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ASSESSING THE COMPARATIVE ADVANTAGE OF INTEGRATED FARMING AND FEEDLOT PRODUCTION SYSTEM OF THE RUMINANT SECTOR IN MALAYSIA: A POLICY ANALYSIS MATRIX APPROACH

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ABSTRACT

Costly operation contributed by land availability and feed cost hurt the production capacity which has been demonstrated by Malaysia's low self-sufficiently level. The objective of this study is to investigate the competitiveness and efficiency of ruminant farms in Malaysia based on its production system particularly on the aspect of cost rationalization of feed. A total of 29 cattle farms operated under the scheme of Permanent Food Production Park have been surveyed and analysed based on the Policy Analysis Matrix (PAM) approach. The analysis reveals that the integrated farms were more competitive and efficient as compared to feedlot farms indicated by the ratio value of Domestic Resource Cost and Social Profitability.

Contribution/ Originality

The findings will provide empirical-based evidence to convince the stakeholders on the importance of having a production system that suits the strength and weaknesses. Domestic production has the potential to be improved if the appropriate production system is adopted. Integrated farming will not only increase Malaysia's self-sufficiency level and correcting the trade deficit but it will also determine whether the sector will become privately and socially profitable or not.

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1. INTRODUCTION

Malaysia's self-sufficiency level for ruminant meat has never exceeded 30 percent for the past 20 years despite numerous intervention programs initiated by the government to boost the production. The inability to improve the self-sufficiency level has pushed Malaysia to opt for import as a measure to improve the supply and availability in the domestic market. The deepening reliance on the international market has resulted in a high import bill of agro-food which has reached USD4.74 in 2018 where ruminant meat together with feed was amongst the major contributors. The deficit is expected to remain the status quo as the conditions needed for the betterment of domestic production have yet to be improved (Sahar and Chamhuri, 2016). Weakened ringgit and shrinking export market for Malaysia's main commodities have further worsened the situation.

The Economic Planning Unit (2015) has suggested that the major challenges faced by the ruminant sector in Malaysia are rooted from the prohibitive cost of feeder and feed. The high cost of the feeder is due to Malaysia's strong dependence on the imported feeder as the domestic activity of breeding is still at its infancy stage. Breeding in Malaysia is largely conducted on a small scale basis with limited involvement from the private sector. It is concentrated amongst a few government-linked companies (GLCs) as part of their business diversification strategies and some selected smallholders whose farms are still far from achieving economies of scale (Ariff *et al.*, 2015).

Dependency on the international market for the supply means that Malaysia has to compete with the other importing countries, which in some cases, are in a better position to secure the supply. It is contributed by the fact that Malaysia's competitors have better purchasing power aided by their economic clouts and favorable bilateral trade arrangements such as long term supply contracts. Stiff competition has contributed to the situation where supply is not paralleled with the surge in demand and this has served as a push factor for the price to trend upward globally (Shahudin *et al.*, 2018).

The situation is almost replicated in the case of feeding. Malaysia is not a grain producer and has to rely on the international market in getting the supply. This reliance has exposed Malaysia to the vagaries of international trade apart from shouldering the ballooning import bill. Grain needed in feed production is also demanded as an important input in food production triggering the worldwide dilemma of 'food versus feed' (Mottet *et al.*, 2017). It has been reported that 6 to 20kg of feed grains are required to produce a kilogram of beef (Muir *et al.*, 2010). The competition for grain has become more intense due to technology advancement in converting grains to biofuel that could power not only land vehicles but also aircraft. Competition in getting the supply by the three sectors and the fact that production is concentrated amongst the limited number of producers has caused the price to increase (Zhong and Zhu, 2017). This trend has posed a serious issue to Malaysia since smallholders are the prominent players in the ruminant sector and their financial capability could not absorb the consistent pattern of the high cost of feed.

