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Challenges faced by beef cattle farmers in innovation adoption towards food security and sustainability: a narrative review

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Abstract

The agricultural industry in Malaysia remains a vital element in providing food and employment. Introducing innovation in beef cattle farming has brought new changes in the livestock sector. Hopefully, it can generate a high income among farmers and brighten the Malaysian economy. However, introducing innovations such as assisted reproduction technology, biosecurity and intensive rearing require more significant effort from all parties, including farmers, extension agents and the government. This paper aims to identify beef cattle farmers' challenges in adopting innovations to improve beef production. Process of identifying, screening and eligibility is essential in producing an extensive literature review paper. From these processes, nine articles were found as the most relevant for this review article. The financial problem, communication failure and inaccessible information were the main challenges faced by farmers and extension agents in implementing innovations. Nevertheless, cooperation from all parties can lead to an excellent distribution of knowledge and skills among farmers.

1. INTRODUCTION

The agricultural industry, consisting of livestock, crops, and fisheries, is the backbone of a country, supplying food to the population and providing employment. Beef cattle farming is part of the livestock sector, an essential protein source for humankind instead of poultry meat and fish. In Malaysia, the production of cattle in the year 2019 declined from 46,923.6 to 45,352.7 tonnes in 2018 (Department of Statistics Malaysia, 2020). This number has shown the discouraging growth of beef production, threatening food security in Malaysia. Meanwhile, the Self-Sufficiency Ratio (SSR) for beef in 2020 was only 22.2% compared to pork and poultry meat with 94.9% and 98.2%, respectively. This situation must be paid more attention to, and it must continuously grow to meet the nation's demand as well as job security for the younger generation (Sazila *et al.*, 2018).

On the other hand, the import dependency ratio is getting higher with 78.1% in 2020 compared to 76.6% in 2019. This number has shown that the imported beef from other countries such as India and Australia will still be high to ensure that it meets the need of the consumers. Price competition between local and imported beef is also becoming one of the main challenges due to the price of imported beef is much lower than that of local beef. This issue has threatened beef cattle farming activity in Malaysia as the customers will tend to buy the imported beef as the purchasing power is theirs. The regular price of local beef ranges from RM 30 to RM 35, while the price for imported beef is only between RM 15 to RM 18. There is a big gap in price between the local and imported beef.

In Malaysia, the Department of Veterinary Services (DVS) under the Ministry of Agriculture and Food Industries is responsible for managing and monitoring Malaysia's ruminant industry, disease control, animal welfare and transferring knowledge as well skills to the farmers. Meanwhile, the Malaysian Agricultural Research and Development Institute (MARDI) is another government agency focusing on research and development (R & D). This agency has conducted various researches on the improved breed of local cattle, the nutritious feed for ruminants and the economic impact. The role of these two agencies is vital to enhance the sustainability and food security in Malaysia by giving extra attention to the farm's infrastructure and increasing the economic activity among small-scale farmers (Abdulla *et al.*, 2016).

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This paper aims to identify the challenges faced by beef cattle farmers in adopting innovations to improve beef production. The respective agencies, including the Department of Veterinary Services (DVS) and the Malaysian Agricultural Research and Development Institute (MARDI) have played their role in sustaining the productivity of beef cattle by researching the current innovations and transferring the skills to beef cattle farmers. The extension agents of each party are the leading players in distributing the current practice and skills.

2. INNOVATION IN BEEF CATTLE FARMING

Assisted reproduction technology, improved forages, converting crop residue as feed, and implementing biosecurity are typical examples of innovations in beef cattle farming. Abdullah *et al* (2020) mentioned that adopting innovation in cattle farming is valuable and will bring more profit if used correctly. As noted, innovation, including technology, has also brought changes among farmers to smoothen the processing activity at the farm (Mohamad Termezai et al., 2017).

