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The implication of Artificial Insemination Technology on Farmers' Willingness to Adopt the Beef Cattle in Soppeng Regency

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ABSTRACT

Artificial insemination is a widely adopted technique in the livestock industry to enhance breeding performance and improve the quality and quantity of cows. However, implementing this technology in Soppeng Regency is currently facing a challenge that has resulted in low pregnancy rates among cows. Therefore, it is imperative to conduct a comprehensive evaluation to identify the root cause of the unsatisfactory outcomes and find practical solutions to improve the success rate of artificial insemination in the region. This study aimed to implicate the factors influencing farmers' adoption of artificial insemination technology. It was carried out between July and September 2023 in Marioriawa, Lalabata, and Marioriwawo districts of Soppeng Regency, South Sulawesi Province. An explanatory study was used to implicate the factors that influenced adopting artificial insemination technology in farmers by involving 140 respondents and analyzed using binary logistic regression. The successful adoption of artificial insemination technology in beef cattle farmers in Soppeng Regency depends on various factors. While technical aspects and supporting infrastructure are critical, other factors, such as farmers' willingness to adopt the technology, proactive attitudes, and positive perceptions, also play a significant role in farmers' decision-making. Additionally, regional accessibility, farming maintenance systems, and extension activities are crucial aspects to consider. Therefore, before implementing the technology, it is essential to pay special attention to these areas and provide appropriate interventions to ensure its success.

Keywords: Beef cattle farmers, Artificial insemination, Natural mating, Technology adoption, Soppeng Regency

Introduction

Soppeng Regency, situated 172 km from the capital city of South Sulawesi Province, Makassar, is a level-II region sprawling over 1,500.00 km2. The Regency is divided into eight sub-district areas, comprising 21 sub-districts and 49 villages, with a population of 226,770 people. The people's livelihood varies significantly, with farming being one of the primary occupations. Among the different livestock options, beef cattle are the preferred choice among farmers. The current population of beef cattle stands at 49,120 heads, with cows dominating 66.11% of the total, accounting for 32,476 heads, which is nearly twice the number of bulls (Badan Pusat Statistik Kabupaten Soppeng and Dinas Komunikasi dan Informatika Kabupaten Soppeng, 2018). The potential for artificial insemination technology in Soppeng Regency is significant, given the plentiful supply of cows that can be utilized as acceptors for the procedure.

Artificial insemination has certain drawbacks. It requires a trained technician who thoroughly understands the cow's reproductive anatomy and functionality and specialized AI equipment (Suteky, 2021). Implementing Artificial Insemination (AI) technology can augment the quantity and quality of beef cattle in smallholder farms. Prior to proceeding with the development stage, it is crucial to conduct an assessment of farmers' willingness to adopt the intended technology. This assessment will provide essential insights into the viability and potential impact of the technology, enabling an adjustment approach accordingly. Farmers are vital in driving innovation as they can significantly influence the acceptance of emerging technologies. A successful adoption process hinges on farmers being able to implement new practices that align with their beliefs and values, and this is mainly dependent on the information they receive. Integrating scientific technologies is critical for improving the efficiency and productivity of livestock enterprises (Hajong *et al.,* 2023).

The government focuses on developing various technological innovations, including AI technology. To encourage farmers to adopt

modern solutions, the government covers all the implementation costs. Offering free AI technology can attract farmers and ease their financial burden, despite financial gain not being the primary motivator for adopting AI. However, data suggests that the total number of pregnancies resulting from NM still exceeds those resulting from AI. This indicates a possible mismatch between the actual field conditions and the needs of farmers, which could be hindering their adoption of AI technology.

Table 1 contains information about AI and NM pregnancies in Soppeng Regency's sub-districts for 2018 and 2022. According to the data, the use of AI technology has significantly increased the number of successful pregnancies in 2022 compared to 2018. The data shows that in 2018, 153 pregnancies resulted from AI technology and 632 from NM. The number of pregnancies resulting from AI technology was 2,490 in 2022, while 1,242 pregnancies were caused by NM. Beef cattle farmers who have adopted AI technology have significantly contributed to the increase in total acceptor pregnancy. It indicates that the farmers' willingness to adopt AI technology and technical factors have piqued their interest. Despite this, NM has a more significant share of total acceptor pregnancies in Soppeng Regency. This suggests that problems with AI implementation may be affecting farmers' willingness to adopt the technology, as well as a mismatch between conditions and farmers' needs that influence their decision to adopt AI technology in Soppeng Regency.

Materials and Methods

Time and location

This study was carried out between July and September 2023 in Marioriawa, Lalabata, and Marioriwawo districts of Soppeng Regency, South Sulawesi Province.

Population and sample

This study was conducted by surveying 140 respondents in the Lalabata, Marioriawa, and Marioriwawo Districts of Soppeng Regency and found that 71 respondents applied NM, while 69 used AI. The researchers used the quota sampling technique to select the participants. This method was chosen based on the total acceptors where AI and NM were most commonly applied and the ease of access to the researchers' location in collecting respondent data. The quota sampling method is a non-random sampling technique in which participants are chosen based on predetermined characteristics, resulting in a total sample with the same characteristic distribution as the larger population. (Firmansyah and Dede, 2022).

Types and data collection methods

This study examined the factors that influence the adoption of AI technology among farmers in Soppeng Regency. The study used quantitative data from a questionnaire, and the type of study was explanatory. The factors that were examined included regional accessibility, farmers' knowledge, forage availability, farming maintenance system, farmers' motivation to attend the extension, farmers' attitude, farmers' subjective norm, farmers' behavioral control, and farmers' participation in the group. The data sources used were primary data from respondents' questionnaires and secondary data from related agencies. The data collection method involved direct field observation and interviews with respondents.