In this regard, it is important to note that the materialization of the National Agro-food Policy (NAP) objective to achieve 30 percent self-sufficiency levels for ruminant meat is subject to how Malaysia would be the response to the issues. Therefore, the objective of this study is to investigate the capability of integrated farming as one of the ruminant production systems in rationalizing the operational cost. Various studies have highlighted the ability to integrate farming to address the mentioned issues. Lemaire *et al*. (2014), Serin *et al*. (2008) and Galnaitytė (2017) have categorized the benefits of integrated farming into two main categories - economic and environmental. Empirical evidence has indicated that integrated farming is proven to be effective in rationalizing the operational cost (Yu and Sun, 2016) apart from being biologically symbiotic (Alberto *et al.*, 2013). Integrated farming could be understood as a farming method that is kinder to the environment and has the characteristics of both conventional and organic farming (Vlahos *et al.*, 2017). The method of integrated farming is not confined to a particular country or region as it has been extensively practiced all over the world integrating varieties of crops with various kinds of suitable livestock.

The dairy farmers of East Java in Indonesia have integrated their livestock with horticultural as a means to increase the farmers' household income as well as preserving a sustainable environment (Osak and Hartono, 2016). In India, integrated farming has been encouraged by the government as a tool for income expansion, especially for the small and marginal farmers. It is practiced based on the principles of input complementarity and minimum input utilization to reduce the operational cost as to increase yields and profits (Goverdhan *et al.*, 2018). Ismail and Abdul (2014) investigate the comparative advantage of Malaysia ruminant production found that economies of scale are an important prerequisite for the sector to achieve the comparative advantage.

2. MATERIALS AND METHODS

Policy Analysis Matric (PAM) has become a chosen method in examining the competitiveness and efficiency of an agricultural system and policy. The ability of PAM to gauge the influence of public policies vis a vis the performance of the economy has made PAM a preferred method. PAM provides connectivity between the profitability of each component of production and the production as a whole and this has allowed PAM to identify the most efficient and the weakest links in a production chain (Dos and Padula, 2017). Those efficient and weak links are identified through the indicators of competitiveness, comparative advantage, and market failure produced by the PAM analysis. This would allow for further identification of domestic and international market distortion policies practiced by certain agro-commodities sector (Liefert and Westcott, 2015). As such, PAM has been recognized and accepted by both scholars and policymakers in investigating competitiveness and comparative advantage as well as input in the formulation of agro-policies.

In general, PAM framework is about the two identities of the basic accounting principle combined with the divergence (Table1). The three columns of PAM are meant for revenue, cost, and also profits respectively. The column for the cost is further divided into two subcomponents-tradable inputs and domestic factors/non-tradable inputs. In the context of PAM, there are two types of input needed in agricultural production. Those inputs are known as tradable inputs as well as non-tradable inputs. Tradable inputs are inputs that have the components of cross-border transactions particularly import and export. Those inputs could be 100 percent from the international market or only a certain percentage of its components are sourced internationally. Prices of tradable input are dictated by the demand and supply of international trade. General tradable inputs involved in the production of ruminants include fuel, feed and medicine, vaccines, and supplements (MVS). The non-tradable inputs which are also known as domestic factors include input that is not traded internationally such as labour and land and its prices are determined by the factors within the domestic market.

The first row of the PAM matrix reflects the private profitability based on actual transactions that refer to the actual prices received and paid by the farmers. It is calculated as revenue (A) minus total costs of tradable and domestic (B+C) where, B and C are tradable and domestic costs, respectively. Private profitability captures the competitiveness of the ruminant production system based on the present technologies, prices of input, output values, and policy transfer. The second row indicates social profitability which is measured using the shadow prices to reflect social opportunity cost. Social profitability is derived from the calculation of revenue values at social prices (E) minus tradable and domestic costs (F+G) which are also valued at social prices. Social profitability is a signal for efficiency and comparative advantage. It is an indication of whether scarce resources have been efficiently managed or not whether. The efficient utilization of resources will cause the production at a social cost to be lower than the cost of importing resulting in the positive value of social profitability.

