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Analysis of Artificial Insemination Success Rates and Sustainability in East Kalimantan Province

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Abstract
The reproductive performance of beef cattle in East Kalimantan remains a significant challenge, particularly concerning the success of artificial insemination (AI) in improving herd productivity. As the region aims to boost livestock production, understanding the effectiveness of AI becomes crucial. This study analyzes the success rate of AI in beef cattle in East Kalimantan from 2022 to 2024. Using a quantitative-descriptive approach, secondary data were obtained from the Indonesian National Animal Health Information System (iSIKHNAS) and verified by the Livestock and Animal Health Service Office of the East Kalimantan Provincial Government. The success rate of AI was measured through calving rate (CvR), relative effectiveness of AI compared to natural mating, and the proportion of calving births from both methods. The results show AI calving rates of 25.86% in 2022, 10.10% in 2023, and 45.36% in 2024. The relative effectiveness of AI compared to natural mating increased in 2024, with a ratio of 1.3. The proportion of calving births through AI fluctuated yearly, indicating that while AI adoption is growing, natural mating continues to play a critical role in the reproductive system of beef cattle in East Kalimantan Province.

Keywords:
Artificial Insemination, Beef Cattle, Calving Rate, Reproductive Effectiveness

1. Introduction

Reproduction plays a crucial role in maintaining the sustainability and improving the productivity of livestock enterprises. The success of reproductive processes determines production efficiency as well as the genetic quality of livestock populations. Along with the advancement of reproductive technology, various innovations have been developed to enhance reproductive performance in animals, one of which is artificial insemination (AI). Artificial insemination (AI) has emerged as a pivotal technological advancement in animal reproduction. By enabling the fertilization of female livestock through the introduction of processed semen from selected bulls, AI circumvents the need for natural mating. This technology has become essential in modern animal husbandry due to its multifaceted benefits, including enhancing genetic quality, increased reproductive efficiency, and mitigating risks associated with reproductive diseases. Furthermore, AI significantly reduces the costs of maintaining breeding sires and optimizes the use of superior

bulls across larger cattle populations. As a result, AI contributes not only to the improvement of livestock productivity but also to the broader objectives of sustainable and efficient farming practices [1].

In Indonesia, artificial insemination (AI) plays a central role in achieving the national goal of increasing beef production to meet the growing domestic demand. The Ministry of Agriculture, through the UPSUS SIWAB program, has widely promoted the implementation of AI as a key strategy to support national beef self-sufficiency. Among various provinces in Indonesia, East Kalimantan stands out due to its vast agricultural potential and the crucial contribution of its livestock sector to national food security. Accordingly, East Kalimantan has been actively encouraging the use of AI to enhance cattle productivity and achieve self-sufficiency in animal protein production. However, despite the widespread implementation of AI, its success rates remain inconsistent across regions. In East Kalimantan, AI's effectiveness is influenced by various factors, including semen quality, the technical proficiency of inseminators, the physiological condition of the dams, and the management practices implemented at the farm level. These variables contribute to the observed variations in the success rates of AI, necessitating further investigation to better understand the underlying factors affecting its efficiency [3].

Artificial insemination (AI) comprises several critical stages that demand precise coordination and technical competence. These stages include estrus detection, the handling of frozen semen, the thawing process, and the insemination procedure itself. The success of AI is commonly evaluated based on the pregnancy rate of inseminated females, which represents the proportion of animals that conceive following insemination. Although the pregnancy rate serves as a primary benchmark, additional indicators such as the comparative efficiency of AI and natural mating, and the proportion of calves produced from each method provide valuable insights into its overall effectiveness. Although AI is becoming increasingly common, natural mating remains the predominant method in several regions. This condition is often influenced by cultural practices, the availability of skilled personnel, and limitations in infrastructure. Understanding the dynamics between these two reproductive methods is therefore essential for improving reproductive management and optimizing cattle productivity.

This study aims to analyze the success rate of artificial insemination (AI) in beef cattle in East Kalimantan Province from 2022 to 2024. The secondary data used were obtained from the Indonesian National Animal Health Information System (iSIKHNAS) and verified by the Livestock and Animal Health Service Office of East Kalimantan. The analysis also includes key factors influencing the success of AI in the region.