Data analysis

The data was analyzed using binary logistic regression. This type of analysis determines the relationship between binary response variables and independent variables that are either interval or categorical. In binary logistic regression, dummy variables (0 and 1) are used. The adoption of AI technology in beef cattle farmers is a dependent variable that can be influenced by various independent variables. These independent variables include regional accessibility, farmers' knowledge, forage availability, farming maintenance system, motivation to attend extension, farmers' attitudes, subjective norms, behavioral control, and participation in the group. A dichotomous model is used to measure the adoption of AI technology. If the significance value of an independent variable is less than $\alpha = 0.05$, it means a significant influence exists between the independent and dependent variables. A logistic regression model analyses the relationship between these variables (Kotimah and Wulandari, 2014).

$$\mathbf{Log}\left(\frac{\mathbf{P}}{\mathbf{1-P}}\right) = \beta_0 + \beta_1 X_1 + \ldots\ldots\ldots + \beta_9 X_9$$

- The dependent variable denoted as P, represents whether the farmer applied AI technology (Y = 1) or NM (Y = 0).
- β0 is a constant
  β_1 to β_9 is a regression coefficient for each independent variable, which are : X_1 is regional accessibility, a dichotomous variable where 2 represents easy access to an AI technician and 1 represents difficult to access; X_2 is the farmer's knowledge, a dichotomous variable where 2 represents specific AI knowledge and 1 represents basic AI knowledge; X_3 is forage availability, scored on a scale; X_4 is a farming maintenance system, a dichotomous variable where 2 represents a semi-intensive system and 1 represents an extensive system; X_5 is the farmer's motivation to attend extension, scored on a scale; X_6 is the farmer's attitude, scored on a scale; X_7 is the farmer's subjective norms, scored on a scale; X_8 is a farmer's behavioral control, scored on a scale; X_9 is participation in farmer groups, a dichotomous variable where 2 represents belonging to a group, and 1 represents not belonging to a group.

In the variables, X_3 forage availability, X_5 motivation to attend the extension, X_6 farmer's attitudes, X_7 is farmers' subjective norms, and X_8 is

Table 1. Recapitulation of pregnancy of artificial insemination and natural mating acceptors in 2018 and 2022 in Soppeng Regency

District	Total of pregnancy (2018)		Total of pregnancy (2022)	
	Artificial insemination	Natural mating	Artificial insemination	Natural mating
Marioriwawo	62	397	258	423
Lalabata	42	25	49	315
Liliriaja	21	521	128	515
Lilirilau	8	120	46	137
Donri-Donri	12	21	50	441
Marioriawa	24	130	84	316
Ganra	7	40	14	238
Citta	1	11	3	105
Total	153	1.242	632	2.490

Source: Agricultural Service of Soppeng Regency, 2018 dan 2022.

farmers' behavior control are independent variables that take the form of questions and generate answers on an ordinal scale. To convert the data from an ordinal scale to an interval scale, the MSI (method of successful interval) was used. If the regression analysis still used ordinal scale data, the interpretation of data from the resulting regression model would be incorrect (Ningsih & Dukalang, 2019). The Likert scale combined several questions to form a score/value representing individual characteristics (Budiaji, 2013). There are two types of questions that use the Likert scale. The first type was positive questions that measured positive interest in AI, and the second was negative questions that measured adverse interest in NM. Positive questions were scored on a scale of 1 to 5, with 5 being the highest score. In comparison, negative questions were scored on a scale of 1 to 5, with 1 being the highest score. The answers to both questions ranged from strongly agree to disagree strongly. Based on the relationship between the variables, a research hypothesis can be formulated as follows:
H_0 rejected, and H_a accepted if the sig value was < $\alpha = 0,05$.

Results and Discussion

Table 2 displays the characteristics of beef cattle farmers in the Soppeng Regency who have adopted AI and NM based on observations and interviews. The statistics reveal that most farmers who have implemented AI and NM in their operations are between the ages of 21 and 50, comprising 79% of the total. The remaining 21% are farmers over 50 years old. The age gap between farmers adopting AI and NM within the productive age range suggests that age was not a significant factor in their decision-making process. In other words, farmers of different ages seem to have equally embraced AI and NM, indicating that the benefits of these technologies may be appealing to farmers across different age groups.

Based on the data, it was discovered that most farmers in Soppeng Regency who adopted AI and NM had only completed elementary school, accounting for 36% of the farmers. In comparison, those with a bachelor's degree made up only 1%. While formal education was not acknowledged as the predominant factor affecting the acceptance of AI, it remains a potential obstacle for extension workers to effectively communicate information through print and electronic media (Burhansyah, 2014). In particular, the lack of formal education may lead to difficulties in understanding and interpreting technical terms and concepts related to AI, which can hinder effective communication and engagement with farmers. Thus, extension workers need to be equipped with technical knowledge, communication skills, and strategies that can help bridge the gap between technical jargon and layman's terms. By doing so, farmers can effectively promote the benefits and potential of AI while addressing concerns and misconceptions that may arise.

The data presented in Table 2 suggests that farming experience was not a main factor in adopting AI or NM technologies. Upon analysis, it was observed that more than 50% of total respondents who were implementing either AI or NM had farming experience ranging from 1 to 10 years. These indicate that while farming experience may not be a determining factor, it is still a common characteristic among farmers who have adopted modern technologies in their operations. Likewise, the characteristics of beef cattle ownership holdings are not important in determining adoption for farmers. The characteristics of small-scale beef cattle ownership dominate both farmers who implement AI and NM. The decision to embrace AI in farming was found to be unrelated to age, formal education, farming experience, or beef cattle ownership, but rather influenced by other factors that were subjected to further statistical analysis. The study conducted an exhaustive examination to identify potential factors that could have impacted farmers' decision-making processes. The research findings could serve as a roadmap for future studies on AI adoption in the livestock sector.