The third and the last row shows the existence of policy transfer or divergence resulted from distorting policies and market failure. It is derived from the difference between observed parameters and parameters that would exist if the divergences were removed. In the ideal situation where the market is free from any market distortions, the two would be the same. The presence of market failures and distortions has caused the observed and shadow parameters to diverge from one another. The PAM matrix is developed to determine policy indicators for policy analysis. As for this study, 3 policy indicators have been used as a basis for policy analysis;

i. Domestic resource cost (DRC)- G/ (E-F)
A DRC value between zero and less than one implies that commodity has a comparative advantage while the value above one suggests that domestic production is not socially profitable due to inefficient utilization of resources as compared to import.

ii. Nominal protection coefficient of output (NPCO) – A/E
Protection on domestic output is detected if the value of NPCO is greater than one and vice versa if the ratio is less than one.

iii. Nominal protection coefficient of input (NPCI) –B/F
NPCI is expressed as B/F (the ratio of the value of tradable inputs at local market prices or private prices to value tradable inputs at world market prices or social prices).

Table 1: Policy analysis matrix: measurement

	Revenue	Cost		Profitability
		Tradable Inputs	Non-tradable Inputs	
Private Price	A	B	C	D = A - (B+C)
Social Price	E	F	G	H = E - (F+G)
Divergence	I = A - E	J = B - F	K = C - G	L = I - (J+K) = D - H

2.1. Data
This study used both secondary and primary data. The secondary data were largely sourced from the Department of Veterinary Services (DVS), Department of Statistics (DOS), Ministry of Agriculture and Agro-Based Industry (MOA), Economic Planning Unit (EPU) and Ministry of Finance (MOF). The secondary data were used to develop an understanding of the sector as well as formulating the research issues. The main data for this study came from the primary data.

A total of 29 cattle farms located in Johor, Pahang, Terengganu, Negeri Sembilan, Selangor, Kedah, and Kelantan operated under the scheme of Permanent Food Production Park (TKPR) have been surveyed using a structured questionnaire. The highest number of farms comes from Johor and Negeri Sembilan with a total of 9 farms for each state followed by Terengganu with 4 farms. Kedah and Selangor have two farms each while 1 farm each from Kelantan, Perak, and Pahang. 10 months have been spent to complete the overall process of the survey which was started on 12 December 2018 until 15 October 2019. Data collected from the survey were entirely on the aspect of production and its related issues. Amongst the issues covered by the survey include the quantity of farm production inputs and outputs, cost of the operation, size of the farm, prices paid and received by the farmers, production method, revenue, profits, and ruminant inventory information. 2017 was used as a reference year for the data collection. In other words, the collected data is the production data of 2017. Each farm was classified into two categories based on its production method- integrated and feedlot.

3. RESULTS AND DISCUSSION

In a total of 29 farms, there were 9 integrated farms and 20 feedlot farms. 8 integrated farms were categorized as commercial farms based on the size of the cattle population which is greater than 250 head (Table 2). The remaining integrated farm was the sole representative for a medium farm where the number of cattle categorized under this category ranging from 50 to 250 head. As for the feedlot farms, the majority of the farms under this production system were the medium farms - 17 out of 20 farms. The other three were the commercial feedlot farms (Table 3).

Table 2: Classification of farms

Commodity	Farm Size	Population
	Commercial	> 250 heads/year
Cattle	Medium	50 – 250 heads/year
	Small	< 50 heads/year

Source: Department of Veterinary Services (DVS), 2005

Table 3: Number of farms according to classification

Production System	Farm Classification	
	Medium	Commercial
Integrated	1 farm	8 farms
Feedlot	17 farms	3 farms

Source: Author calculation based on data collection 2017

The classification was to assist the comparison process to determine its specific characteristics of production especially in the utilization of resources which will influence the overall operating cost, revenue as well as profit. The selection of those farms was based on purposive samplings or authoritative sampling where knowledge of the Department of Veterinary Services Malaysia was utilized in determining the representative sample. The secondary data obtained from different sources, including the DVS, the Department of Statistics, Ministry of Agriculture and also Ministry of Finance (MOF). Secondary data were useful in determining the information related to FOB prices, the shadow exchange rate, international trade of ruminant and other relevant data.

The cost-related data compiled from the survey are totally in private value. The calculation of PAM indicators requires the cost related data to be converted into social values. The conversion from private value to social value is done based on the value of conversion factors (CF) as mentioned by Veitch (1986) (Table 4). The estimation by CF required all the production input to be categorized under two types of input namely immediate and primary input. The immediate input involved the following: feeds, livestock purchased, maintenance, utility MVS (medicine, vaccines, and supplements), fuel, repair and office supplies. The primary input included labor, land rent, interest, and depreciation. Other items included taxes, licenses, and losses (Table 5).

