Evaluation of the Success of Artificial Insemination in Bali Cattle in Borong, East Nusa Tenggara

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Abstract. Artificial insemination (AI) is a reproductive technology implemented to increase the population and genetic quality of beef cattle in Indonesia, including Bali cattle. This study aims to evaluate the success rate of AI in Bali cattle in Borong District, East Manggarai Regency, and analyze the factors influencing it. This study used a quantitative descriptive method with a survey technique of 173 productive female cattle that had received AI treatment. Parameters used in this evaluation included Service Per Conception (S/C) and Conception Rate (CR). The results showed that the S/C value obtained was 3.84, which means that on average a cow requires one insemination before pregnancy occurs. Meanwhile, the CR value reached 26.01%, which indicates that the success rate of AI is not good enough. The success of this AI program is influenced by several factors, including the skill of the inseminator, the quality of frozen semen, the health condition of the cows, and the correct detection of estrus. These findings indicate that the implementation of AI in Borong District has been running well and effectively in increasing the productivity of Bali cattle. This research is expected to serve as a reference for local governments and breeders in further developing AI programs. Extension to breeders on estrus detection techniques and cow husbandry management needs to be improved to maintain and improve AI success in the future.

Keywords: Artificial insemination, Bali cattle, Service Per Conception, Conception Rate

1 Introduction

One agricultural subsector with significant growth potential is livestock farming. Beef cattle are a livestock commodity with promising business prospects, and economic growth can impact food demand due to population growth, which in turn increases the demand for animal products [1]. Beef cattle is a livestock product with promising business prospects [2]. National demand for meat is increasing along with economic growth, population growth, increased education, and public awareness of the importance of consuming nutrients from livestock.

As a source of animal protein for the community, Bali cattle are one of the most profitable meat-producing livestock. Currently, the amount of animal protein consumed per person is 4.19 grams per day, equivalent to 5.25 kilograms of meat, 3.5 kilograms of eggs, and 4.94 kilograms of milk. The normal level of animal protein consumption is 62.33 grams per

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day. The government must import beef to meet Indonesia's beef needs. This import policy will make us dependent on beef-exporting countries, so we need to make efforts to increase domestic beef production.

Based on statistical data from East Manggarai Regency (2023), the beef cattle population in this region was recorded at 2,065 in 2021, increasing to 3,061 in 2022, but then dropping again to 2,976 in 2023. This decline was due to high cattle sales by livestock farmers. Livestock farmers in East Manggarai Regency, particularly in Borong District, face a major challenge: low cattle productivity and genetic quality. This is because livestock development methods are still traditional and have not adopted technology, impacting livestock production and genetic quality.

This situation will make smallholder livestock farming increasingly uncompetitive. The implementation of artificial insemination technology, which can accelerate cattle population growth, is one of the government's efforts to encourage an increase in the cattle population. One technology that has been optimized in livestock development is Artificial Insemination (AI), which has increased livestock productivity and improved farmer income and welfare. The use of AI is also considered beneficial for improving livestock performance and potential, facilitating progeny testing, and increasing the number of offspring from males proven to possess superior traits for specific production purposes [3].

East Manggarai Regency has implemented an AI program to increase the beef cattle population, with Borong District being one of the most intensively implemented districts. The goal of implementing the AI program in Borong District is to increase livestock productivity. The success of the artificial insemination program for cattle in East Manggarai Regency has resulted in improved cattle quality and improved livestock farmer incomes. According to data from the East Manggarai Livestock Service, the AI program in Borong District has been successful for the past two years, with a success rate of 60%. To ensure the program's smooth operation, the East Manggarai Regional Government employs staff trained at the Lembang Insemination Center in Bandung, West Java. With East Manggarai's status as a livestock district, this AI program is crucial for improving the economy and reducing extreme poverty in East Manggarai Regency.

2 Research Methods

This research is a quantitative descriptive study, which involves collecting data from the field and analyzing it to draw conclusions. The sample of this study was 173 productive female cattle from 64 respondents in Borong District, East Manggarai Regency, who had undergone Artificial Insemination (AI). This research was conducted in Borong District, East Manggarai Regency. This research used a direct survey technique to obtain data from breeders and inseminators. Primary data is data obtained from information from breeders' responses. Secondary data is data obtained from related agencies, such as breeders who received artificial insemination in Borong District.

The population in this study comprised the entire analysis unit of 173 productive Bali cattle in Borong District, mated using AI. The sample size represents a subset of the population and its characteristics; the sample taken must be truly representative. Because the Bali cattle population being studied is spread across these locations, descriptive analysis was conducted using the Slovin formula:

$$n = \frac{N}{1 + N(\,e\,)^2}$$

Where:
N = Population Size
n = Sample Size
e = Error Rate (0.5%)

The data collection and collection techniques used in this study were:
a) Observations were conducted through direct observation at the research site.
b) Interviews were conducted with each farmer at the research site, asking several questions to obtain the information or data needed for the study.
c) Documentation was conducted by taking photographs of the research objects to prove that the research was actually conducted.