Table 3 presents the outcomes of the multicollinearity test, revealing that the tolerance values of all independent variables X_1 to X_9 exceed 0.1 and that the VIF value is less than 10. This suggests that the independent variables in the regression model are not associated with each other. As a result, the regression model is deemed suitable for analysis (Ghozali, 2016). Furthermore, the significance test analyzed the data results simultaneously and partially. Table 4 displays the impact of various independent variables on the dependent variable. The Nagelkerke R Square value in Table 4 was 0.785, which indicates that the independent variables, including regional accessibility (X_1), farmers' knowledge (X_2), forage availability (X_3), farming maintenance system (X_4),

Table 2. Respondent characteristics

Respondent characteristics	Unit	Category	Quantity		Total	Percentage (%)
			IB	KA		
Age	Year	Group (21 – 50)	59	52	111	79
		Group (>50)	10	19	29	21
		Total			140	100
Formal education	Year	Elementary school	25	35	60	43
		Junior high school	16	18	34	24
		Senior high school	25	18	43	32
		College	3	-	3	1
		Total			140	100
Farming experience	Year	Experience (1-10)	59	46	105	75
		Experience >10	10	25	35	25
		Total			140	100
Beef cattle ownership	ST	Small scale (1-5)	61	64	125	89
		Big scale (>5)	8	7	15	11
		Total			140	100

Source: Primary data processed, 2023.

farmers' motivation to attend the extension (X_5), farmers' attitudes (X_6), farmers' subjective norms (X_7), farmers' behavioral control (X_8), and farmers' participation in the group (X_9), simultaneously explain 78.5% of the dependent variable (adoption of AI technology in beef cattle farmers). This means that 78.5% of the independent variables impact the dependent variable.

Table 3. Multicollinearity test results between independent variable

Model	Collinearity statistics	
	Tolerance	VIF
X_1 (Regional accessibility)	.647	1.545
X_2 (Farmers' knowledge)	.751	1.332
X_3 (Forage availability)	.646	1.548
X_4 (Farm maintenance system)	.914	1.094
X_5 (Motivation to attend the extension)	.852	1.173
X_6 (Farmers' attitude)	.856	1.168
X_7 (Farmers' subjective norm)	.923	1.084
X_8 (Farmers' behavioral control)	.914	1.095
X_9 (Participation in group)	.742	1.347

Source: Data processed using SPSS, 2023.

Table 4. Summary R square model

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	69.635[a]	.589	.785

Source: Data processed using SPSS, 2023.

The results of parameter estimation for the dependent variable are presented in Table 5, which reflects an overall percentage value of 87.1%. This figure indicates that the binary logistic regression equation model can explain up to 87.1% of the conditions observed in the study's location, demonstrating high accuracy and reliability. Furthermore, the table also provides a detailed breakdown of the independent variables that were considered to influence the dependent variable. In this case, the dependent variable is the adoption of AI technology among beef cattle farmers in Soppeng Regency, and the table highlights the key factors that play a significant role in this process. Overall, the findings suggest that the binary logistic regression equation model is a robust and effective tool for predicting the adoption of AI technology among beef cattle farmers in Soppeng Regency, including regional accessibility (X_1), farmers' knowledge (X_2), forage availability (X_3), farming maintenance system (X_4), farmers' motivation to attend the extension (X_5), farmers' attitude (X_6), farmers' subjective norm (X_7), farmers' behavioral control (X_8), and farmers' participation in group (X_9).

Table 5. Parameter estimation results of the dependent variable

Observed		Predicted		
		Adoption of AI technology		Percentage correct
		NM	AI	
Step 1. Adoption of AI technology	NM	63	8	88.7
	AI	10	59	85.5
Total percentage			87.1	

Source: Data processed using SPPSS, 2023.

Based on the findings presented in Table 6, six variables played a significant role in the adoption of AI technology among beef cattle farmers in the Soppeng Regency. These variables include regional accessibility (X_1), farming maintenance system (X_4), farmers' motivation to attend the extension (X_5), farmers' attitude (X_6), farmers' subjective norm (X_7), and farmers' behavioral control (X_8).

Regional accessibility

The statistical analysis revealed an undeniable impact of the regional accessibility variable on the adoption of AI technology among beef cattle farmers in the Soppeng Regency. The significance value of 0.000 further supports this claim. The AI technicians considered various aspects, including convenience and proximity, while carrying out their tasks. According to Ingabire *et al* (2018), farmers who live closer to AI centers are more likely to adopt and use the technology compared to those farther away. It revealed that farmers who voluntarily applied AI technology incurred additional operational costs for AI technicians, indicating their willingness to adopt the technology despite the extra expenses. Access to AI centers plays a crucial role in farmers' adoption of AI technology. However, the uneven distribution AI technicians in the region pose a significant challenge in reaching certain areas. Nevertheless, it is essential to find ways to access these areas to ensure farmers can access the AI centers, regardless of the difficulties involved. Efforts to increase AI adoption in livestock should also focus

Table 6. Partial effect test of independent variable

Research variable	B	S.E.	Wald	df	Sig.	Exp(B)
X_1 (Regional accessibility)	3.233	.860	14.147	1	.000	25.366
X_2 (Farmers' knowledge)	1.343	.812	2.734	1	.098	3.830
X_3 (Forage availability)	-1.150	.604	3.623	1	.057	.317
X_4 (Farming maintenance system)	1.984	.724	7.514	1	.006	7.270
X_5 (Motivation to attend the extension)	-1.420	.682	4.339	1	.037	.242
X_6 (Farmers' attitude)	7.893	1.962	16.186	1	.000	$2.679x10^3$
X_7 (Farmers' subjective norm)	3.732	1.157	10.401	1	.001	41.780
X_8 (Farmers' behavioral control)	-1.938	.707	7.517	1	.006	.144
X_9 (Participation in group)	-.074	.674	.012	1	.912	.928
Constant	-24.900	8.713	8.167	1	.004	.000

Source: Data processed using SPSS, 2023.

on educating farmers about the benefits of AI technology and its impact on their yields, efficiency, and profitability. Moreover, the government and private sector stakeholders should collaborate to provide financial incentives to farmers to offset the costs of adopting AI technology. Bahar *et al*. (2017) said farmers were eager to avail themselves of AI technician services due to the convenience of shorter distances. The technicians were more inclined to visit locations where AI services were provided, even when the services were offered for free. Farmers who incorporated AI technology still willingly provided operational costs such as food and gasoline for the technicians. However, some farmers refrained from using AI due to hindrances in accessing their location, such as bad roads and long distances in Soppeng Regency.