Table 4: Conversion factors from financial to economic analysis

Input	Conversion factor
Intermediate input	
Feed	0.95
MVS	0.88

Livestock Purchase	0.95
Fuel	0.88
Repairs & Maintenance	0.78
Water	0.75
Electricity	0.84
Office Supplies	0.90
Primary input	
Labor	0.82
Depreciation	
Building Equipment Transportation	0.86
Interest	0.90
	0.70
Land rent	1.00
Tax	0.00
Licence	0.00
Losses	1.00

Source: Veitch, 1986

Table 5: Allocation of costs between domestic and foreign component

Input	Foreign/ Tradable (%)	Domestic/ Non-Tradable (%)
INTERMEDIATE INPUT		
Feed		
Beef	90	10
Goat	80	20
MVS	80	20
Repairs & Maintenance	0	100
Water	10	90
Electricity	10	90
Fuel	50	50
Livestock Purchase		
Beef	50	50
Goat	50	50
Office Supplies	0	100
Tax	0	100
Land rent	0	100
License	0	100
PRIMARY INPUT		
Labor	0	100
Depreciation		
Building	0	100
Equipment	0	100
Transportation	33	67
Interest	5	95
LOSSES	0	100

Source: Veitch, 1986

3.1. Analysis of comparative advantage

The analysis is meant to gauge the level of efficiency in the utilization of domestic resources is whether it gains or save foreign exchange. In this regard, domestic resource cost (DRC) has been used to estimate the comparative advantage of Malaysia's ruminant sector according to the production method. Comparative advantage is closely associated with the efficient utilization of domestic resources. The DRC is used as an indicator of whether the ruminant sector in Malaysia has efficiently utilized the domestic input and resources in producing the output. The measurement is based on the fact that resources used in the production manage to save or earn one unit of foreign exchange. The indication of comparative advantage is from the value of the Domestic Resource Cost (DRC). If DRC is less than one and greater than zero it indicates that ruminant production has a comparative advantage because the value of domestic resources used in production is less than the value of foreign exchange saved. If DRC is greater than one it indicates that ruminant production has a comparative disadvantage because the value of domestic resources used in production is greater than the value of foreign exchange saved (Dos and Padula, 2017).

Table 6: Results from policy analysis matrix

Type of Farm	Average Domestic Resource Cost	Average Social Profitability	Average Nominal Protection Coefficient of Output	Average Nominal Protection Coefficient of Input
Feedlot	1.32	1.18	1.40	1.10
Integrated	0.31	0.40	1.43	1.06

Note: Author's calculation

Based on the findings provided in Table 6, it is obvious that integrated farms have a comparative advantage as compared to the feedlot farms. Integrated farms have a comparative advantage with the average DRC ratio of 0.31. On the other hand, feedlot farms have a comparative disadvantage indicated by the average DRC ratio of 1.32. The values of DRC calculated from the integrated farm show that the value of domestic resources utilized by the integrated farm is lower than the value of the output produced. The comparative advantage enjoyed by the integrated farm is partly contributed by the fact that this farm has a low dependency on tradable or imported inputs (Goverdhan *et al*., 2018). Its inputs are largely sourced from non-tradable ones or domestic. This is proven based on the calculation which has clearly shown the bigger amount of domestic input compared to the tradable input for both private and social prices. Dependency on domestic input has made the farms free from the risk of price fluctuations caused by currency depreciation.

It is quite normal for the integrated farm to practice a mixed production system that combined the managed grazing in oil palm plantation (integrated farming) and feedlot. The mixed production system has allowed the farm to have a relatively short duration of feedlot period which was around 30 to 45 days where the commercial practice of feedlot is between 3 months to 6 months. Shorter feedlot duration means a lesser feed cost borne by the farmer. Feedlot for integrated farming was just a 'finishing stage' to achieve the targeted market weight. The early stage of the cattle was largely spent in the oil palm plantation where cattle were allowed to graze the vegetative available in oil palm plantation based on managed grazing where grazing plot was controlled by a portable electric fence. Some scientific journals have also highlighted that the nutrients content of those vegetative in oil palm plantation was, in fact, comparable with commercially farmed grass.