The findings are expected to provide an updated overview of AI performance and offer insights for optimizing its implementation at the farm level. Moreover, the results are anticipated to contribute to the development of more effective livestock management strategies and inform policy formulation aimed at improving the efficiency and sustainability of AI programs. Ultimately, this study seeks to support increased production of high-quality beef and strengthen food security in East Kalimantan.

2. Material and Methods

Research Design and Scope

This research applied a descriptive design with a quantitative approach to evaluate the effectiveness of artificial insemination (AI) in beef cattle. The study focused on analyzing numerical data, particularly Calving Rate (CvR), Relative Effectiveness (RE) of AI, and the proportion of

calvings from both AI and natural mating. The population observed was beef cattle in East Kalimantan, using secondary data recorded from 2022 to 2024.

Study Subjects and Scope

The study focused on beef cattle populations in East Kalimantan. Its scope comprised the assessment of artificial insemination (AI) outcomes, specifically Calving Rate (CvR), Relative Effectiveness (RE) of AI, and the proportion of births generated through AI in comparison with natural mating. The analysis was based on secondary records spanning the years 2022 to 2024, sourced from the official livestock data reporting system.

Type of Study

This study is descriptive research with a quantitative approach. This method was chosen to systematically and measurably describe the success rate of AI in beef cattle in East Kalimantan. The quantitative approach was used to analyze numerical data and identify trends, including CvR, RE of AI, and proportion of calving births from AI and natural breeding in East Kalimantan from 2022 to 2024.

Data Collection Techniques

This study utilized secondary data obtained from the Indonesian National Animal Health Information System (iSIKHNAS) and verified by the Livestock and Animal Health Service Office of East Kalimantan Province. The dataset consisted of artificial insemination (AI) and calving performance records obtained from several hundred beef cattle between 2022 and 2024. Data collection covered multiple districts across East Kalimantan, representing variations in management practices and environmental conditions. However, it is important to note that the iSIKHNAS recording system relies on field officer reports, which may not always be real-time or complete. Some AI procedures and calving events may have been underreported, leading to potential discrepancies between the recorded data and actual field conditions. Despite these limitations, the dataset provides a valuable overview of AI implementation in beef cattle under practical farming conditions within the province. The data used in this study include:

a) Annual data for 2022-2024 on the number of AIs in each district/city
b) Annual data for 2022-2024 on the number of calvings resulting from AI in each district/city
c) Annual data for 2022-2024 on the number of births from natural breeding in each district/city. The variables in this study were grouped into dependent and independent variables. The dependent variable was the success of artificial insemination (AI), which was measured using three indicators, namely Calving Rate (CvR), Relative Effectiveness (RE) of AI, and the proportion of calvings resulting from AI compared to natural mating. The independent variables consisted of the research location, which referred to districts or cities in East Kalimantan, and the observation period covering three consecutive years from 2022 to 2024. Data for all variables were obtained from secondary sources, particularly the iSIKHNAS system and records from the Livestock and Animal Health Service Office of East Kalimantan Province.

Research Variables

The variables in this study were grouped into dependent and independent variables. The dependent variable was the success of artificial insemination (AI), which was measured using three indicators, namely Calving Rate (CvR), Relative Effectiveness (RE) of AI, and the proportion of calvings resulting from AI compared to natural mating. The independent variables consisted of the research location, which referred to districts or cities in East Kalimantan, and the observation period

covering three consecutive years from 2022 to 2024. Data for all variables were obtained from secondary sources, particularly the iSIKHNAS system and records from the Livestock and Animal Health Service Office of East Kalimantan Province.

Research Procedure

The procedure of this study was carried out in several steps. The first step was identifying and collecting secondary data on artificial insemination (AI) performance in beef cattle. Data were taken from the iSIKHNAS system and confirmed with records from the Livestock and Animal Health Service Office of East Kalimantan Province. The dataset consisted of the number of AI services, the number of calvings from AI, and the number of calvings from natural mating during 2022–2024. After collection, the data were checked and refined to maintain accuracy and consistency, then organized by district and year. The next step was quantitative analysis to calculate Calving Rate (CvR), Relative Effectiveness (RE) of AI, and the proportion of calvings between AI and natural mating. Finally, the results were interpreted to evaluate reproductive performance and to describe trends in AI success among beef cattle in East Kalimantan.

