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FACTORS SUPPORTING THE SUCCESS OF ARTIFICIAL INSEMINATION IN BEEF CATTLE IN EAST LANGSA DISTRICT LANGSA CITY

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ABSTRACT

Cattle farming plays a crucial role in ensuring food security and meeting the protein requirements of humans. It is not only appealing due to its simplicity in care but also because it can make use of plant-based feed. Artificial insemination (AI) can be employed to boost the cattle population. This study aimed to analyze the factors influencing the success of AI in beef cattle within the East Langsa District of Langsa City. The sampling method utilized was purposive sampling, involving 42 respondents. Statistical analysis involved classical assumption tests, multiple linear regression, and hypothesis testing to identify the factors impacting the success of AI in beef cattle. Data processing was conducted using the SPSS computer software. The results revealed that the AI tool variables (X_2), including inseminator origin, inseminator service, AI success rate, and AI equipment, had a significant effect (significance value 0.010) on the success of artificial insemination (Y). Similarly, the inseminator variable (X_4), involving inseminator ability without special education, AI special education, inseminator ability to detect cattle in heat, and the inseminator's capability to insert frozen semen into the uterus even when the animal is not in heat, demonstrated a significant impact. Conversely, examining the livestock condition variable (X_1), such as no sick cows in the last year, cows in good health before AI, and yearly calving, did not exhibit a significant effect (significance value 0.816). Further research is urgently required, incorporating additional variables to strengthen the factors that can enhance artificial insemination and increase livestock production.

Keywords: abilities of the inseminator; artificial insemination; calving cows.

INTRODUCTION

Cattle farming provides an important food source for the human population. Beef is a rich and high-quality source of animal protein, containing 22 grams of protein, 4.5 grams of fat, and 123 kilocalories of energy (Ahmad et al., 2018). Adequate protein consumption is important for human health and growth. Beef also contains important vitamins and minerals, such as vitamin B12, vitamin B3, vitamin B6, vitamin B2, and vitamin B5 (Li, 2017). Meanwhile, the minerals found in beef include iron, zinc, phosphorus, selenium, and potassium (Roseland et al., 2018). Countries can sustainably meet their people's protein needs through thriving cattle herding. Cattle farming provides opportunities for many people in various sectors, from breeders and regular workers to sales and marketing personnel. The cattle farming industry can create significant jobs (Iyai et al. 2020), helping to reduce the unemployment rate and provide income for the people. Countries with a thriving cattle farming industry can import and export livestock products, such as beef, cow's milk, and derivative products. This can create significant foreign exchange income through exports of livestock products (Dennard 2019). The foreign exchange earned can be used to strengthen the country's economy, develop infrastructure, and finance the country's development. Cattle farms are usually located in rural areas and can increase economic growth (Guntoro et al., 2016). Cattle farming requires a supply of feed and animal care, which can encourage the development of the agricultural sector and the surrounding industry. This provides opportunities for rural residents to engage in sustainable economic activities and contribute to their well-being.

Langsa City is a city in the province of Aceh, Indonesia. It is approximately 400 km from the city of Banda Aceh. Administratively, Langsa City consists of five sub-districts: Langsa Barat, Langsa Baro, Langsa Kota, Langsa Lama, and Langsa Timur. It covers an area of 39.83 km^2. In 2021, the population of Langsa City was 185,622 people. The people in this area are predominantly engaged in economic sectors such as fisheries, plantations, industry, services, and the livestock sector. Langsa City has been experiencing significant annual development and progress. This continuous development provides promising prospects for cattle breeding in Kola Langsa. According to the Central Bureau of Statistics for Langsa City (BPS, 2022), cattle farms increased from 7,177 heads in 2020 to 8,715. This figure is expected to continue increasing each year. The residents of Langsa City themselves have a preference for consuming beef, leading to a constant rise in market demand, particularly during the days of sacrifice and meugang (an Acehnese tradition of welcoming the holy month of Ramadan) (Budisatria et al., 2019). To meet the continuously increasing demand, Langsa City urgently requires innovative measures to support the accelerated growth of the cattle population.