Most of the integrated farms also have their breeding program and this has reduced the cost of getting the feeder since the feeders were not bought but come from its breeding program (Ayob and Kabul, 2009). This was quite essential in reducing the overall operational cost. The situation is contributed by the fact that the owners of these farms are largely well-established operators. *Aqil Berjaya* Enterprise, for instance, has been recognized by the DVS as an expert and reference point for integrated farming and cattle breeding specializing in Brahman breed. RISDA Livestock which was formerly known as ESPEK Livestock Sdn Bhd has been involved in the ruminant sector since

1996 and currently has 12 integrated farms throughout peninsular Malaysia with some of its farms are solely focussed on breeding activities.

The situation of non-comparative advantage amongst the feedlot is majorly rooted in the high operating cost. Studies have shown that feed contributes almost 60-70 percent of the total operating cost for the feedlot farms. The cost of feed which should be kept at the maximum level of RM3 per head per day (but also depend on other factors as well) could sometimes shoot up due to supply disruption. Palm Kernel Cake (PKC) or Palm Kernel Expellant (PKE) which is extensively used in the mixed ration for ruminant is highly involved in cross-border trade and highly exposed to the price fluctuation. In this regard, as an alternative, instead of using PKC in the mixed ration, feedlot farms should be encouraged to switch to a cheaper source of feed such as palm oil mill effluent (POME) or popularly known as decanter cake which could be purchased at RM200 to RM300 per ton compared to RM450 to RM 550 for PKC. Even though the crude protein (CP) of decanter cake is lower than PKC, but when combined with roughage such as Napier, that mixed ration could achieve the required 14 percent of CP needed by the ruminant.

3.2. Analysis of protection

Nominal Protection Coefficient of Output (NPCO) and Nominal Protection Coefficient of Input (NPCI) are the indicators of PAM used to measure the level of policy distortion in a particular agriculture system. The presence of policy distortion has caused the domestic prices to diverge from the social prices which could be detected from the ratio value of NPCO and NPCI. In the case of NPCO, if its ratio value exceeds one, the domestic prices are higher than the import or export price. This is an indication to show that the domestic market is protected by the government. On the other hand, the ratio value of less than one shows that the domestic prices are lower than the import or export price reflecting that the domestic market is free from any protection.

The NPCO for both types of farms –integrated and feedlot exceed one reflecting that the domestic output prices are higher than the world price. The NPCO ratio value of 1.439 for integrated farms and 1.773 for feedlot farms represents the fact that the policy interventions by the government have resulted in higher domestic output prices of the ruminant sector as compared to the world price by approximately 43.9 percent and 77.3 percent respectively. This could be interpreted as a transfer of 43.9 percent and 77.3 percent gains from the local consumers to the producers. The gains could be transferred from consumers due to the tax imposed while producers receive protection in the form of subsidy – transfer of gains from one actor to another actor resulted from government policy.

The impact of policy interventions, as well as market failure on the input of production, could be traced from the ratio value of the nominal protection coefficient on input (NPCI). Intervention policies on production inputs exist in the form of subsidies and taxes. NPCI is an indicator to indicate the level of divergence experienced by the domestic prices of tradable input as compared to social prices. NPCI is interpreted based on its ratio value. If the ratio value of NPCI is greater than one, the cost of production input domestically is higher than the cost of input at the world prices. The high price of domestic input is caused by the tax policy imposed by the government. On the other hand, the subsidization of production inputs will reduce the prices of production inputs domestically which makes it cheaper than the international prices. This is shown by the ratio value of NPCI where the value is less than one.