One of the technical problems that arose during the implementation of AI was the necessity of real-time communication between AI technicians and farmers. Occasionally, farmers encountered difficulties when attempting to reach AI technicians through their mobile devices. In such cases, alternative options were available, such as visiting the AI technician's residence directly since the area was easily accessible to the farmer. The possession of a mobile device is also a crucial determinant factor that enables AI beneficiaries to receive prompt service from the AI technician when their cows come into heat (Abraha *et al*., 2020). According to research conducted by Bonewati *et al* (2020), a minority of farmers in Soppeng Regency showed no intention of getting their cows' pregnancy checked. Farmers have identified a lack of knowledge and awareness regarding the significance of a particular task. Farmers assumed contacting an AI technician was only necessary when their cows were nearing delivery time. This perception is concerning because it puts the health and well-being of both the cows and calves at risk, as early detection of pregnancy-related issues is crucial for timely and effective treatment. Therefore, it is imperative to raise awareness among farmers about the significance of regular pregnancy checks for cows to ensure proper care and management.

Farming maintenance system

The statistical analysis shows that the farming maintenance system variable has a significance value of 0.006, indicating that the adoption of AI technology is influenced by factors related to farming maintenance systems. In Soppeng Regency, most farmers still rely on traditional farming maintenance systems, such as semi-intensive and extensive systems. These methods allow the beef cattle to graze freely on rice fields and mountainous areas, then release them in yards without caging them at night. However, this practice involves feeding the cattle with inadequate nutritional feed, which can compromise their health and well-being. According to Susilawati & Yekti (2018), AI technology's efficacy is subject to various environmental factors, with sufficient and superior quality feed for bulls as semen donors and cows as AI acceptors being of particular importance. Farmers who embrace AI technology in farming practices tend to be more vigilant when monitoring their cows. Farmers carefully observe cows' behavior to ensure cows are in good health and protected from potential harm. This level of attention is maintained, even when the cows are not entirely confined in the cage. Farmers alert AI technicians immediately in case of any issues. Hajong *et al* (2023) said that numerous farmers who practice traditional farming systems refrain from using AI technology due to allowing their beef cattle to graze freely, which increases the risk of NM in the herd. Moreover, detecting heat at the right time can be challenging in specific conditions, leading to a low success rate. While financial considerations are essential, the perception of profit adequacy is more likely to influence farmers' willingness to adopt new innovations than profit maximization. Additionally, livestock farming activities are deeply ingrained in the farmers' traditional farming systems, resulting in their reluctance to change their methods (Ranacher *et al.*, 2021). Socio-cultural identity refers to how a person views themselves as a member of a particular social group, with its own unique culture. This cultural identity is considered more significant than financial motivations when participating in agricultural production (Warren *et al.*, 2016). Despite their enthusiasm, many farmers in South Sulawesi Province are not actively taking measures to change their farming maintenance system. This may be because over 90% of beef cattle farmers in the region are smallholders who view livestock farming as a secondary occupation (Sirajuddin *et al.,* 2019). Livestock productivity can often suffer due to suboptimal maintenance management, including using traditional systems, pursuing non-agribusiness side ventures, and neglecting vital production inputs (Sultan, 2018). Farmers who kept traditional maintenance systems

often have lower levels of education, both formal and informal, such as extension activities. Because of this, they may lack the specific knowledge required to adopt AI technology. Conversely, farmers with lower education levels typically prefer traditional farming systems and are resistant to innovation (Azizah *et al.*, 2022).

Farmers' motivation to attend the extension

The significance value of the farmers' motivation to attend the extension variable was 0.037, indicating that their motivation to attend the extension impacted the adoption of AI technology in Soppeng Regency. A high level of motivation positively influences the adoption of AI technology. A direct relationship exists between motivation and farmers' attitudes towards using technology (Okkyla *et al.,* 2013). Farmers who use NM were not participating in extension activities frequently due to the infrequent occurrence of such activities in their areas. The limited AI-related activities among farmers have resulted in their inadequate knowledge of AI, affecting their understanding of its potential benefits. Farmers who have incorporated AI into their farms and have actively participated in extension activities are categorized as medium-level farmers. This is due to their proficiency in recognizing the signs of heat in cows. These farmers are keenly interested in AI-related information and regularly attend local extension activities. Despite having a positive perception of AI, the challenge is that these farmers have limited knowledge about it (Rasouliazar & Fealy, 2014).

The information that farmers require can be classified into two categories, namely general and specific. General information pertains to fundamental knowledge widely understood by society, while specific information is necessary to engage in new farming innovations. In Soppeng Regency, the farmers who have incorporated AI into their farming practices have gained specific knowledge, such as identifying the signs of heat and pregnancy in cows and knowledge of medicines and vitamins related to pregnant cows. This particular knowledge has been obtained through insights provided by AI technicians and extension workers. It is possible that farmers who have applied NM may not possess adequate knowledge concerning the capabilities of AI technology, such as the ability to produce calves without bulls directly. Farmers who receive detailed information about the technology are assumed to be more likely to embrace it than those who possess only rudimentary knowledge or no overall information (Wanglin *et al*., 2017). When deciding to adopt technology, farmers consider not only the benefits of the technology acceptance from the extension workers but also the psychological processes within themselves (Baba *et al*., 2014), including farmers attitudes, beliefs, and perceptions about the technology, as well as their level of trust in it. Additionally, farmers may seek guidance from extension workers to help them better understand the technology and its potential benefits. Adopting technology is a complex process involving multiple factors, and farmers must carefully weigh the costs and benefits before deciding.

