OVERVIEW OF THE CURRENT STATUS OF THE CATTLE ARTIFICIAL INSEMINATION INDUSTRY IN MALAYSIA

AFIQAH FASIHAH, A.R.[1*] AND NURUL HIDAYAH, A.R.[2]

1 Institut Biodiversiti Veterinar Kebangsaan, Department of Veterinary Services, Jerantut, Pahang, Malaysia
2 Veterinary Research Division, Department of Veterinary Services, Ministry of Agriculture and Food Security, Putrajaya, Malaysia

[*]*Corresponding author:* afiqahfasihah@dvs.gov.my

ABSTRACT. This paper intends to review the current status of the artificial insemination industry in Malaysia. The application of assisted reproductive technologies, such as artificial insemination (AI), is one of the strategies that has been employed to enhance the sustainability of ruminant production systems in Malaysia. Traditional breeding methods are encountering challenges in keeping pace with the growing demand for livestock products. Despite significant progress that has been made, data indicate that the success rate of artificial insemination remains relatively low. Research suggests that the current procedures are not fully optimized for routine implementation. Follow-up studies are warranted to assess interventions such as record-keeping on feed supplementation, AI technician training, timed AI, heat detection, and timely pregnancy diagnosis. Thoroughly documenting progress is essential for enhancing reproductive efficiency and optimizing the likelihood of success in artificial insemination. Efficient management of documentation on the use of artificial insemination in the cattle industry is crucial to identify potential areas where the commodity is more likely to improve, as this will help in genetic improvement and provides significant impact on global beef production.

***Keywords*:** artificial insemination, assisted reproductive technologies, biotechnology, cattle industry, food security

INTRODUCTION

A sustainable food system is essential to support human population growth. According to interpolation of recent United Nations data, Malaysia's population was approximately 33.4 million as of 2023, and the population is expected to reach 36.09 million by 2030 (Population of Malaysia, 2021). The predicted growth in the total urban population will generate an increase in both food supply and demand, including agriculture commodities. According to Ariff *et al.* (2015), more than 60% of the Malaysian population consumes beef as their protein source. However, the livestock industry in Malaysia is facing a low self-sufficiency ratio (SSR) of ruminant output, which stands at 22.28% in 2019 and is still highly reliant on exports. According to data from the Department of Veterinary Services' 2019-2020 livestock statistics, the SSR trend for livestock products in Malaysia remained below 30% from 2016 to 2020, with no significant change (DVS, 2021). Due to the low SSR value, production in Malaysia has to import more livestock products to meet the demand (Zayadi, 2021). Currently, the Malaysian government is working to reduce its 80% dependency on imported meat supplies from India, Australia, and New Zealand (Abdullah *et al.*, 2021).

Analysis of Trends in the Adoption and Success Rates of Artificial Insemination

The Ministry of Agriculture and Food Security views the development of effective breeding practices in the cattle industry, such as artificial insemination (AI), as one of the means to increase local beef and milk production while simultaneously enhancing food security

among Malaysians. Additionally, it can help in achieving Sustainable Development Goal 2 (SDG 2), which aims to improve access to healthy nutrition and increase food security. This effort will also be in line with the goals of the FAO's Strategic Framework (2022-2031), which puts a strong emphasis on the benefits of improved productivity, nutrition, environment, and quality of life. Nowadays, growing awareness of the advantages of artificially inseminating cattle has made artificial insemination a preferred reproductive technique among Malaysia's livestock breeders. Consequently, there has been a steady rise in demand for semen straws from IBVK annually, as indicated in Table 1 below. It is believed that bull semen distribution increased for five consecutive years, largely driven by interest, which coincided with the beneficial profit of rising productivity.

Table 1. Statistical analysis of the number of semen straws supplied by Institut Biodiversiti Veterinar Kebangsaan from 2017 to 2021

State/Year	2017	2018	2019	2020	2021	Total	Mean	SD
DVS Negeri Sembilan	540	2,250	800	899	2,655	7,144	1,428.8	954.46
DVS Perlis	0	300	900	450	1,300	2,950	590.0	512.84
DVS Kedah	0	720	0	50	0	770	154.0	317.14
DVS Kelantan	324	4,448	2,400	7,943	8,545	23,660	4,732.0	3,528.41
DVS Johor	0	500	1,550	750	0	2,800	560.0	641.68
DVS Melaka	1,900	500	1,099	1,200	3,420	8,119	1,623.8	1,120.33
DVS Pahang	500	0	1,935	1,648	1,347	5,430	1,086.0	810.49
DVS Perak	1,500	0	897	570	1,110	4,077	815.4	567.28
DVS Terengganu	301	0	4,800	2,500	0	7,601	1,520.2	2,111.02
DVS Pulau Pinang	100	350	400	0	425	1,275	255.0	192.35
DVS Sarawak	3,400	0	0	0	0	3,400	680.0	1,520.53
DVS Selangor	500	0	0	0	0	500	100.0	223.61
Others	460	1,100	754	212	344	2,870	574.0	355.67
Total	9,525	10,168	15,535	16,222	19,146	70,596	1,086.1	1,679.94