The analysis of PAM has indicated that NPCI for Malaysia's ruminant for both integrated and feedlot farms are all exceeding one. The values ranging from 1.056 to 1.071. It is a sign that prices for the production input in Malaysia are higher as compared to the prices in the international market. In getting the inputs for their production, ruminant producers in Malaysia are paying 5.6 to 7.1 percent higher than the prices in the international market. They have been taxed at 5.6 to 7.1 percent per unit of tradable input. This could be understood from the fact that input needed in ruminant production was subject to the consumption tax and GST which were imposed at the rate of 6 percent. Apart from GST, there were various processing fees, import permits and approval involved in the importation of feed, medicine, vaccine and supplements (MVS) as well as feeder animals – the important prerequisite in the production of a ruminant. Those production inputs have a high degree of foreign/imported components. Feed which contributes to almost 70-80 percent of the overall ruminant production cost contains around 90 percent foreign components. Foreign components of MVS could reach up to 80 percent and it is 50 percent foreign components for livestock feeder. The dependency on foreign components has made them susceptible to external shocks such as currency fluctuation, price hike and uncertainties of supply.

Some of the foreign components contained in the input are subject to import taxes by the government of Malaysia. For instance, rice for use in feed production is subject to a 15 percent import duty. Although there are no taxes imposed on the importation of soybean and corn meant for feed, it is still subjected to import approvals from both the Department of Veterinary Services (DVS) and the Department of Agriculture (Saidin *et al.*, 2018). Under the Feed Law, importers are required to apply for an import license from the DVS. The import license required the importers to provide a Certificate of Origin; Certified composition by a competent agency of the exporting country; relevant packaging, manufacturing and labeling requirement; and import registration. In addition to the feed law, corn imports are subject to the Agriculture Quarantine Law, which requires registration with the Department of Agriculture for an import license and a Phytosanitary Certificate for every consignment.

Effective Protection Coefficient (EPC) is a parameter of PAM that is used to gauge the overall results produced by the intervention policies in both input and output markets. The greater than one value of EPC demonstrates that the intervention policies introduced by the government have led to positive incentives to the producers. It could be said that a supportive environment has been created through the intervention policies. On the other hand, less than one value of EPC shows that policy interventions do not provide any incentive or protection to the producers. The calculated PAM of the ruminant farms has produced the EPC values of greater than one for both integrated and feedlot farms. The EPC for integrated farms is 1.464 while the feedlot farms have generated EPC values of 1.640. Those values have reflected the positive effects of government intervention in implying that government policies provide positive incentives to the producers.

Table 7: Sensitivity analysis

Production System	Sensitivity Analysis	DRC	SCB
All	Normal	0.57	0.68
	Increased feed 50%	0.60	0.71
	Increased feeder 20%	0.64	0.75
	Increased feed 50% + Increased feeder 20%	0.68	0.78
Integrated	Normal	0.31	0.40
	Increased feeder 20%	0.32	0.42
	Increased feeder 20%	0.34	0.44
	Increased feed 50% + Increased feeder 20%	0.35	0.46
Feedlot	Normal	1.32	1.18
	Decreased feed 50%	1.17	1.11
	Decreased feeder 20%	1.10	1.06
	Decreased 50% + Decreased feeder 20%	0.98	0.99

It is important to acknowledge that parameter assumptions and values in any economic model are dynamic and not insulated from change and error (Pannell, 1997). Since the ruminant sector in Malaysia is highly exposed to various factors that have the potential to influence its comparative advantage level, sensitivity analysis has been conducted to ascertain the impact of changes in key variables. In this regard, sensitivity analysis is widely utilized as a tool in determining the effect of changes in input to the outcome of the outputs which reflect the level of dependency that the outputs have the input. This would help the decision-makers to understand the riskiness of a strategy which allows them to make informed and appropriate decisions.

The cost of the ruminant production system in Malaysia is largely dictated by the cost of feed and feeder. In the case of this study, the input cost has been increased as part of its sensitivity analysis to gauge its effects on the level of comparative advantage of the ruminant production system. The analysis is conducted by increasing the input cost of feed by 50 percent and feeder cattle by 20 percent for the integrated production system as well as decreasing the input cost of feed by 50 percent and feeder cattle by 20 percent for the feedlot production system (Table 7).
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The production system of integrated has shown to possess the comparative advantage even in the situation where the cost of feed is increased by 50 percent and the cost of the feeder by 20 percent. Its comparative advantage has also not been adversely affected in the situation where both the cost of feed and feeder be jointly increased at the same time by 50 percent and 20 percent respectively. The feedlot production system does not have a comparative advantage, so the sensitivity analysis is done by lowering input costs- the feed and feeder cost. The results of sensitivity analysis have shown that the individual cost reduction of either feed or feeder of the percentage of 50 percent and 20 respectively will not be able to improve its comparative advantage level. The efficiency of the feedlot production system can be improved to nearly achieve comparative advantage only if the cost for both feed and feeder be reduced in tandem by 50 and 20 percent respectively.