Analytical Techniques

a) Calving Rate

The success rate of AI is the achievement of pregnancy in female livestock after the process of sperm deposition into the female reproductive tract without going through natural mating. In simple terms, this success indicates that the insemination technique applied is effective, characterized by livestock showing signs of pregnancy until finally giving birth to healthy offspring [5]. CvR is used to measure success in breeding or artificial insemination programs, as well as to assess reproductive efficiency in cattle farming. The CvR using the formula [6]:

$$CvR = \frac{Number\ of\ calvings\ by\ AI}{Number\ of\ AI\ services}\ x\ 100\%$$

Intrepetation:

- A high CvR (>50%) indicates a good success rate of artificial insemination (AI)
- A low CvR (<50%) suggests that the success of AI remains suboptimal and requires improvement.

b) The Relative Effectiveness of AI

The relative effectiveness of artificial insemination (AI) is the ratio between the number of births that occur and the number of animals inseminated, expressed as a percentage. The relative effectiveness (RE) of AI is measured by the formula:

$$RE\ = \frac{Number\ of\ calvings\ by\ AI}{Number\ of\ calvings\ by\ natural\ mating}$$

Intrepetation:

- If the ratio is >1, AI is more effective than natural mating.
- If the ratio is <1, natural mating is more effective than AI.
- If the ratio approaches 1, both methods are nearly equivalent in effectiveness.:

c) Proportion of AI and Natural Mating

The calculation of the proportion of AI and natural mating is a method used to compare the number of calvings resulting from AI with those from natural mating [7]. The aim is to assess the effectiveness and contribution of each reproductive method in increasing the

livestock population. The calculation of the Proportion of Artificial Insemination and Natural Mating Births is measured by the formula:

$$Proportion\ of\ AI = \frac{Number\ of\ calvings\ from\ AI}{Total\ of\ calving\ birth}\ x\ 100\%$$

$$Proportion\ of\ Natural\ Mating = \frac{Number\ of\ calvings\ from\ Natural\ Mating}{Total\ of\ calving\ birth}\ x\ 100\%$$

Intrepetation:

- If the proportion of AI is high (e.g., >50%), it indicates that artificial insemination is more dominant in producing births compared to natural mating.
- If the proportion of AI is low (<50%), it suggests that natural mating is still more widely used and more successful in resulting in births.

3. Results and Discussion

3.1. Calving Rate

To assess the success of AI, the reproductive parameter of CvR is used. CvR is the percentage calculated based on the birth of calves that occur after the first AI [8]. The results of the analysis of the CvR in East Kalimantan Province during 2022-2024 are presented in Table 1

Table 1:
Calving Rates in East Kalimantan Province during 2022-2024.

Year	Calving Rate (%)
2022	25.86
2023	10.10
2024	45.36

Source: Processed Primary Data, 2025

Based on Table 1, the success rate of AI in East Kalimantan Province from 2022 to 2024 showed annual fluctuations. In 2022, the CvR was recorded at 25.86%, indicating that approximately a quarter of the inseminated females successfully conceived and gave birth. In 2023, the CvR declined sharply to 10.10%. This decline may be due to inaccurate reporting by field officers, as well as other factors such as the quality of frozen semen used, feed management, and environmental conditions, including the emergence of foot and mouth disease (FMD) outbreaks that impacted livestock farming activities. This outbreak led to disruption of staff mobility, restriction of livestock traffic, and increased stress levels and decreased physiological condition of livestock, which overall decreased the success of AI. This finding aligns with Sama et al. [9], who stated that the low success of artificial insemination is influenced by various factors, including environmental conditions related to the health and stress levels of livestock and the quality of frozen semen. In addition, Adiputra et al. [10] emphasized that environmental conditions have an important role in determining the health of livestock, which affects reproductive performance.