Source: *Institut Biodiversiti Veterinar Kebangsaan*, DVS Malaysia (DVS, 2022)

A one-way ANOVA was conducted to compare the semen straw demand based on states in Malaysia. The results showed that there was a significant difference between the semen straw demand as grouped by state in Malaysia [$F(12, 52) = 4.046, p < 0.05$]. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for DVS Kelantan (M = 4732, SD = 3528.4) was significantly higher than in other states ($p < 0.05$). This indicates that the breeders from Kelantan are actively practicing AI, positioning Kelantan as the largest hybrid cattle producer and solidifying its role as the primary supplier hub for the country's industry (Bernama, 2024).

Although the production and demand for semen straws have been steadily increasing

since 2017, the result of a one-way ANOVA showed that there was no significant difference between the semen straws supplied over the years [$F(4, 60) = 0.450$, $p = 0.772$]. This is because the semen straws supplied are influenced by both breeders' requests and annual production quantities by IBVK.

Over the past 11 years, the cattle industry has heavily utilised artificial insemination technology (DVS, 2023). The bar graph below depicts the number of artificial insemination cases over the years, the number of cattle births as a result of artificial insemination activity, and the percentage of artificial insemination efficiency in Peninsular Malaysia (Figure 1). The number of annual inseminations increased year over year from 2011 to 2021. The figure has nearly tripled from the figure of 18,599 that Raymond and Saifullizam (2010) reported in their first report on the artificial insemination cattle industry in 2009. In 2011, AI cases were relatively low, with only 18,640 cases recorded. However, there was a constant increase in AI cases throughout the year, peaking in 2021 with 47,435 AI cases and 22,160 cattle births.

Table 2 illustrates the efficiency of artificial insemination from 2011 to 2021 based on the data provided by the Genetic Development and Livestock Technology Division (BPGTP, DVS). Overall, a consistent pattern of AI effectiveness is observed, with nearly half of the AI cases resulting in cattle births. The difficulties in obtaining AI services and disease outbreaks, such as Foot and Mouth Disease in 2016, made it harder to use artificial insemination (Nordin *et al.*, 2007; WOAH, 2022). Additionally, Table 2 indicates that only 29–50% of artificial