East Langsa District administratively has 16 villages and has the highest prospects for cattle development in Langsa City. According to BPS (2022), cattle production has increased from 2,375 in 2020 to 3,059 in 2021. The East Langsa people traditionally raise cattle by relying on forage. The extent of plantations in this area makes forage easy to find to meet livestock needs. This location is also dominated by the PTPN 1 plantation, which is planted with oil palm, so many people work at the company. Opportunities exist to improve the people of East Langsa in raising cattle. Animal husbandry activities carried out in this area do not always run smoothly. One of the obstacles experienced by the community is the low rate of livestock reproduction, so the population growth rate is still slow. One of the factors that support the success of cattle reproduction can be done with artificial insemination.

Artificial insemination (AI) is an artificial reproduction technique in which sperm from carefully selected bulls is artificially injected into the uterus of a female cow (Parkinson & Morrell, 2018). This method helps farmers maximize the use of superior bulls by fertilizing many female cows. Under natural conditions, one bull can only fertilize a few cows at a time, whereas with AI, male sperm can fertilize hundreds of cows quickly (Anggraeni et al., 2016). This method helps to increase pregnancy rates and accelerate the growth of the productive female cattle population. Through AI, breeders can ensure that the sperm they use is free from infectious diseases and genetic disorders (Kaya et al., 2021). Artificial insemination helps prevent the spread of diseases and minimizes the risk of diseases in newborn livestock (Mohammed 2018). Selecting disease-free and genetically healthy sperm can also reduce the risk of health problems and increase livestock resilience.

Knowing the factors that influence the success of AI in cattle is very important for farmers to increase the efficiency and productivity of their livestock (Müller-Sepúlveda et al. 2020). The selection of the right factors and the application of the right steps will provide an opportunity to increase the success of AI (Setiana et al. 2020), resulting in high-quality, productive, and profitable cattle populations. Several studies related to this topic have been conducted in various regions but have never been conducted in Langsa City. A similar study was conducted by Putri et al. (2020) in Asahan District, North Sumatra Province. This study utilizes limited variables such as the farmer's age, education, and inseminators. Müller-Sepúlveda et al. (2020) also conducted a similar study using social, environmental, and biological variables in Chile. It is important to conduct this research using different variables to determine which factors can increase artificial insemination in cattle. This study aimed to analyze the factors influencing the success of AI in beef cattle within the East Langsa District of Langsa City.

MATERIALS AND METHODS

The research occurred in East Langsa, Langsa City, Aceh, from October 2021 to November 2021. The survey method was used to collect data for this research. Questionnaires and interviews were used as research instruments. The acquired data consisted of both primary and secondary data. A descriptive analysis was conducted on a significant sample population in East Langsa, utilizing the Slovin formula as described by (Dodi Sukma R.A et al., 2021). The Slovin technique allowed for a sample range of 10-20% of the study population. For this study, a 15% error rate was employed. The sample consisted of 42 farmer respondents who owned at least one female cow that had undergone Artificial Insemination (AI) technology. The researchers used the Likert scale to evaluate attitudes, opinions, and individual or group perceptions of the social phenomena under investigation. The Likert scale used was a checklist, where the measured variables were divided into variable indicators. The Likert scale's objective was to assess the impact of livestock conditions, AI devices, breeders, and inseminators on the success of AI.

Classical Assumption Test

a. Normality Test

The normality test aims to ascertain whether the variables in the distributed regression model, both dependent and independent, follow a normal distribution. The effectiveness of the regression model can be assessed by examining whether the data conforms to a normal distribution or is in proximity to a significant value on the Kolmogorov-Smirnov test. If the significance value (sig.) > 0.05, it signifies that the data are normally distributed (Adha et al., 2020).