Then in 2024, the CvR increased significantly to 45.36%. This increase indicates an improvement in the implementation of the AI program, including insemination techniques, selection of healthy parents, and optimized reproductive management. However, the calving rate recorded is still below the normal value category of 50%. This is in agreement with the opinion of Masruroh et al. [11], who stated that under normal conditions, in Indonesia, a CvR level of around 50% is considered adequate, while the calving rate range of 60 to 70% is a standard commonly applied in developed countries. The ideal calving rate is in the range of 65 to 70%.

Various factors that can contribute to the calving failure and reduced calving rate include embryo death, abortion, fetal mummification, inseminator efficiency, male and female fertility, and the ability of the mother cow to care for the calf from pregnancy to birth [12]. Furthermore, the ability of farmers to detect signs of estrus and farmers who have not reported their cows when

pregnant after AI to the relevant agencies. This is in line with the opinion of Lukman et al. [13], who stated that the success of artificial insemination in cattle is influenced by various factors, including the skills of farmers in handling cattle after pregnancy, the right time for insemination, education and training of inseminator officers, and the health and nutritional conditions of cows that will undergo insemination. These findings differ from those reported by Marwa et al. [14], where the average CvR was 51% in 2021 in Sigi District.

3.2. Relative Effectiveness of AI

AI has long been adopted as one of the methods of artificial reproduction to improve the efficiency of livestock production. The effectiveness of this technique is influenced by various factors, such as semen quality, insemination techniques, physiological conditions of the dams, and farm management [15]. According to the results of research conducted by Fania et al. [16], the success rate of IB varies greatly between locations and livestock species. The results of the relative effectiveness (RE) analysis of artificial insemination are presented in Table 2.

Table 2.
Relative Effectiveness of Artificial Insemination in East Kalimantan Province during 2022-2024

Year	Relative Effectiveness
2022	0.6
2023	0.5
2024	1.3

Source: Processed Primary Data, 2025

Based on Table 2, the RE of AI shows fluctuations over the last three years. In 2022, the RE value of AI was 0.6, indicating that natural mating still provided better reproductive results than AI. This value then decreased further to 0.5 in 2023, indicating that the effectiveness of AI in that period was still not optimal. In 2024, there was a significant increase, with the RE value of AI reaching 1.3, meaning that IB began to show better results than natural mating. In general, a ratio of less than 1 indicates that natural mating is more effective, a ratio of more than 1 indicates that AI is superior, and a ratio close to 1 means that both have almost equal success rates. This change in results illustrates an improvement in the quality of AI implementation, both in terms of technical and management resources involved. Merpati et al. [17] stated that the success of the AI program in livestock is greatly influenced by the quality and amount of semen used.

The application of AI technology is expected to accelerate the increase in livestock population, support the meat self-sufficiency program, and strengthen food security both at the regional and national levels. However, understanding and utilization of the technology is still limited, especially in remote areas. The utilization of this technology should be one of the solutions in an effort to improve the genetic quality, productivity, and population of local livestock [18].

3.3. Proportion of AI and Natural Mating

To assess the contribution of each method to increasing the livestock population, the proportion of calving births from artificial insemination and natural breeding was analyzed. This comparison is important to determine the extent to which AI technology has been adopted and how much influence it has on reproductive outcomes in the field. The results of the analysis of the proportion of calvings from artificial insemination and natural mating are presented in the form of a pie chart (Figure 1).

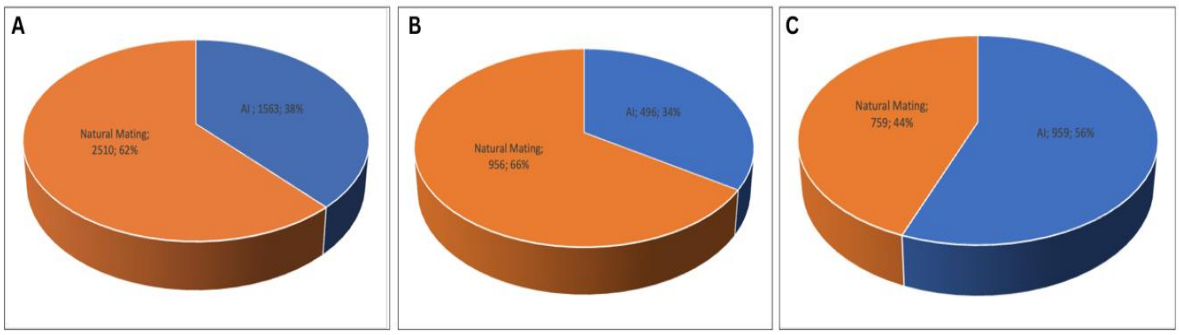

Figure 1.
Pie Chart of the Proportion of IB and Natural Mating: a) 2022, b) 2023, and c) 2024