2.1. Assisted reproduction technology

Artificial insemination (AI) is categorised as an assisted reproduction technology (ART) (Paramio & Izquierdo, 2014). This technique manually injects bull semen into the cow's uterus without the natural mating tools to obtain rapid livestock genetic improvement and production (Yimer *et al.,* 2015). In Malaysia, the responsible agencies, including DVS and MARDI, also helped farmers deliver AI services. This technique has a vital role in ruminants' breeding, especially in an intensive rearing system whereby to control their reproduction with accurate progeny testing to improve the production of milk, hair and meat. Instead of AI, multiovulation and embryo transfer (MOET), in vitro embryo production (IVEP) and embryo cryopreservation were also used to increase the reproductive efficiency of ruminants, improve genetic material, and preserve genetic material for possible use in the future.

A study found that distance to the extension centre showed a significant influence with a negative coefficient towards partially and fully adopting AI (Rathod *et al.,* 2017). This finding indicated that the longer distance from the farm to the extension centre causes the farmers to be away from ART due to the difficulty of getting close monitoring from the extension agents on the advanced breeding techniques. Certain farmers do not afford to adopt AI due to several socioeconomic factors, notably among low-income farmers (Rathod *et al.,* 2017). Research has noted that ART, especially AI, has been widely practised among cattle farmers around the globe. It is believed to improve beef production and produce high-quality meat for the nation's food security.

2.2. Forage technology

Napier, also known as elephant grass (*Pennisetum purpureum*) was first introduced from East Africa to Malaysia in the 1920s and currently has become the most popular feed source for livestock, especially ruminants (Halim *et al.,* 2013). Several varieties of Napier grass, such as Pakchong, Indian Napier, Taiwan Napier, Red Napier, Dwarf Napier, Australian Napier and Zanzibar Napier, are used mainly by the farmers in Malaysia (Zakaria, 2019). Napier has not only been acknowledged as a promising high-yield grass but also has high nutritional value. Scientists have developed this crop worldwide to suit the local conditions, a wide range of habits, yield potential and nutritional value. Besides, Napier grass has become farmers' choice as it is a fast-growing crop with immense annual productivity which also depends on climatic and soil conditions (Haryani *et al.,* 2018). In 2017, Pahang, Johor and Negeri Sembilan became the top states producing Napier grass (Zakaria, 2019). The selection of the most suitable Napier varieties is essential for the farmers as they must consider the protein content, digestion process and productivity of the ruminant before the feeding process. Napier grass has become the feed substitution for ruminants due to the limitation of the grazing area and the spike up of pallet prices (Zakaria, 2019).

2.3. Feed technology

Feed technology is also an emerging innovation in beef cattle farming. The limited source of native pastures has changed the feed supply for ruminants. Rice and corn straw have become an alternative feed source among beef cattle farmers (Baba *et al.,* 2019). Some farmers have made silage from the slices of Napier. This method can be the primary feed source during drought and flood seasons. In Malaysia, Kelantan and Terengganu are the states that receive a high amount of rain from November to December. Hence, the conversion of Napier into silage could help farmers to provide food for the ruminants. The procedure of making silage involves fermenting the Napier grass with the addition of effective microorganisms (EM) or molasses for 21 to 28 days before use. MARDI has innovated a machine named OTOSIL for smoothing the process of making silage among farmers (Salehhudin et al., 2019). About 22% of production cost can be reduced with an increase of 12% in silage quality by employing this machine.

Furthermore, salt block supplementation is commonly practised to overcome mineral deficiencies in ruminants; however, most of the salt blocks in the local markets are imported and not purposely to solve protein and energy deficiencies (Panadi *et al.,* 2018). Due to these issues, urea-molasses mineral blocks (UMMB) or

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medicated urea-molasses mineral blocks (MUMB) supplementation are more effective as supplements because it is high in energy, nitrogen (N) and macro-micro minerals. The findings found that goats supplemented with the commercial mineral block (CMB) showed severe parasite infection as CMB lacked protein and energy sources. Abid *et al* (2016) also supported that the nutritional benefits attributed to UMMB and MUMB were evidenced as additional protein, energy and minerals were directly supplied to the animals, enhancing growth rate and, most likely, increased nutrient digestibility.