b. Multicollinearity Test

The multicollinearity test examines whether there is a correlation among the independent variables in the regression model. To determine the presence of multicollinearity, an analysis of the correlation matrix of the independent variables can be conducted, considering the Variance Inflation Factor (VIF). When the tolerance value is low, it results in a high VIF value (due to VIF–1/tolerance), indicating significant collinearity. The commonly accepted threshold for VIF is greater than 10. If the VIF value is less than 10, multicollinearity is absent (Hızlı 2022).

c. Autocorrelation test

The autocorrelation test is used to examine whether there is a connection between noise in the time series, specifically between the current time (t) and the preceding time (t-1), within a linear regression model. When such a connection exists, it is referred to as autocorrelation. One can perform the Durbin-Watson test (DW) to determine autocorrelation, where the DW value is computed and compared to the DW table (Basriwijaya et al. 2021).

Multiple Linear Analysis

Multiple regression analysis involves two or more independent variables affecting the dependent variable. In this case, there is a functional relationship between the dependent variable, namely Artificial Insemination Success (Y), and the four independent variables, namely Livestock Condition (X_1), AI Equipment (X_2), Breeder (X_3), and Inseminator (X_4). To facilitate regression calculations from quite a lot of data, this study was completed with the help of SPSS 20 computer software (Sugiarto et al., 2019).

To find out the effect, you can use the multiple linear regression analysis equations as follows (Zone, 2020):

$$Y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + e \quad (1)$$

Where : Y = Artificial Insemination Success (Score); a = Constant; b = Regression Coefficient; x_1 = Livestock Condition (score); x_2 = AI device (score); x_3 = Breeder (score); x4 = Inseminators (score); e = Standard Error

The questions asked of respondents (Table 1) to get the results of this study are as follows:

Table 1. List of AI supporting factor questions based on the specified variables

Livestock Condition (X_1)	AI device (X_2)
- None of the cows have been sick in the last 1 year	- The inseminator comes from the agriculture service
- Cattle before AI must be in good health	- Satisfying inseminator service
- Every year the mother cow gives birth/breeds	- The AI success rate that is done reaches 100%
- Cattle in AI with appropriate breeds	- The AI equipment used is complete, sterile and in good condition.
Breeder (X_3)	**Inseminator (X_4)**
- Breeders understand the condition of the cow in heat	- Inseminators can carry out AI activities without obtaining certain training and education
- Breeders understand about handling cows giving birth	- Expertise as an inseminator is obtained through special education
- Breeders understand the management of cattle feed	- The inseminator must be able to recognize the cow
	- Who are in heat
- Breeders understand the management of cattle maintenance	- Inseminators may insert frozen semen into the uterus even if the animal is not in heat

Hypothesis

This study assumes that factors such as livestock conditions, AI equipment, breeders, and inseminators influence the success rate of artificial insemination. To test the hypothesis, an analysis was carried out using multiple linear regression methods with the following conditions H0: The success of artificial insemination is not affected by the condition of the livestock (X_1), AI equipment (X_2), breeder (X_3), and inseminator (X_4). H1: The success of artificial insemination is influenced by several factors, namely the condition of the livestock (X_1), AI equipment (X_2), breeder (X_3), and inseminator (X_4). The criteria for accepting or rejecting the hypothesis are Fcount < Ftable at $\alpha = 0.05$, H0 is accepted, Fcount > Ftable at $\alpha = 0.05$, and H1 is accepted.

RESULTS AND DISCUSSION

Farmer profiles (Table 2) included in this study encompass age, education level, and occupation. The percentage of farmer profiles among the respondents in Asahan District appears favorable and supports increased productivity in the livestock sector. According to Putri et al. (2020), individuals between the ages of 25 and 45 are considered highly productive.