Figure 1 shows a significant change in the proportion of calving births between AI and natural mating from 2022 to 2024. In 2022, the proportion of calving births that occurred through AI reached 38%, while 62% of calvings occurred through natural mating. In 2023, the proportion of AI births decreased slightly to 34%, while births through natural mating increased to 66%. However, in 2024, there was a considerable increase in the proportion of AI births, which reached 56%, while births through natural mating were only 44%. This change indicates an increase in the success and acceptance of AI technology among farmers, which may be influenced by increased knowledge, training, and improved techniques in the application of AI. The increase in the proportion of births through artificial insemination in 2024 also reflects the effectiveness of this technology in improving the genetic quality of livestock in a faster and more controlled manner.

One of the key factors behind this increase is the support from the government through extension programs, technical training, and direct assistance to livestock farmers. These efforts have helped increase public understanding of the benefits of AI and how to apply it appropriately so that the use of this technology is more widespread and the results are more optimal. As stated by Fahrullah et al. [19], government support can encourage livestock farmers to choose to use AI programs in their livestock businesses.

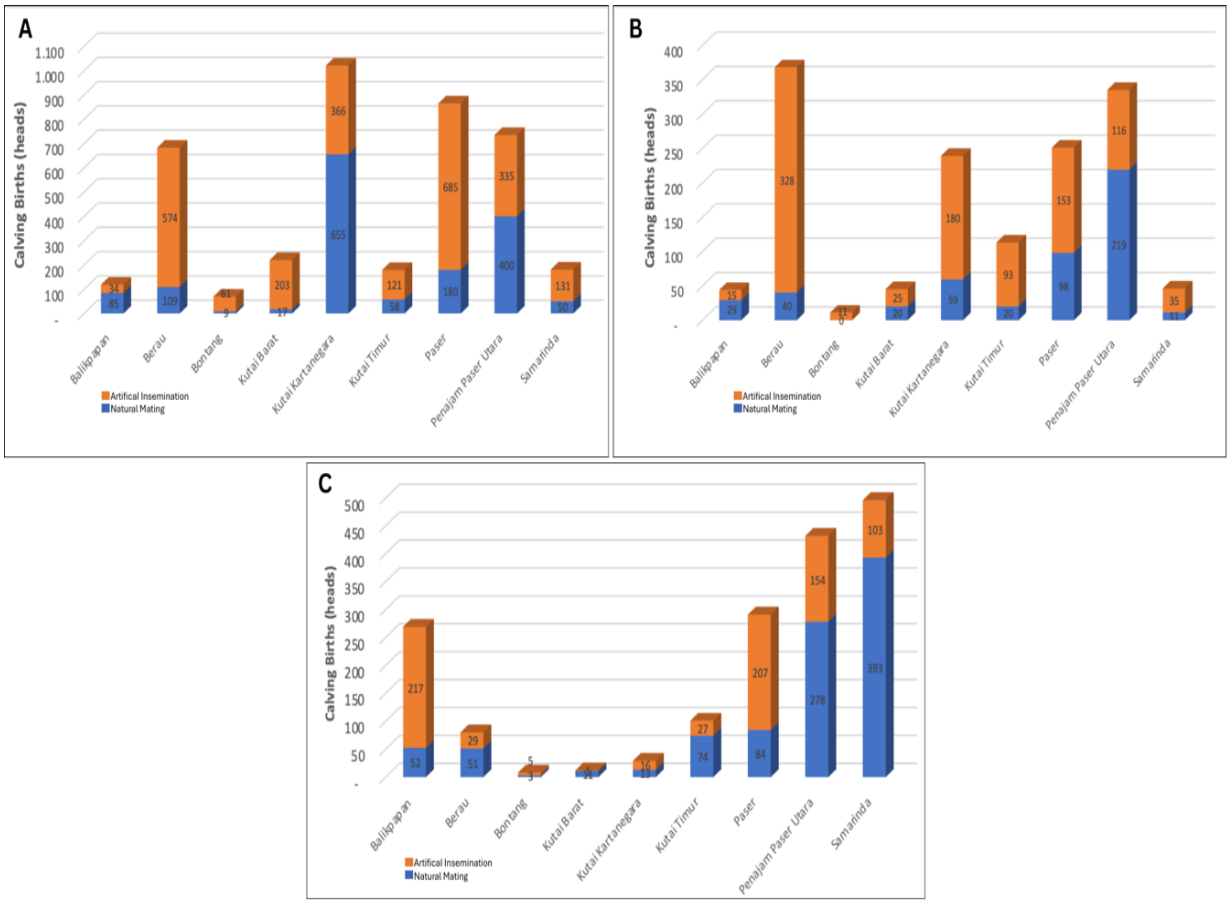

Figure 2.
Bar Chart of the Proportion Comparison Between Artificial Insemination (AI) and Natural Mating Across Districts/Cities in East Kalimantan: a) 2022, b) 2023, and c) 2024

Figure 2 presents a bar graph of the comparison of the number of calving births resulting from AI and natural mating in various districts/cities of East Kalimantan in the period 2022-2024, which illustrates the application of AI technology in efforts to increase livestock productivity. Penajam Paser Utara District shows high consistency in implementing the AI program. This reflects success in building a support system that includes counseling, technical training, and provision of supporting facilities and infrastructure. The stability of the AI birth rate in this area indicates that this method has been widely accepted by local farmers. Meanwhile, there was a significant increase in 2024 in Samarinda City, where the AI birth rate exceeded births from natural breeding. This may have been triggered by various factors, such as more farmers understanding the benefits of AI, increased access to quality frozen semen, and technical and policy support from the local government. Training programs for inseminators and incentives to farmers who participate in AI may also have contributed to this increase.