4. CONCLUSION

This study applied the Policy Analysis Matric (PAM) in the ruminant sector in Malaysia. The results showed that the comparative advantage of the ruminant sector could be achieved dependent on the chosen production system. Malaysia had a comparative advantage in the production of ruminants if integrated farming is adopted as the main production system. This has been proven based on the calculated domestic resource cost of PAM. It is because the major contributing factor in determining the comparative advantage is the operational cost. The rationalization of operational cost where feed is the biggest component is crucial not only in increasing competitiveness (at the private prices) but also in the efficiency level (at the social prices). The integrated farm has the potential to reduce the feed cost through the utilization of natural resources which is available at a minimum cost. What is more important is its ability to minimize the use of imported feed. It is important to note that almost 80 to 90 percent of commercial feed consists of imported components. The externalities associated with imports have caused the sector to be exposed to various risks associated with currency exchange, shortage of supply, and stiff competition from other importers/sectors. In this regard, it is also important to note that the call for the sector to embrace integrated farming does not mean that we are going to abandon the feedlot production system. Feedlot should only be meant for the finishing stage and the duration for feedlot should be kept as short as possible to reduce the feed cost.

As a recommendation, there must be concerted efforts amongst all the stakeholders involved in the ruminant sector. Integrated farming needs to be aggressively promoted as a means to achieve the targeted Self Sufficiency Level (SSL). There must be a mechanism that could be taken in the form of joint action between the Ministry of Agriculture and Agro-based Industries, Ministry of Primary Industries and Ministry of Economic Affairs to further institutionalize the participation of government-linked companies and big plantation companies in integrated farming. Their involvement is crucial because almost 70 percent of agricultural land uses is monopolized by an oil palm plantation. Moreover, 60 percent of total oil palm plantation is suitable for integrated farming due to its topography and almost 70 percent of herbage available in oil palm plantation is nutritionally beneficial to the ruminant. On the issue of feed, a quota system should be considered to allocate a certain percentage of Palm Kernel Cake (PKC) production to be maintained in the country for the use of the ruminant sector. Currently, producers of PKC have a strong preference for the export market encouraged by strong demand and attractive prices. Various financial and non-financial incentives can be considered for wiling companies to further stimulate their involvement. On top of that, research and efforts to expand the pool of local resources that can be utilized as feed need to be seriously undertaken by our research institutions. Crops like sorghum, barley, coconut, and tapioca which are suitable for the weather conditions of Malaysia can be further researched and developed to become our source of feed. The utilization of local resources will enable the industry to reduce its dependency on foreign-based feed. This will ultimately reduce the operation cost since feed is the most expensive component of the overall production components. Home-grown feed development needs to be complemented with home-grown breeding activities. Breeding is a long term solution to increase the ruminant population in Malaysia since the importation of live animals from a limited source of countries particularly Thailand and Australia is getting costlier. The focus should be given to the breeds that have a high adaptation level with local conditions. Getting the feeder ruminant sourced locally will further strengthen the financial sustainability of feedlot farms that have been associated with operational cost issues.

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References

Alberto, C., Oliveira, O. De, Bremm, C., Anghinoni, I., Moraes, A. De, Kunrath, T. R., Carvalho, D. F. (2013). Comparison of an integrated crop-livestock system with soybean only: Economic and production responses in southern Brazil. *Renewable Agriculture and Food Systems*, *29*(3), 230-238. doi.org/10.1017/s1742170513000410.

Ariff, O. M., Sharifah, N. Y., & Hafidz, A. (2015). Status of beef industry of Malaysia. *Malaysian Society of Animal Production*, *18*(December), 1–21.

Ayob, M. A., & Hj Kabul, M. A. (2009). *Cattle integration in oil palm plantation through systematic management*. 1st International Seminar on Animal Industry, 2007(November), 66–74.