2.4. Biosecurity and Vaccination

Biosecurity is essential in beef cattle farming to prevent unwanted diseases and ensure healthy and clean cattle. Vaccinations, animal traffic management, and sanitation are the things that must be given more attention in implementing biosecurity on the farm (Lestari et al., 2019). Biosecurity on the farm aims to avoid transmitting diseases, including Anthrax and other high-risk diseases to humans (Lestari *et al.*, 2019). Farmers are usually informed about biosecurity but are not ready to implement it on their farms. Besides that, a study in Cambodia on farmers' knowledge regarding interventions that can improve cattle production and health, including biosecurity and other practices to control disease transmission. The result indicates that smallholder farmers are motivated by nutritional interventions that improve the price of their cattle and promising marketing opportunities (Nampanya *et al.*, 2012). Hence, this situation provides more information on introducing disease risk management to be implemented by smallholder farmers through intensive training programmes.

Donadeu *et al* (2019) stated the strategies needed to encourage more smallholder livestock farmers to adopt animal vaccines. The strategies include increasing the awareness of the benefits of vaccines and disease control programs. In addition, the strategies of establishing community supply by buying the vaccine in bulk to get price discounts and technical considerations by packaging into a smaller vaccine to prevent any wastage and maintain the vaccine's cold chain. These kinds of strategies of appropriate to be practised among the smallholder livestock farmers who reared livestock for their livelihood and, at the same time, could prevent the transmission of zoonotic diseases and death due to the diseases (Donadeu *et al.*, 2019).

On the other hand, vaccination aims to produce healthy cattle by avoiding unwanted diseases. Research done in India by Basunathe *et al* (2010) mentioned that 80% of farmers vaccinated their ruminants to avoid infectious diseases and obtain good health and feeding habits. Meanwhile, a study by Serin and Hashim (2010) found that 73% of the farms surveyed underwent animal vaccination programs. A widely used vaccine to avoid Hand Foot and Mouth Disease (HFMD) is essential to stop spreading the virus to other farm animals.

2.5. Intensive Rearing System

An intensive rearing system is an alternative to overcome problems in the limitation of land for beef cattle farming and insufficient grazing area (Baba *et al.,* 2014). The competition for land among industries such as manufacturing and services has become the primary global constraint (Siwar *et al*., 2014). Besides, the adoption level among farmers of intensive rearing is also low. Instead of application of cattle housing, feeding, reproduction and waste management, intensive rearing includes the production of compost and ensuring good animal health. However, most farmers have only adopted cattle housing without adopting feed technologies and waste management. These applications were limited to certain beef cattle farmers due to socioeconomic factors such as the difficulty of information access and the high cost of adopting such innovations.

In another way, employing intensive rearing techniques will produce high-quality meat, good health condition, and practising good handling of animal waste (Baba *et al.,* 2014). Besides, this technique can also earn higher profit returns if it is done correctly (Young *et al.*, 2014). Besides that, Selecting the most suitable area for beef cattle farming can smoothen the procedures of intensive farming techniques.

2.6. Integrated Farming System

The integrated crop-livestock system is understood as the ecological interactions over space and time between crops, grassland and animals. These components allow farmers to reduce the input use, such as 1) organic fertiliser generates from livestock waste and 2) crop-pasture rotations for animal feed (Ryschawy et al., 2017). In Malaysia, most farmers run their livestock farming activity in a palm oil plantation where palm oil crops are integrated with cattle (Md. Said and Man, 2014).

