (Abdullah et al., 2021).

Meanwhile, social capital or networking impacted negatively, as cited in Cofré-Bravo et al (2019), where redundant knowledge within the network might prevent the acquisition of new knowledge obtained from other social capital types (Jamison & Moock, 1984; Eklinder-frick et al., 2012; McFadyen & Cannella, 2004; Smith et al., 2012; Fisher, 2013; Tregear & Cooper, 2016). Bonding and social capital might be isolated from knowledge brokers (such as advisors and extension staff), which may lead to a lower capacity to make changes on the farm and develop an atmosphere that encourages innovation (Eklinder-frick et al., 2012; Fisher, 2013; Smith et al., 2012; Tregear & Cooper, 2016).

Education and household income are two important determinants that be drivers of fully efficient farms. Jamison and Moock (1984) supported the idea of education as a determinant of efficiency in agricultural-based organizations like farms. Regarding household income, Tipi et al (2009) did not support the results, having found that off-farm income negatively influenced technical efficiency, while Lubis et al (2014) found that off-farm income contributed to technical inefficiency.

The intention when employing AI technology is to increase the number of cattle through in-farm breeding. The results showed this had a negative impact on the farms' technical efficiency, which was contrary to its intention. The benefits of AI technology depend on the AI system. Anzar et al (2003) explained that this might have occurred as the AI industry must be improved by the management for both ; the animals and the farm, while it depends on the supply of high-quality frozen semen and the enhanced insemination skills of the AI technicians.

In Peninsular Malaysia, AI services offered to cattle breeders through exclusive payment. Besides, AI is more applicable to dairy milk farming when using imported semen because imported breeds have high lactating rates. Most beef cattle breeders used AI with their cattle just as a hobby and not for commercial purposes. Adopting innovations like AI would require a considerable commitment but could accelerate the growth of this beef sector (Abdullah et al., 2021). Moreover, producers with high education levels are more ready to accept new knowledge and practices than non-educated producers, who were not prepared to accept any changes and generally preferred to retain the traditional farming system (Abdullah et al., 2021).

Conclusions

This study concludes that less than half (only 28.78 percent) of the beef cattle farms are operate in full capacity technically. This shows the beef cattle farms in Peninsular Malaysia are still struggling to perform efficiently. Besides, six states show the smallholders as main contributors of the technically efficient farms (Kedah, Melaka , Perak , Pulau Pinang , Terengganu and Kelantan) while another three states (Negeri Sembilan, Johor and Pahang) technically efficient by depending more on commercial farms operation. The determinants of technical efficiency include experiences, corporate networking, online (offline) networking, education, household income and natural breeding technique. The strongest drivers for farms technical in Peninsular Malaysia come from offline networking amongst producers (farmers), networking with corporate entities and experience gained through the years.

From the findings, it show the smallholders' farms are still dominating the operation with full efficiency. Smallholders' farms are easily to manage as it operation in small scale with low risks of profit loss. Producers' experiences affect the farms technical efficiency as the farms operation need technical skills to operates in full capacity. Managing the farms is a hands on things that cannot be practice in a short period. On the other hands, networking amongst the producers helps them sharing the operations and managements tips even if they have a short time experiences. This is benefits for a young farmers and producers. In addition, corporates entity plays their roles in supporting the farms operation through the financial aid, marketing platforms and brands. Commercials farms have an advantages as the livestock supplier for smallholders farms, at the same time selling their own products using the corporate brands. For example, RISDA Livestock Pvt. Ltd (Malaysia) plays the role as livestock supplier and at the same time producing their owned downstream beef products under the registered name of "Chekoley". Smallholders farms gained advantages from corporate networking through the marketing and sales support where they provides financial aids like grants, knowledge transfer and the supervision of farms operations.

The government should encouraging corporate entities to involve in beef cattle farming. The smallholders' farms advice to merge or strengthen their collective action in improving the current standard of operation in beef cattle farming. Besides, innovations in beef cattle industry have to be comprehensive, accessible by most of the beef cattle producers, and gained capital support from government and non-government entities. It is suggesting that government should encourage more educated youth to involve in this industry by providing training incentive, tax reduction for agro-food producers and strong support group that linked with authority, Malaysian Department of Veterinary Services.

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