Table 2. Profile of cattle breeder respondents in East Langsa

Characteristics	Amount (Person)	%
Age		
20 - 40 Year	18	42,85
41 - 60 Year	22	52,38
>60 Year	2	4,76
Education		
Elementary school (SD)	14	33,33
Junior high school (SMP)	12	28,57
Senior High School SMA)	16	38,09
Work		
Breeder	6	14,28
Farmer	26	61,90
Laborer	5	11,90
Self-employed	3	7,14
Past Daily Laborers	1	2,38
Civil Servants	1	2,38

Table 2 shows that the age of the respondents is predominantly in the 41-60 age group, accounting for around 52.38%. Agus & Widi (2018) state that age can influence the seriousness of a livestock business. When a person is more mature, their thinking patterns become more mature, and they are better prepared to face the challenges of finding alternative businesses or exhibiting high seriousness in running a business. The education level of these respondents indicates that 16 people have the highest education, namely SMA. The higher the education level of the breeder, the more advanced their perspective will be (MacKay, 2020). However, it is also possible that breeders with low education may lack certain abilities. This occurs because the level of experience greatly influences how to raise livestock, as knowledge can be acquired through seminars and counseling activities (Bennett et al., 2022). The primary occupation of the breeders with the highest percentage is farming, accounting for 61.90% with 26 people. Farmers typically have sufficient land for raising livestock, and forage feed is readily available from their agricultural lands. Farmers choose livestock as a side business to mitigate the risk of crop failure and as an additional source of income to meet their household needs (Ghosh, 2022).

Classical Assumption Test

a. Normality Test

Based on the normality test results, it was found that the Asymp.Sig (Table 3) value was 0.832, which indicates that this value is greater than $\alpha = 0.05$. Based on these findings, the research data meets the normality test requirements. Suppose the value found is less than 0.05, and the data has no even distribution and does not follow a diagonal pattern. In that case, the research data does not follow a normal distribution (Khatun, 2021). Therefore, based on this normality test, it shows that the data has a normal distribution.

Table 3. Normality test

Normality test		Unstandardized Residual
N		42
Normal Parameters[a,b]	Mean	0E-7
AI success	Std. Deviation	16,273
Livestock Condition	Positive	0.020
AI Device	Negative	-0.201
Breeder	Positive	0.149
Inseminators	Negative	-0.233
Kolmogorov-Smirnov Z		0.624
Asymp. Sig. (2-tailed)		0.832

Müller-Sepúlveda et al. (2020) stated that the factors influencing the success of artificial insemination will exhibit normally distributed results. Table 1 shows that the factors influencing artificial insemination (livestock conditions, AI equipment, breeders, and inseminators) on beef cattle farms in East Langsa exhibit 16.27% distributed data.

b. Multicollinearity Test

Based on the calculation results, no independent variable has a tolerance value of less than 0.10 (Table 4). In this case, the tolerance value for each variable is as follows: Livestock Condition (0.929), AI Set (0.901), Breeder (0.982), and Inseminator (0.843). The Variance Inflation Factor (VIF) calculation results also show that no independent variable has a VIF value of more than 10. The VIF values of each independent variable are as follows: Livestock Conditions (1.077), AI Equipment (1.109), Farmers (1.019), and Inseminators (1.186). Referring to the results of calculating the Tolerance and VIF values, it can be concluded that the data does not show signs of multicollinearity.

Table 4. Multicollinearity Test

Model	Collinearity Statistic		Information
	Tolerance	VIF	
Livestock Condition	0,929	1.077	Multicollinearity does not occur
AI Device	0,901	1.109	Multicollinearity does not occur
breeder	0,982	1.019	Multicollinearity does not occur
Inseminator	0,843	1.186	Multicollinearity does not occur

Table 4 shows that the factors used do not exhibit a strong linear relationship between the variables employed. This indicates that numerous other factors influence the success of artificial insemination. Cows are living beings influenced by various biological factors, including genetics, health, nutrition, and the environment (Alemneh and Getabalew 2019). These factors may vary among individual herds, resulting in response to AI devices, husbandry conditions, and inseminator performance variations. Farm management activities can also differ among breeders (Agus and Widi 2018). This encompasses aspects such as consistent use of AI tools, proper livestock care, environmental hygiene, and effective reproductive management. Such disparities in managerial practices can impact livestock response to AI devices and inseminator performance (Thaiuba & Nikzaad, 2023).