Extension workers play a crucial role in farmers' decision to adopt AI. Most AI information is obtained from extension workers, followed by fellow farmers and other media sources such as television and newspapers (Muhyidin, 2023). Based on relevant research, the low pregnancy rate in beef cattle using AI technology in Soppeng Regency can be attributed to several factors. To begin with, the intention of farmers to check pregnancy by the AI technician is still low. In addition, farmers apply an extensive maintenance system. Furthermore, the location of farmers is difficult for AI technicians to reach. In conclusion, farmers lack knowledge regarding detecting heat in beef cattle. The profitability of a farming enterprise is a crucial factor that motivates farmers to adopt new technologies. If a technology is perceived to be profitable, farmers are more likely to implement it in their farming practices (Bonewati *et al.*, 2020). Profitability is a crucial driver of business success and sustainability, and farmers are no exception to this rule. Farmers continuously explore ways to improve their yields, reduce expenses, and increase profits. Therefore, if a technology can assist farms in achieving these objectives, it is highly probable to embrace it. The profitability of a farming enterprise is a vital consideration when assessing the adoption of new technologies. If a technology can demonstrate that it will lead to enhanced profitability, farmers will be more inclined to incorporate it into their farming practices. As a result, it is critical to evaluate and communicate the potential profitability benefits of any new technology being introduced to farmers.

Farmers attitudes

The statistical analysis reveals that the variable measuring farmers' attitudes has a level of significance with a value of 0.000. This suggests that the attitudes of beef cattle farmers in Soppeng Regency play a vital role in adopting AI technology. Specifically, the economic benefits of AI, the sustainability of AI technology, the ease or complexity of implementing AI, and the availability of free AI provided by the government are the key components of farmers' attitudes that drive the adoption of AI technology. Individuals who implemented AI were confident in the positive outcomes that the technology had to offer. The implementation of AI technology has brought about a significant improvement in the economic status of farmers in the Soppeng Regency. This progress has also led to an increase in the production of calves, demonstrating the positive impact of AI technology on their livelihoods. As a result, farmers in the region have embraced this technology with open arms and remain optimistic about its potential. Farmers frequently engage the services of an AI technician to extract straw from large bulls, including the Limousin and Simental breeds. However, due to the limited supply of government-funded straws available for these particular breeds,

AI technicians may need to procure additional straws to fulfill the farmers' requirements. By applying AI technology, genetic improvement of livestock and economic benefits for small farmers are expected (Müller-Sepúlveda *et al*., 2020). Farmers have demonstrated a proactive attitude and increased enthusiasm towards integrating AI technology into their farms, primarily due to the ability of AI technicians to enable them to select the sex of the calves produced through AI implementation. Typically, farmers prefer bull calves over cow calves, as the prices of bulls are relatively stable when sold. This positive attitude towards AI implementation in the agricultural sector highlights the potential benefits of AI technology for improving farm productivity and profitability.

Their perception of its consequences influences farmers' adoption of AI technology. A positive attitude increases farmers' chances of adopting technology as it reflects in their behavior. The reasons that motivate farmers to implement conventional or organic farming systems depend on several factors, such as their level of awareness, social perception, available resources, and perceived profitability (Riar *et al.*, 2017). Farmers' attitudes are significantly influenced by perceived interests in cases where farmers perceive that AI can enhance the output and productivity of businesses, likely to indirectly alter disposition towards improving farming practices (Okkyla *et al.*, 2013). According to Ajzen (2005), an individual's attitude toward a particular behavior is determined by the person's beliefs about the positive and negative consequences of engaging in that behavior. Behavioral beliefs and outcome evaluations are the two factors that determine an individual's attitude toward a behavior. Behavioral beliefs refer to the person's understanding and perception of a particular behavior's positive and negative consequences. In contrast, outcome evaluations refer to the person's value and subjective assessment of the outcomes of that behavior. Therefore, a person's attitude towards a behavior is shaped by their beliefs about the outcomes of that behavior and their values regarding those outcomes.

Farmers subjective norms

Subjective norms refer to external factors impacting farmers' decisions to adopt AI technology, such as family, fellow farmers, government, media, AI technicians, and extension workers. In Soppeng Regency, a predominantly rural region where most of the population is farming, this occupation significantly influences the social environment. The farmers' subjective norms variable was found to hold a significance value of 0.001, indicating its crucial role in influencing farmers to adopt AI technology in this area. This allowed the farmers' decision to adopt AI to be influenced by a social environment that shared the same perspective on AI technology. Additionally, the adoption process begins within the immediate environment, such as family members. Farmers in Soppeng Regency rely primarily on their family members to work on farms. Family members' opinions and decisions significantly influence whether farmers adopt AI or NM. Farmers consider family members' opinions when making decisions. Families with members working in both the agriculture and livestock sectors were more likely to opt for AI, possibly due to increased exposure and awareness of AI information (Mushonga *et al*., 2017). The influence of others in one's social environment on one's behavior is known as subjective norms, as defined by Effendi *et al* (2020).

To expedite the adoption process, it is recommended that extension workers engage local community figures or role models. The rapid acceptance of innovations presented by individuals known and respected within these communities is a proven approach (Ismael, 2019). Farmers who utilize AI technology typically participate in farmer groups organized and facilitated by local government authorities. These groups provide a platform for farmers to engage and interact with multiple stakeholders and industry players. Participation in the group variable did not significantly affect the adoption of AI technology in Soppeng Regency. However, it was observed that joining farmer groups provided the benefit of accessing information on the technology. According to a study conducted by Ediset & Heriyanto (2018), the adoption of AI innovations among farmers was not influenced by farmers' status within or outside the group. However, the study found that group membership was preferred over non-membership, as it facilitated easy and timely access to relevant information from colleagues. However, it is essential to note that group membership did not necessarily correlate with more incredible innovation among the farmers.