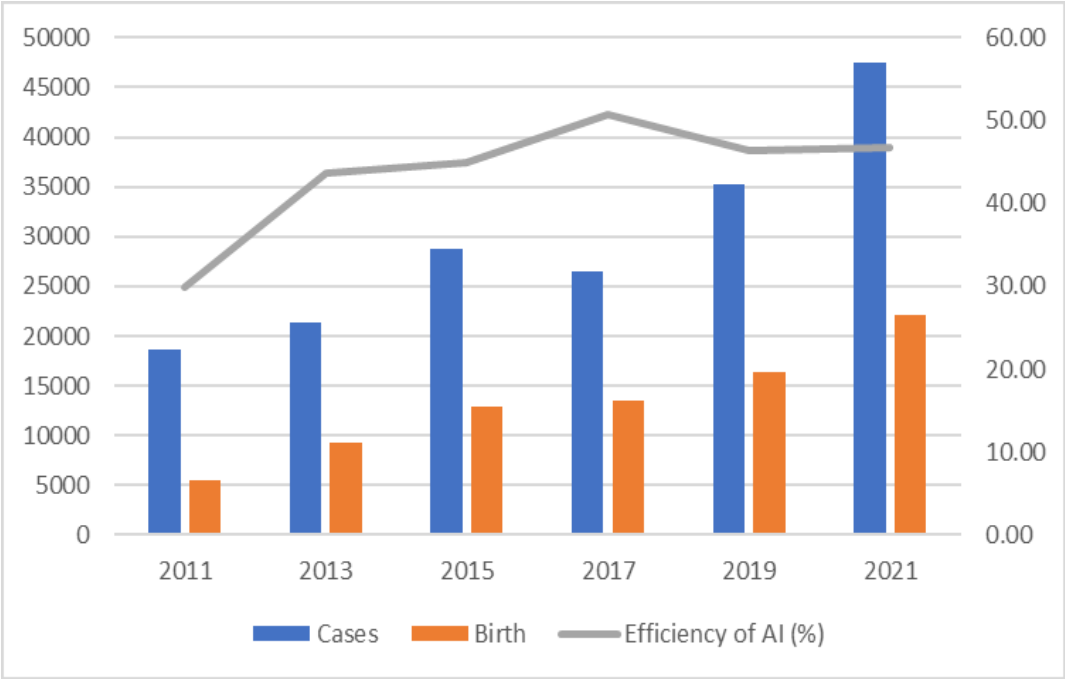

Figure 1. Number of artificial inseminations cases and cattle births as a result of artificial insemination and the percentage of efficiency of AI in Peninsular Malaysia from 2011 to 2021

insemination attempts had been successful over the past 11 years. Therefore, it's crucial to identify the obstacles to successful artificial insemination and motivate more breeders to utilise this reproductive technology, in order to significantly boost Malaysia's livestock industry. Eliminating these barriers could enhance the quality and quantity of livestock in the future. Moreover, the application of artificial insemination is believed to be able to keep up with the increasing food demand, making it one of the main drivers of the agriculture market.

Table 2. The number of artificial inseminations (AI) conducted, the number of cattle births resulting from AI, and the efficiency of the AI conducted in Peninsular Malaysia from 2011 to 2021

Year	2011	2013	2015	2017	2019	2021
AI Cases	18,640	21,317	28,783	26,539	35,203	47,435
Birth	5,556	9,291	12,913	13,461	16,346	22,160
Efficiency of AI (%)	29.81	43.58	44.86	50.72	46.43	46.72

Factors Influencing Artificial Insemination Success Rates

Artificial insemination has benefited the economy by reducing the cost of producing a large number of bulls. This approach improves animal production by developing genetically superior progeny (Raymond & Saifullizam, 2010). Valergakis *et al.* (2007) found that female offsprings of AI-proven bulls produce more milk than normal offsprings.

However, various factors have been identified as the potential limits to the low success rate of artificial insemination, in which this study highlights the diverse factors that influence the success of AI across different countries. In Indonesia, implementing a management system and data recording on reproductive disorders, fostering collaboration between farmers and AI technicians, and ensuring inseminator knowledge, semen transportation, and skills play crucial roles in AI activity (Tjiptosumirat *et al.,* 2007). In Africa, recording data on cow performance and reproductive tract conditions, including endometrial thickness and ovarian stimulation, and employing timed AI are emphasised for effective AI practices (Tadesse *et al.,* 2022).

In Myanmar, previous study emphasised the importance of determining optimal insemination timing, verifying sperm quality, and providing comprehensive pre-AI training for inseminators, while in Spain, factors such as female and male seasonality, farm environmental conditions, and AI technique are emphasised (Anel *et al.,* 2006 ; Win *et al.,* 2007). In Malaysia, Nordin *et al.* (2007) identified factors that contribute to the success of AI, including ensuring proper semen deposition, appropriate feeding and nutrition, timing of insemination, and the experience of the AI technician in heat detection. These diverse factors play a crucial role in maximizing artificial insemination outcomes globally.

Main Constraints in the Application of Artificial Insemination in Malaysia

Several challenges have been identified in the cattle artificial insemination industry. The three major constraints were lack of collaboration between farmers and technicians, lack of expertise as well as high expense of the artificial insemination service. A good working relationship between farmers and AI technicians can result in a better understanding of the management system regarding cow

reproductive performance and proper feeding. According to Valergis *et al.* (2007), artificial insemination is frequently ineffective due to poor nutrition and health management.

Another issue is a shortage of qualified personnel capable of performing semen deposition into cow uterine horns and handling frozen semen. Good handling skills are crucial steps for improving the success of artificial insemination and reproductive performance (Faghiri *et al.,* 2019). The high success rate of artificial insemination will generate trust in breeders and increase smallholder breeders' willingness to use this approach, despite the cost of the artificial insemination service.

Regarding the cost of artificial insemination, the majority of cattle breeders in Malaysia are smallholders who typically operate on limited budgets in managing farm expenses (Tong *et al.,* 2018). Hence, adopting artificial insemination is a significant additional financial burden for them, as they are now facing high feed costs. According to Shaw and Dobson (1996), there is a cost constraint during the first year of the artificial insemination program because it includes capital investment and serves as a learning period. However, the profits earned in the subsequent years are adequate to recoup the expenses involved in establishing the DIY-AI program on the farm.