Meanwhile, livestock also possess inherent characteristics that can contribute to variations in reproductive performance and response to artificial insemination (Lafontaine et al., 2023). In addition to internal factors, external factors like weather changes, diseases, and market conditions can also affect livestock performance and the effectiveness of artificial insemination (Thaiuba and Nikzaad, 2023). When these factors change, the linear relationship between variables can become more unstable or weak.

c. Autocorrelation test

Autocorrelation arises because there is a relationship between successive observations over some time. This phenomenon often occurs in time series data, where previous observations or samples influence certain observations. The method used to identify the presence of autocorrelation is the Durbin-Watson test (DW test). The results of the autocorrelation test (Table 5) show that the DW value is 1.894, the Du value is 1.7202, and the 4-du value is 2.2798.

The DW value is a statistic used to test autocorrelation (the relationship between variables in a time series) in the residual (predictive error) regression model. The range of DW values ranges from

0 to 4 (Turner 2020). A DW value of around 2 indicates no residual autocorrelation, meaning that the residuals are independent. A DW value above 2 indicates the presence of negative autocorrelation (negative serial correlation), while a DW value below 2 indicates a possible positive correlation (positive serial correlation) (Chen 2016). The dU value is one of the components in calculating the DW value. The dU value indicates the degree of correlation between two adjacent residual observations in the time series. dU values range from -2 to 2, and dU values close to 2 indicate positive autocorrelation, while dU values close to -2 indicate negative autocorrelation. A dU value close to 0 indicates no autocorrelation (Poppe et al., 2020). The 4-dU value is also a component in calculating the DW value. The 4-dU value provides additional information regarding autocorrelation in the residuals. The 4-dU value ranges from -4 to 4. A 4-dU value close to 2 indicates positive autocorrelation, while a 4-dU value close to -2 indicates negative autocorrelation. A 4-dU value close to 0 indicates no autocorrelation (Abdulhafedh 2017).

Table 5. Autocorrelation test

Model	R	R Square	Adjusted R Square	Std. The error in the Estimate N=42	Durbin-Watson	dL	dU	4-dU
1	0.563	0.317	0.243	0.940	1.894	1,3064	1,7202	2,2798

Multiple Linear Analysis

Following are the results of testing the multiple regression model (Table 6) on the Livestock Condition variables (X_1), AI Equipment (X_2), Breeders (X_3), and Iseminator (X_4), which have an impact on the success of AI after being analyzed:

Table 6. Multiple linear analysis

Variable	Regression Coefficient	T_{count}	Sig
Constant	16.273	5.982	0.000
X_1 = Livestock Condition	0.020	0.234	0.816
X_2 = AI Device	-0.201	-2.711	0.010
X_3 = Breeder	0.149	1.904	0.065
X_4 = Iseminator	-0.233	-2.713	0.010
R-Square	0,317		
F-Count	4,287		0.006
F-table	2,850		
T-table	1,685		

The regression equation of the factors that influence the success of artificial insemination is as follows:

$$Y = 16.273 + 0,020X_1 - 0,201\, X_2 + 0,149X_3 - 0,233X_4 + e \qquad (2)$$

With the following information, If you maintain the X variables (Cattle Condition, AI Equipment, Breeder, Inseminator) with unchanged (constant) values, Artificial Insemination will still be successful with a success rate of 16.273. The regression coefficient X_1, with the number 0.020, indicates that for every one-unit increase in livestock conditions (X_1), the Y variable for Artificial Insemination Success will increase by 0.020 points. The regression coefficient X_2, which is -0.201, indicates that if the AI Toolkit (X_2) increases by one unit, the Success of Artificial Insemination (variable Y) will experience an additional 0.201 points. The regression coefficient X_3, namely -0.149, indicates that for every increase of one breeder unit (X_3), the Y variable for Artificial Insemination Success will increase by 0.149 points. The regression coefficient X_4 is -0.233, indicating that for every increase of one Inseminator unit (X_4), the Y variable for Artificial Insemination Success will decrease by 0.233 points.