Furthermore, the use of AI is more than natural mating, one of which is that artificial insemination not only increases livestock productivity, such as growth and production, but also allows for more structured and efficient recording and monitoring of reproduction in supporting government programs in the livestock sector. This is in line with the opinion of Poli et al. [20], who stated that AI is an effective reproductive technology in accelerating genetic improvement and increasing reproductive efficiency in small- and large-scale farms. With the proper application of AI, farmers not only obtain superior offspring more quickly but can also manage the reproductive cycle

of their livestock more systematically, which ultimately has an impact on increasing income and sustainability of the livestock business.

The success of AI programs in livestock is influenced by various factors, including the biological quality of the semen used, livestock species, and variations in environmental conditions in each region. Frozen semen with high motility, good viability, and intact cell morphology has a greater chance of producing pregnancy. Selection of superior bulls and proper semen management are important components in supporting the achievement of AI [22]. This is particularly important because each livestock species has physiological differences [23, 24] that affect the response to the reproductive system. Differences in estrous cycles, hormone sensitivity, and environmental requirements, for example, between beef cattle, dairy cattle, and buffalo, demand technical adjustments based on their respective biological characteristics [25].

Local environmental conditions also have a significant influence on the reproductive system. Factors such as temperature, humidity, feed availability, and husbandry systems can affect reproductive function through stress mechanisms and hormonal imbalances. Adaptation of technology to regional characteristics is an important step in improving the efficiency and sustainability of livestock reproduction [26, 27, 28].

4. Conclusion

The results showed that the implementation of artificial insemination (AI) in East Kalimantan during the period 2022-2024 experienced variations in the level of success and effectiveness. Although the CvR declined in 2023, the significant increase in 2024 indicates an improvement in the technical and managerial implementation of the AI program. In addition, the proportion of calving births from AI also increased, even exceeding natural mating in 2024, especially in Kota Samarinda. This reflects farmers' increased acceptance and understanding of the benefits of AI, including increased livestock productivity and more orderly recording of reproduction. Therefore, AI is proven not only as an alternative to natural mating but also as a reproductive strategy that supports sustainable livestock development programs at the regional level.

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