Although some of these challenges are related to regulatory and policy considerations that are beyond the scope of research, the cost of standard artificial breeding, proper nutrition, and affordable high-quality feed for cattle require immediate attention from local authorities because they affect the impact on animal production and the national economy.

Strategies for Improving Artificial Insemination Outcomes in Malaysia

Improving artificial insemination outcomes in Malaysia involves steps like strengthening partnerships between farmers and AI technicians, and providing knowledge as well as training for cattle industry players. In addition, it is crucial to understand how to achieve high conception rates using cryopreserved semen. In addition, knowledge of the site of semen deposition is critical in order to ensure successful egg fertiliation, thereby increasing the conception rate. The deposition of semen using a catheter is quite difficult for beginners due to complexities in the cervix. Depending on the breed, variation in cervix length, width, folds, eccentricity of the fold lumens, fold type, distance between the external uterine orifice, and shape can affect the ease and effectiveness of catheter insertion during artificial insemination (Anel *et al.,* 2006).

According to Cardoso *et al.* (2021), improved fertility in cattle is achieved through advancements in artificial insemination techniques, including timed artificial insemination (TAI) and hormonal control of the estrus cycle (estrus resynchronisation). Research indicated that combining a TAI program with effective cow management results in higher fertility compared to artificial insemination after detecting standing estrus. In terms of artificial insemination in small ruminants, there are two common AI methods: either vaginal-cervical insemination using refrigerated sperm or laparoscopic inseminations with thawed sperm. Anel *et al.* (2006) suggested that fertility rates are higher with the laparoscopy method, as it mitigates some detrimental influences of fertility variations.

Furthermore, the success of artificial insemination heavily depends on confounding factors such as the breeding season of the cattle, environmental conditions during AI procedures, and temperature (Zubor *et al.,* 2020). High temperatures often lead to low-fertility outcomes. This observation is consistent with a study conducted by Nordin *et al.* (2007).

Addressing these challenges requires strong and dynamic cooperation due to the complexity of the situation.

Future Works

To intensify artificial insemination activities in Malaysia, researchers should shift their focus to upstream and downstream research, which has the potential to open up new research avenues. Every department within an organisation engaged in the livestock industry is encouraged to form a small research group whose membership is open to researchers from various fields so that more ideas and novel research programs can be produced. Research should examine the performance and adaptability of crossbred progeny to the Malaysian environment. Furthermore, it is necessary to understand genetic variability, as it provides important insights into how genes interact with the environment at multiple levels to produce a phenotype. The industry needs scientific data and information to evaluate its productivity and prevent species extinctions.

In recent years, the Department of Veterinary Services under the Ministry of Agriculture and Food Security has organised a do-it-yourself AI (DIY-AI) program for Malaysian breeders. It enables breeders to do their breeding with the guidance of a technician. This program is designed to increase the quality and performance of local breeding animals. In 2022, the Department of Veterinary Services had only 192 registered AI-men. More trained personnel are necessary to provide services to the livestock industry. There is a need to encourage more young breeders to participate in artificial breeding, as they are more energetic, open to innovation, and determined than established industry players.

Aside from that, future artificial insemination initiatives should include the use of sexed semen technology. Sexed-sorted semen products have the potential to accelerate herd expansion, reduce waste, improve animal welfare, and increase profitability (Holden & Butler, 2018). Determining the gender of the offspring can impact profitability and improve production operations, making it beneficial to industrial players.

CONCLUSION

In conclusion, the livestock sector requires further development, particularly in the application of assisted reproductive technology, which improves the livelihoods of smallholder breeders and allows sustainable livestock production. Long-term government support and incentives, as well as networking with established international partners, should be explored in the future to improve the industry's profitability.

REFERENCES

1. Abdullah, F. A., Ali, J., & Noor, M. S. Z. (2021). Factors influencing the adoption of innovation in beef cattle farming: A study in Peninsular Malaysia. In *IOP Conference Series: EES* (Vol. 756, No. 1, p. 012021). IOP Publishing.
2. Anel, L., Alvarez, M., Martinez-Pastor, F., Garcia-Macias, V., Anel, E., & De Paz, P. (2006). Improvement strategies in ovine artificial insemination. *Reprod. Domest. Anim*, *41*, 30-42.
3. Ariff, O. M., Sharifah, N. Y., & Hafidz, A. W. (2015). Status of the beef industry of Malaysia. *J. Anim. Sci, 18(2), 1-21*.
4. Bernama (2024). Demand for cattle to increase by over 30,000 for Aidiladha -Kelantan exco. *The Sun*. Available at: https://thesun.my/local_news/demand-for-cattle-to-increase-by-over-30000-for-aidiladha-kelantan-exco-JE12437169 (Accessed: 22 May 2024).
5. Cardoso Cosentini, C. E., Wiltbank, M. C., & Sartori, R. (2021). Factors that optimize reproductive efficiency in dairy herds with an emphasis on timed artificial insemination programs. *Animals*, *11*(2), 301.