According to Ajzen (2005), subjective norms refer to an individual's perception of the social pressure exerted by essential people in their lives, which determines whether the individual is inclined to exhibit or refrain from a particular behavior as demanded by such people. Subjective norms refer to an individual's perception of the social pressure their environment exerts to either engage in or refrain from certain behaviors. These norms are shaped by the individual's normative beliefs about agreeing or disagreeing with a particular person or group they hold in high regard and their motivation to comply with these recommendations. Therefore, subjective norms result from accumulating normative beliefs and the individual's motivation to comply.

Farmers behavioral control

Farmers' behavioral control influences the decision to adopt AI technology in farming practices, including the increased costs associated with raising AI cows, providing additional costs to AI technicians, the ability to participate in the AI program, and the potential risks. A statistical analysis conducted on the farmers revealed that the level of behavioral control had a significant value of 0.006. These findings suggest that the

farmers' behavioral control level plays a vital role in their decision to adopt AI technology in Soppeng Regency. It is important to consider these factors when implementing AI technology in farming practices to ensure a successful adoption. According to (Roumei *et al*., 2016), most farmers who have implemented AI technology have reported feeling capable of carrying out AI activities, despite the additional investment of time and resources. Farmers can reap significant benefits from the simplicity and flexibility provided by AI technology, especially if the innovation is unique from earlier technologies that were financially and temporally expedient. The prospect of potential risks, such as the cows perishing during the birthing process or failing to conceive, coupled with the farmer incurring additional costs for implementing AI, led them to reconsider adopting this technology. Farmers who did not utilize AI faced various obstacles and constraints that created a negative perception. The farmers' perception of AI adoption was so strong that it impeded them from moving ahead with the implementation phase. Simply put, they were only open to adopting AI technology if they had seen it work successfully for others. Whether AI succeeds or fails has a noteworthy impact on people's inclination to embrace such technology. The adoption of AI by farmers is contingent on its success or failure, which can be influenced by factors such as socio-economic status, risk and economic orientation, and the number of livestock held (Rathod *et al*., 2017). As observed by Bayan (2018), farmers found AI technology risky, hindering farmers' adoption, such as difficulty accessing local breeding bulls.

The government's policy of implementing AI technology for free, providing high-yielding straw types of bulls, like Simental and Limousin, and allowing farmers to control the sex of the calf produced has successfully persuaded more farmers in Soppeng Regency to adopt this technology. However, only a small percentage of farmers have done so. Most farmers have exhibited a favorable response towards the incorporation of AI technology provided by the government. Only a negligible fraction has expressed indifference. A few farmers who have not yet embraced AI have encountered technical impediments in implementing it, particularly in Soppeng Regency. Nevertheless, most farmers who have adopted AI have found it highly convenient and advantageous and intend to persevere in their usage. Some farmers are hesitant to adopt AI technology due to challenges related to regional accessibility and limited communication options. As a result, farmers' perception of AI technology is often negative, influenced by the barriers they face during the adoption process. These obstacles make it more difficult for farmers to reach the adoption stage, which can hinder their ability to benefit from the technology entirely. Ajzen (2005) said that behavioral control is influenced by a person's control beliefs, which are their beliefs about the factors that could either support or inhibit their behavior. If someone believes they can do something based on their ability, they will feel more in control of their behavior. These beliefs can stem from past experiences with a behavior, knowledge obtained by observing others, or other factors that can affect how difficult or easy it is to carry out the behavior. Ultimately, a person's sense of behavioral control depends on their belief in their ability to adopt a behavior.

Extension workers had a critical role in changing the mindset of rural farmers towards AI technology. By serving as intermediaries between the government and farmers, they can effectively disseminate information and facilitate the adoption of new technology. This can help overcome the obstacles that hinder the widespread adoption of AI technology in rural areas, ultimately leading to improved agricultural practices and increased productivity (Baba *et al*., 2019). Researched by Kubkomawa (2018), although AI technology could bring financial gains, it also has some drawbacks, such as added labor costs. Expertise in AI was crucial to detecting heat in cows accurately, which helped predict the best time for insemination. In addition, the proper technical facilities and high-quality feed were also essential to ensure the cows' well-being during the process.

A collaborative effort between governments and relevant stakeholders should be undertaken to facilitate the widespread availability and cost-effectiveness of AI technology to benefit farmers of all kinds. To ensure the successful development of AI, it is crucial to have a clear understanding of the goals and direction of the farmers. For instance, farmers may wish to introduce a profitable gene of cattle, hire more AI technicians, provide the necessary equipment and transportation, and ensure adequate access to the AI. In addition, it is imperative to intensify the extension process, particularly in detecting heat, which plays a vital role in the farming process (Valeta & Boelema, 2015). Farmers who participate in groups and attend extension activities have access to information that can positively impact the productive activities of the livestock sector (Bonewati *et al*., 2022). This data can encourage incorporating AI technology in farmers' operations, particularly among those considering doing so. Factors such as the quality of frozen sperm, the skills of AI technicians, heat reporting, the reproductive condition of cows, farmers' knowledge of heat detection supported by recording results, and farmers willingness to adopt AI technology, as well as their farming experience, business scale, and participation of extension workers in providing information can all play a role in successful artificial insemination. At the same time, there are risks to consider (Chalak *et al.*, 2017).