Dos, S. A. C. E., Belarmino, L. C., & Padula, A. D. (2017). Feedstock diversification for biodiesel production in Brazil: Using the Policy Analysis Matrix (PAM) to evaluate the impact of the PNPB and the economic competitiveness of alternative oilseeds. *Energy Policy*, *109*, 297-309. doi.org/10.1016/j.enpol.2017.07.009.

Economic Planning Unit. (2015). *Strengthening infrastructure to support economic expansion. rancangan malaysia kesebelas (Eleventh Malaysia Plan):* 2016-2020.

Galnaitytė, A. (2017). Evaluation of technological, economic and social indicators of different farming practices in Lithuania. *Economics and Sociology*, *10*(4), 189–202.

Goverdhan, M., Latheef, P. M., Sridevi, S., & Pragathi, K. C. (2018). Integrated farming approaches for doubling the income of small and marginal farmers. *Bulletin of the Indian Society of Soil Science, 7*(32), 68-88. doi.org/10.20546/ijcmas.2018.703.387.

Ismail, D., & Abdul, W. K. (2014). Sustainability of cattle-crop plantations integrated production systems in Malaysia. *International Journal of Development and Sustainability*, *3*(2), 252–260.

Lemaire, G., Franzluebbers, A., Carvalho, P. C. de F., & Dedieu, B. (2014). Integrated crop-livestock systems: Strategies to achieve synergy between agricultural production and environmental quality. *Agriculture*, *Ecosystems and Environment*, *190*, 4-8.

Liefert, W. M., & Westcott, P. C. (2015). *Alternative policies to agricultural export taxes that are less market distorting*. ERR-187, U.S. Department of Agriculture, Economic Research Service, June 2015.

Mottet, A., de Haan, C., Falcucci, A., Tempio, G., Opio, C., & Gerber, P. (2017). Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. *Global Food Security*, *14*(August), 1–8.

Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M., & Toulmin, C. (2010). Food Security : The Challenge of Feeding 9 Billion People. *Science*, *327*(February), 812–819.

Osak, R. E. M., & Hartono, B. (2016). Sustainability Status Assessment (SAA) in the integrated farming system of dairy-cattle and horticultural-crops in Indonesia. *International Journal of ChemTech Research*, *9*(8), 575–582.

Pannell, D. J. (1997). Sensitivity analysis of normative economic models: Theoretical framework and practical strategies. *Agricultural Economics*, *16*(2), 139–152. doi.org/10.1111/j.1574-0862.1997.tb00449.x.

Sahar, N., & Chamhuri, N. (2016). Agricultural policies effect on livestock industry - perspectives from Malaysia and New Zealand. *International Journal of Agriculture, Forestry and Plantation*, *2*, 77–83.

Saidin, N., Rahman, F. A., & Abdullah, N. (2018). A critical analysis of the legal framework on animal feed in Malaysia: with special reference to the Feed Act 2009. *International Journal of Engineering & Technology*, *7*(2.10), 21-25. doi.org/10.14419/ijet.v7i2.10.10947.

Serin, T., Radam, A., Shamsudin, M. N., & Mohamed, Z. (2008). The efficiency of beef cattle production : A case study in the target area of concentration in Johor. *Malaysia. Economic and Technology Management Review*, *3*, 57–74.

Shahudin, M. S., Ghani, A. A. A., Zamri-Saad, M., Zuki, A. B., Abdullah, F. F. J., Wahid, H., & Hassim, H. A. (2018). The necessity of a herd health management programme for dairy goat farms in Malaysia. *Pertanika Journal of Tropical Agricultural Science*, *41*(1), 1–18.

Vlahos, G., Karanikolas, P., & Koutsouris, A. (2017). Integrated farming in Greece : A transition-to- sustainability perspective. *International Journal Agricultural Resources, Governance and Ecology*, *13*(1), 43–59. doi.org/10.1504/ijarge.2017.084033.

Yu, Y., Feng, K., Hubacek, K., & Sun, L. (2016). Global implications of China’s future food. *Journal of Industrial Ecology*, *20*(3), 593-602.

Zhong, F., & Zhu, J. (2017). Food security in China from a global perspective. *Choices*, *32*(2), 1–5.