The results of this study indicate that livestock health factors do not significantly increase the success of artificial insemination in cattle. This is because people lack knowledge and understanding of artificial insemination. The selected cows are old enough and believed to be capable of reproducing properly. This is following Khoirani (2022), who observed artificial insemination on 90 cows based on their age. This study showed that 85.6% of the cows experienced thirst. The people of East Langsa still depend on inseminators, so the decisions and actions of inseminators greatly affect them. Cows that are inseminated are determined by the inseminator. The inseminator plays a very important role in this activity. The results of research conducted by Salana, Dethan, and Purwantiningsih (2021) show that feed quality, inseminator skills, semen quality, and estrus detection influence the success of artificial insemination.

Cattle farming in East Langsa is still traditional farming and depends on nature. The results of this study are inversely proportional to Putri et al. (2020), which suggests that healthy cows with good body structure and a good reproductive history have a higher chance of success in the insemination process, greatly affecting artificial milk production. The healthier the cow, the higher the pregnancy rate. The more complete the equipment, the more supportive it will be in injecting semen into heifers, resulting in a higher cow pregnancy rate (Parkinson and Morrell 2018). Breeders need to understand the cow's reproductive cycle well and know when the right time is to perform artificial insemination (Agustine, Widi, and Putra 2019). They must observe signs of reproduction in cows and determine the optimal time for fertilization. Reproduction synchronization can also help increase the success of artificial insemination (Lamb and Mercadante 2016). Breeders should also understand and provide adequate nutrition. Proper nutrition is crucial in increasing the success of artificial insemination (Utami et al., 2022). Cows must be provided with a balanced diet and adequate nutrition to maintain good body condition and prepare their bodies for pregnancy. Breeders must ensure that the cows are in good health before carrying out artificial insemination. Proper vaccinations, health checks, and disease control will help increase the success rate of insemination.

Inseminators with in-depth knowledge of cattle reproduction and technical skills in carrying out insemination procedures will be able to increase the success of insemination (Müller-Sepúlveda et al. 2020). They must understand the reproductive cycle of cows, signs of heat (estrus), and correct semen injection techniques. Inseminators are responsible for identifying and monitoring signs of estrus in cows (Haadem et al., 2023). They must be careful in observing changes in the behavior and physical appearance of cows that show heat. Accurate identification and monitoring will ensure that insemination is done at the right time, thereby increasing the chances of successful insemination (Fania, Trilaksana, and Puja, 2020). Inseminators should also have good knowledge of semen quality and select high-quality semen for artificial insemination. Good semen has a high sperm concentration, viability, and motility. Inseminators must be able to store and process semen properly to maintain its quality until it is used (Novita, Zika, and Sari, 2022). Healthy cows have a higher chance of successful artificial insemination. Ensuring livestock is disease-free, receiving the right vaccinations, and obtaining routine health care are important factors. Good physical condition and a strong immune system will increase the chances of successful insemination (Mutmainna, Baco, and Hasbi, 2022).

Hypothesis Test

Data analysis revealed that the effect of livestock conditions (X_1) on AI's success was insignificant. The calculated t-value of 0.234 is smaller than the t-table value of 1.685, and the significance value of 0.816 is greater than 0.05. Thus, it is evident that the H1 hypothesis is rejected, indicating no relationship between the livestock condition variable (X_1) and the success of AI (Y). On the contrary, it appears that the AI tool (X_2) significantly influences the success of artificial insemination. The calculated t-value of -2.711 is smaller than the t-table value of 1.685, and the significance value of 0.010 is less than 0.05. These results signify that the Ha hypothesis is accepted, implying a relationship between the AI tool variable (X_2) and the success of artificial insemination (Y).

CONCLUSIONS AND SUGGESTION

The results showed that the supporting factors for artificial insemination in Langsa City were AI equipment, breeders, and inseminators. Each region has different breeding styles. Therefore, the factors supporting artificial insemination's success will also be different. The importance of adjusting to geographical conditions and considering other supporting factors for success.

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