To encourage more beef cattle farmers in Soppeng Regency to adopt AI technology, it is crucial to enhance the supporting facilities and infrastructure throughout the entire process. This includes deploying a well-distributed team of AI technicians and conducting regular outreach programs in areas where most non-adopters

reside. By doing so, it can ensure that farmers can access the right resources and knowledge to implement AI technology in their operations successfully. This will assist farmers in developing a positive perception of AI technology, making them more receptive to it. According to (Sa'adah *et al*., 2019), AI technicians should be distributed evenly across the work area for equal opportunities and fairness. Regular evaluation of AI technology is vital to achieve the goal of improving the technical implementation of AI. To optimize the services provided to farmers, it is crucial to identify areas that require improvement through a focused assessment of AI. Such an initiative can result in significant benefits for farmers and the agriculture industry at large. The government must ensure the program remains on track and produces a positive outcome. It's worth mentioning that AI technology has demonstrated promising results in increasing the number of beef cattle and improving their genetic quality. Utilizing advanced techniques such as artificial insemination, in vitro fertilization, and embryo transfer, farmers can breed superior quality of calves possessing desirable traits such as enhanced meat quality, disease resistance, and faster growth rates. Implementing AI technology enables local farmers to achieve financial benefits by producing a greater quantity of higher-quality beef cattle, which can be sold at premium prices. In addition, using AI technology can assist in reducing labor expenses while simultaneously improving the efficiency of farmers' operations.

Conclusion

The successful adoption of artificial insemination technology in beef cattle farming in Soppeng Regency depends on various factors. While technical aspects and supporting infrastructure are critical, other factors, such as farmers' willingness to adopt the technology, proactive attitudes, and positive perceptions, also play a significant role in their decision-making. Additionally, regional accessibility, farming maintenance systems, and extension activities are crucial aspects to consider. Therefore, before implementing the technology, it is essential to pay special attention to these areas and provide appropriate interventions to ensure its success. The findings of this study hold significant value in identifying areas that warrant further attention and government interventions before implementing the proposed technology. It is imperative to carefully evaluate the outcomes of this study to ensure a smooth and efficient implementation process. Therefore, these study findings serve as a vital tool in the decision-making process for successfully executing the proposed technology.

Conflict of interest

The study was conducted under pristine conditions in the field, considering the opinions and perspectives of farmers in Soppeng Regency. This ensured no conflict of interest with financial entities or organizations regarding the subject matter discussed in the manuscript.

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Author's contribution

The first author has full responsibility and control for this manuscript starting from determining the theme, literature, and field study, performing the statistical analysis, to manuscript revision. Meanwhile, other authors contributed to the field and literature study of this manuscript.

Ethics approval

The research has complied with all relevant national regulations and institutional policies and has been approved by the authors's institutional review board or equivalent committee based on the final report that has been reported on the BIMA application belonging to Indonesia's Ministry of Education and Culture, Research and Technology.

References

Abraha, B., M. Gezahegn, and J. Yousuf. 2020. Adoption of artificial insemination service for cattle crossbreeding by smallholder farmers in Laelay-Maichew district, Tigray, Ethiopia. Journal of Development and Agricultural Economics 12: 104–112.

Ajzen, I. 2005. Attitudes, Personality, and Behavior (2nd Eds). Open University Press-McGraw Hill Education, Berkshire, UK.

Azizah, S., F. Wardani, and I. H. Djunaidi. 2022. Breeder satisfaction and cows' artificial insemination in a national cow artificial insemination program. Archivos de Zootecnia. J. Arch. Zootec. 71: 262-268.

Baba, S., M. I. A. Dagong., S. Sohrah, and R. F. Utamy. 2019. Factors affecting the adoption of agricultural by-products as feed by beef cattle farmers in Maros Regency of South Sulawesi, Indonesia. Tropical Animal Science Journal 42: 76–80.

Baba, S., S. N. Sirajuddin, A. Abdullah, and M. Aminawar. 2014. Hambatan adopsi integrasi jagung dan ternak sapi di Kabupaten Maros, Gowa dan Takalar. JITP 3: 114–120.

Badan Pusat Statistik Kabupaten Soppeng and Dinas Komunikasi dan Informatika Kabupaten Soppeng. 2018. Kabupaten Soppeng dalam Angka. 1102001.7312. ISSN: 0215-4447.

Bahar, L. D., I. Sudirman, and S. N. Sirajuddin. 2017. Artificial insemination in Bali cattle. Entomol. Appl. Sci. Lett. 4: 34–37.

Bayan, B. 2018. Factors Influencing the extent of adoption of artificial insemination (AI) technology among cattle farmers in Assam. Indian Journal of Economics and Development. 14: 528-534.

Bonewati, Y. I., S. N. Sirajuddin, and A. Abdullah. 2022. Peran perempuan yang tergabung dalam kelompok wanita tani (KWT) pada usaha ternak sapi potong dengan sistem integrasi. Jurnal Sains dan Teknologi Peternakan 4: 1–9.

Bonewati, Y. I., S. N. Sirajuddin, and M. Yusuf. 2020. Causes of low pregnancy rates in beef cattle through artificial insemination technology in Soppeng Regency (Case Study: Performance of the 2018 UPSUS SIWAB). IOP Conf Ser : Earth Environ. Sci. 492: 1-7.

Budiaji, W. 2013. Skala pengukuran dan jumlah respon skala likert. Jurnal Ilmu Pertanian dan Perikanan 2: 127–133.

Burhansyah, R. 2014. Factors affecting the adoption of agricultural innovation among farmers groups in West Kalimantan (Case Studies: Pontianak and Landak Districts). Informatika Peternakan 23: 65–74.

Chalak, A., A. Irani, J. Chaaban, I. Bashour, K. Seyfert, K. Smoot, and G.K. Abebe. 2017. Farmers' willingness to adopt conservation agriculture: New evidence from Lebanon. J. Environmental Management 60: 693–704.

Ediset and E. Heriyanto. 2018. Tingkat keberhasilan dan pengaruh status sosial ekonomi terhadap adopsi inovasi inseminasi buatan (IB) pada usaha peternakan kerbau di Kabupaten Padang Pariaman Sumatera Barat. Jurnal Peternakan Sriwijaya 7: 6-14.