Besides, this system also improves nutrient cycling by re-combining nitrogen and carbon cycles (Martin *et al.,* 2016; Ryschawy *et al.*, 2017), besides achieving economic efficiency by lessening the production costs and risks according to market fluctuations (Md. Said and Man, 2014; Wilkins, 2008). The farms' and local community's profitability and environmental sustainability can be boosted by adopting integrated crop-livestock systems. For instance, the wedding cost can be reduced by more than 50% besides the increase in fruit yield due to the lack of competition between the grass and palm oil trees (Md. Said and Man, 2014; Reddy, 2016). However, the main challenges of on-farm integration are commonly related to a knowledgeable and skilful farm workforce optimising crop-livestock systems (Martin *et al.*, 2016).

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2.7. Composts

The intensive use of chemical fertiliser among crop farmers may harm the soil structure in terms of chemical compounds and the soil's physical and biological aspects (Supaporn *et al.,* 2013). Generally, compost is derived from crop by-products such as oil palm residue, rice straw and livestock wastes, including the cattle's urine and faeces. Organic wastes are already known as it benefits crop farmers by becoming fertilisers. The transformation of agricultural waste, including cattle waste, into organic fertiliser can generate additional income besides improving the farmers' livelihood. Abdullah *et al* (2021) also agreed that farmers could potentially have a better social status by producing compost. Besides, a study done among farmers on Caribbean Island by Paul *et a.* (2017) stated that most crop farmers applied organic fertiliser onto their crops to achieve maximum sustainability. However, Abdullah *et al* (2020) added that the utilisation of these organic wastes was not at an optimal level to increase the productivity at the farm, as well as low adoption of organic fertilisers by Asian farmers.

2.8. Biogas technology

Biogas technology is an anaerobic digestion process by converting organic wastes, including cattle manure, into biogas (Wahyudi, 2017). Installing a biogas digester can reduce households' expenditure, enhance income generation, and act as a job creator among the local people (Haryanto *et al.,* 2017). In addition, implementing this technology can reduce environmental pollution. Nevertheless, the cost to install the digester is high; thus, not all farmers can afford to have it. In Indonesia, only farmers with a good relationship with the government agency and those who lead them will have the opportunity to install the biogas digester and the other relevant facilities at their farm (Wahyudi, 2017). Due to the high cost of construction and biogas management compared to the price of livestock, it has become a significant challenge for beef cattle farmers.

Although various initiatives of innovation in beef cattle farming have been introduced, there are several challenges faced by farmers globally. The low adoption of organic compost is due to the worldwide food crisis, which has led to food security issues as it incurs higher demand for food and feeds production; hence this situation caused farmers to low adoption of organic compost (Supaporn *et al.,* 2013). Besides, the climate change issues have also contributed to the main problem of food production and limits the farmers to feed their cattle (Raza *et al.,* 2021). Thus, in an effort to ensure zero waste in farming activity, the utilisation of resources among all types of farmers is necessary. The question raised in this study was: what are the challenges faced by cattle farmers in adopting innovations to improve their beef production? This question will lead this review paper to identify relevant literature on the specific topic.

3. DISCUSSION

There are myriad challenges faced by beef cattle farmers to adopt innovations to improve their beef production. These challenges were found in various aspects, such as financial problems, lack of information and the role of extension agents.

3.1. Financial problem

The introduction of innovation or technology by the scientists in beef cattle farming had significantly impacted the individual farmers with high social status in a community and good relationships with extension officers. Farmers within this group can improve the farm's production by enjoying benefits to improve their income and standard of living compared to their counterparts with low social status and financial problems (Wahyudi, 2017). Giving incentives was one of the strategies the government could implement to support beef cattle farmers. These incentives can boost them to excel in their farming businesses.

Moreover, several alternatives can be undertaken to overcome financial problems, such as convenient short-term loans as well as provision scheme of tools and equipment for agricultural purposes. Besides, recycling the cattle waste into crop fertiliser and implementing biosecurity can enhance their productivity while sustaining the environment at the same time. The research done by Ashley *et al* (2018) in Cambodia found that the short planting period of the introduced forages had given a social impact on the local community. The increase in cow productivity had improved the socioeconomic status of beef cattle farmers. Moreover, the innovation has also reduced child and woman labour involvement. Thus, the women can enjoy other activities to generate more income, such as planting fruits and vegetables and rearing pigs and poultry. At the same time, the children can spend more time in school and assist the household activities (Maxwell *et al.,* 2012).