6. DVS (2021). (2019/2020) Livestock Statistics. Department of Veterinary Services (DVS), December 2020. [Online]. Available: Jabatan Perkhidmatan Veterinar Perangkaan Ternakan 2019/2020. (Accessed 27 October, 2022)
7. DVS (2022). Unpublished data from Institut Biodiversiti Veterinar Kebangsaan (IBVK), Department of Veterinary Services, Malaysia.
8. DVS (2023). Unpublished data from Genetic Development and Livestock Technology Division (BPGTP), DVS, Malaysia.
9. Faghiri, H., Yusop, Z., Othman, M. H., & Krauss, S. E. (2019). Structural Analysis of Factors Affecting Dairy Cattle Industry Development in Malaysia. *ROPE*, *1*(1), 23-42.
10. Holden, S. A., & Butler, S. T. (2018). Applications and benefits of sexed semen in dairy and beef herds. *Animal*, *12*(s1), s97-s103.
11. Nordin, Y., Zaini, N., & Wan Zahari, W. M. (2007). Reproductive status following artificial insemination and factors affecting conception rate in dairy cows in smallholder production systems. *Improving the reproductive management of dairy cattle subjected to artificial insemination*, 79-91.
12. Population of Malaysia (2021) Malaysia population 2021- StatisticsTimes.com. Available at: MPC 2024 - StatisticsTimes.com (Accessed: January 16, 2023).
13. Raymond, A., & Saifullizam, AK., (2010). The cattle artificial insemination industry in Malaysia. *MJVR*, *1*(1), 1-7.
14. Shaw, C., & Dobson, H. (1996). Reproductive and financial impact of a do-it-yourself artificial insemination programme compared with keeping a bull. *Vet. Rec*, *139*(24), 594-597.
15. Tadesse, B., Reda, A. A., Kassaw, N. T., & Tadeg, W. (2022). Success rate of artificial insemination, reproductive performance and economic impact of failure of first service insemination: a retrospective study. *BMC Vet. Rec*, *18*(1), 1-10.
16. Tjiptosumirat, T., Tuasikal, B. J., Murni, A. P., Lela Ningtyas, N., Toleng, A., Arman, C., & Rizal, Y. (2007). Improvement of the efficiency of artificial insemination services through the use of radioimmunoassay and a computer database application. *Improving the Reproductive Management of Dairy Cattle Subjected to Artificial Insemination*, 57-77.
17. Tong, A. X., Nor, N. M., Indrawan, D., & Suhaimi, N. A. M. (2018). A Review: Should smallholder dairy farms rear own young stock? *Mal. J. Anim. Sci*, *21*(2), 1-6.
18. Valergakis, G. E., Arsenos, G., & Banos, G. (2007). Comparison of artificial insemination and natural service cost effectiveness in dairy cattle. *Animal*, *1*(2), 293-300.
19. Win, N., Win, Y. T., Kyi, S. S., & Myatt, A. (2007). Evaluation of reproductive performance of cattle bred by artificial insemination in Myanmar through the use of progesterone radioimmunoassay. *Reproductive Management of Dairy Cattle Subjected to Artificial Insemination*, 93.
20. WOAH (2022) *SEACFMD Bulletin - WOAH*, *Foot and Mouth Disease Situation January to December 2016*. World Organisation of Animal Health. Available at: https://rr-asia.woah.org/wp-content/uploads/2019/10/2016_seacfmd_bulletin.pdf (Accessed: January 19, 2023).
21. Zayadi, R. A. (2021). Current outlook of the livestock industry in Malaysia and ways towards sustainability. *JSuNR*, *2*(2), 1-11.
22. Zubor, T., Hollo, G., Pósa, R., Nagy-Kiszlinger, H., Vigh, Z., & Húth, B. (2020). Effect of rectal temperature on efficiency of artificial insemination and embryo transfer technique in dairy cattle during hot season. *Czech Journal of Animal Science*, *65*(8).

ACKNOWLEDGEMENTS

The authors would like to thank the Director General of DVS for permitting us to publish this study and many thanks to the Genetic Development and Livestock Technology Division (BPGTP), Dr Wan Aini Wan Mahamood and Mohd Safwan Ab Manan for providing valuable information in this study.