Effendi, M. I., D. Sugandini, Y. Istanto, R. Arundati, and T. Adisti. 2020. Adopsi Teknologi Pada UKM. Zahir Publishing, Yogyakarta.

Firmansyah, D. and Dede. 2022. Teknik pengambilan sampel umum dalam metodologi penelitian: Literature Review. Jurnal Ilmiah Pendidikan Holistik 1: 85–114.

Ghozali, I. 2016. Aplikasi analisis multivariete dengan program IBM SPSS 23 (8th Ed). Universitas Diponegoro Press, Semarang.

Hajong, D., A. K. Patel, Pramendra, B. L. Manjunatha, S. Kachhawaha, and P. Tewari. 2023. Adoption of artificial insemination among large ruminants in Arid Western Rajasthan, India. Indian Journal of Extension Education. 59: 65–69.

Ingabire, M. C., Y. Liu., J. C. Pesha, and A. Hardi. 2018. Factors affecting adoption of artificial insemination technology by small dairy farmers in Rwanda: A Case of Rwamagana District. Journal of Economics and Sustainable Development 9: 46-53.

Ismael, Y. I. 2019. Teknik dan Strategi Penyuluhan Pertanian Era Kreatif. Manggu Makmur Tanjung Lestari (Anggota IKAPI), Bandung.

Kotimah, M. K. and S. P. Wulandari. 2014. Model regresi logistik biner stratifikasi pada partisipasi ekonomi perempuan di Provinsi Jawa Timur. Jurnal Sains dan Seni Pomits 3: 2337–3520.

Kubkomawa, H. I. 2018. The use of artificial insemination (AI) technology in improving milk, beef and reproductive efficiency in tropical Africa: A review. Journal of Dairy Veterinary Sciences 5: 1–18.

Muhyidin, M. 2023. Analisis tingkat pengetahuan, sikap, dan motivasi peternak sapi dalam adopsi teknologi inseminasi buatan di Sumbawa Barat. Jurnal Ilmu dan Teknologi Peternakan Tropis 6: 304–312.

Müller-Sepúlveda, A., C. Foerster, G. Arrigada, J. E. Silva, and M. Ortiz. 2020. Factors that affect the success of artificial insemination in cattle of small farmers in the O´Higgins region of Central Chile. Rev FCA UNCOYO. 52: 376–388.

Mushonga, B., J. P. Dusabe, E. Kandiwa, E. Bhebhe, G. Habarugira, and A. Samkange. 2017. Artificial Insemination in Nyagatare District: Level of Adoption and the Factors determining its Adoption. Alexandria Journal of Veterinary Sciences 55: 1-7.

Ningsih, S. and H. Dukalang. 2019. Penerapan metode suksesif interval pada analsis regresi linier berganda. Jambura Journal of Mathematics 1: 43-53.

Okkyla, S., Isbandi, and D. Samsudewa. 2013. The correlation of motivation and behavior to artificial insemination used of dairy cattle farmers group members (Case studies in Sub-district of West Ungaran, Semarang Regency). Animal Agricultural Journal 2: 1-7.

Ranacher, L., B. Pollakova, P. Schwarzbauer, S. Liebal, N. Weber, and F. Hesser. 2021. Farmers' willingness to adopt short rotation plantations on marginal lands: Qualitative study about incentives and barriers in Slovakia. BioEnergy Research 14: 357–373.

Rasouliazar, S. and S. Fealy. 2014. Analysis of knowledge and attitude of cattle ranchers towards artificial insemination in dairy cattle (Case study: West Azerbaijan Province, Iran). International Conf on Earth, Environment and Life Sciences (EELS 2014): 57–59.

Rathod, P., M. Chander, and C. Sharma. 2017. Adoption status of artificial insemination in Indian dairy sector: Application of multinomial logit model. J. Appl. Anim. Res. 45: 442–446.

Riar, A., L. S. Mandloi, R. S. Poswal, M. M. Messmer, and G. S. Bhullar. 2017. A diagnosis of biophysical and socio-economic factors influencing farmers' choice to adopt organic or conventional farming systems for cotton production. Frontiers in Plant Science 8: 1-11.

Roumei, X., W. Yanrui, and L. Jingdong. 2016. Analysis of farmers' willingness to adopt genetically modified insect-resistant rice in China. China Agricultural Economic Review 8: 368–382.

Sa'adah, I., Mukson, and Y. S. Ondho. 2019. Pengukuran tingkat kepuasan peternak dalam pelayanan inseminasi buatan menggunakan analisis customer satisfaction index (CSI) dan importance performance analysis (IPA). Jurnal Ekonomi Pertanian dan Agribisnis 3: 557–567.

Sirajuddin, S. N., Hastang, V. S. Lestari, and Rosmawaty. 2019. Livestock ecology research on institution and traditional sharing systems in cattle farms. Eurasia J. Biosci. 13: 239–244.

Sultan, R. 2018. Kajian pelaksanaan program insiminasi buatan dalam mendukung program pencapaian sejuta ekor sapi pemerintah Sulawesi Selatan. Agrovital Jurnal Ilmu Pertanian Universitas Al Asyariah 3: 87–92.

Susilawati, T. and A. P. A. Yekti. 2018. Teknologi Inseminasi Buatan Menggunakan Semen Cair (Liquid Semen): Solusi untuk Daerah yang Tidak Ada/Sulit Nitrogen Cair. UB Press, Malang.

Suteky, T. 2021. Factors affecting adoption of beef cattle artificial insemination (AI) in smallholder farmers in Bengkulu Province, Indonesia. Research Proceedings of the International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020) 13: 194–198.

Valeta, A. and R. Boelema. 2015. Final report on artificial insemination business model assessment. ATRADE Partners, Zambia.

Warren, C. R., R. Burton, O. Buchanan, and R. V. Birnie. 2016. Limited adoption of short rotation coppice: the role of farmers' socio-cultural identity in influencing practice. Journal of Rural Studies 45: 175–183.