3.2. Information access

Accessing information has also become an obstacle to adopting innovation and practising sustainable agriculture. Beef cattle farmers faced difficulty obtaining information regarding the training given by the relevant agencies and the information on animal diseases and biosecurity implementation (Lestari *et al.,* 2019; Wahyudi, 2017). Several beef cattle farmers were also seen as reluctant to practice biosecurity, as reported by Lestari *et al* (2019) in Luwu Region, South Sulawesi Province, Indonesia. This issue was due to the limited information on animal diseases, which has also been agreed upon by Hernández-Jover *et al* (2016). To overcome this challenge,

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the farmers need to get easy access to information as it has a significant relationship with the adoption of innovation (Paul *et al.,* 2017). However, this situation is similar to when the information is more accessible to farmers if they have a strong bonding with extension workers, research institutes and farmers' associations. The dissemination of information will be great if research centres and extension workers work together to ensure no farmers are left behind in getting the current innovation (Folefack, 2015).

3.3. Extension agents

The role of extension agents and government agencies is vital in adopting innovation in beef cattle farming (Baba *et al.,* 2019). The extension workers primarily work for farmers' needs not only as counsellors or assistants but also to help the farmers to identify problems that occurred on the farm and try hard to solve the problems (Hauser *et al.,* 2016). However, this contradicts the research findings obtained by Lestari *et al* (2019), showing that the government agencies were not playing their role in supporting farmers in adopting innovation. The failure in communication between farmers and extension agents will lead to the failed functioning extension system. The adoption of innovation in beef cattle farming needs excellent cooperation from every stakeholder to achieve mutual understanding, food security and sustainability of the environment.

The farmer-to-farmer extension has become primary in disseminating and promoting innovation among beef cattle farmers. It is an alternative role in facilitating farmers to improve their production in beef cattle farming. Beef cattle farmers in Wajo Regency, South Sulawesi Province, Indonesia, began to adopt intensive rearing as one of the innovations after it was conclusively proven and employed by the high committee of farmers' association in 2001 (Baba *et al.,* 2014). The top committee of the farmers' association plays the best example for the other beef cattle farmers in the farming community (Heong *et al.,* 2002; Manner and Gowdy, 2010).

3.4. Food Security and Sustainability

Food security is a matter of national security, and insufficient food supply may threaten a country. Food security is understood as food affordability, availability, quality and safety. The effort to achieve food security is still far, and it needs more hands to work together, including the farmers, feed suppliers, retailers, wholesalers and the responsible agencies. Meanwhile, sustainable agriculture has again been voiced out in the *Dasar Agromakanan Negara 2.0* (DAN 2.0), stating the three main principles: economy, social and environment. One of the objectives mentioned encouraging sustainable food consumption and production practices. Hence, this policy could contribute to national economic growth and ensure environmental sustainability in the future (Zayadi, 2021).

4. CONCLUSION

Based on the literature and discussion above, the financial problem, lack of information and role of extension agents inhibited beef cattle farmers from adopting innovation. Farmers with poor socioeconomic background were more reluctant to adopt innovation as the information are not accessible, and they do not have high self-esteem to have a good relationship with the extension workers. These challenges should be overcome to ensure the skills and knowledge are well disseminated to all beef cattle farmers. The government should encourage private companies to promote recent innovations and indirectly collaborate with the farmers by providing funding, technical assistance and training. The government can give tax exemption to companies with excellent collaboration with the farmers as a reward for assisting the nation's heroes to ensure a sufficient supply of protein. Besides, the participatory technology transfer with the representation by all farmer groups, including the small, medium and large, could help these farmers to adopt innovation. The feedback from each group is valuable and can be considered for upcoming innovations.

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