The collected data will be processed and analyzed descriptively, namely by describing the research results to draw conclusions regarding the evaluation of the success rate of Bali cattle AI in Borong District, East Manggarai Regency.

3 Results

3.1 Characteristics of Respondents in Borong District

The characteristics of the farmers in this study include the farmer's age, education, length of farming, and gender as in Table 1.

Table 1. Characteristics of Respondents in Borong District, Nangalabang Village

	Category/Quantity	Percentage / %
Respondent Gender	Male / 63 people	98.44%
	Female / 1 person	1.56%
Respondents' Education	Elementary – Middle School / 62 people	96.88%
	High School – Bachelor's Degree / 2 people	3.13%
Respondent's age	40 - 49 years / 34 people	53.13%
	30 - 39 years / 13 people	20.31%
	50 - 70 years / 11 people	17.19%
	20 - 29 years / 6 people	9.38%

Length of Breeding	20 - 32 years / 28 people	43.75%
	3 - 20 years / 36 people	56.25%

Respondent characteristics were used to determine the identity of the farmers involved in this study, namely the farmers used as samples. A farmer used as a sample is not free from factors that influence the success of artificial insemination, including gender, age, highest level of education, and length of farming experience.

Based on Table 1, the highest age group among breeders is 40-49, representing 34 individuals, representing a percentage of 34%. This indicates that breeders are still within the productive age range. Overall, most breeders are between 46-49 years old. According to Asyraf [4], breeder age influences the success rate of AI in Bali cattle. Age can contribute to the success rate of AI. The relationship between age and experience and skills increases with age[5].

Table 1 also shows that the majority of breeders are elementary school graduates (SD-SMA), with 62 individuals (62%). Furthermore, the highest percentage of inseminators with a bachelor's degree (S1) was achieved by 2 individuals, representing 66.7%. Although the level of formal education of breeders is relatively low, this does not prevent them from possessing the knowledge and skills that play a significant role in the success of AI. According to Kastalani [6], education level influences the absorption of information and knowledge, as well as the way breeders think. However, these difficulties can be overcome through experience gained by breeders and through extension activities. The education level of inseminators is quite high, as stated by Ardhani [7], who stated that the average education of inseminators is high if they have completed 12 years of basic education.

The highest number of years of farming experience, based on Table 1, is 20-32 years, with a percentage of 36.4%. This indicates that farmers have considerable farming experience. Length of experience influences the success of AI, which is in line with Kastalani [6] who stated that farmer experience is positively correlated with productivity. The longer the farming experience, the higher the productivity. This is because longer experience allows farmers and inseminators to gain more practical knowledge and skills relevant to livestock management, including AI techniques. Success factors can be influenced by a person's age and their ability to work, which is manifested in the results they obtain.

The gender of the livestock farmers, as shown in Table 1, was predominantly male, with 63 representing 98.44% of the population, and 1 female representing 1.56%. This indicates a male predominance in this study. Success factors can be influenced by a person's gender, which affects their work ability, which is reflected in the results they achieve.

3.2 Characteristics of Livestock

The type of livestock selected for this study was Bali cattle, the most commonly raised in Borong District. Based on observations, the cattle sampled in this study were of medium size, with an average Body Condition Score (BCS) of 4. One of the parameters used for visual assessment is the *Body Condition Score* (BCS). The BCS of beef cattle is influenced by the level of feed consumption and the digestibility of the nutrients in the feed consumed [8]. In general, these livestock are broodstock or adult female cows that have previously gone through the birthing process.

Livestock farming in Borong District is still dominated by traditional systems with semi-intensive husbandry. Although livestock populations and productivity are relatively

stable, key challenges such as feed availability, livestock health, and the implementation of modern technology remain obstacles that need to be addressed to improve livestock yields. The lower the value of S/C (*Service per Conception*), then the value CR (*Conception Rate*) will be higher. In terms of S/C values, heifers showed higher values compared to mother cows. This is in line with the opinion of Huda [8], which states that as age increases, the reproductive ability of mother cows tends to decrease, thus potentially reducing the CR value.

The mother cow has *Body Condition Score* (BCS) of 4, indicating good body condition. There were 173 breeding cows, ranging in age from 21 to 22 months. The artificial insemination process in this group showed excellent results, with cows successfully becoming pregnant with just one AI. Meanwhile, the heifers also had a BCS of 4, indicating their body condition was also considered good. There were 17 heifers recorded, ranging in age from 16 to 19 months. However, the success rate of AI in heifers was slightly lower than in breeding cows, as two AIs were required to achieve pregnancy. Overall, both groups were in ideal body condition for reproduction, with breeding cows showing higher efficiency in the process of becoming pregnant through artificial insemination.

3.3 Service per Conception (S/C)

The ideal S/C value indicates good reproductive efficiency, namely when pregnancy can be achieved with the minimum number of services possible [9]. The lower the S/C value, the better the fertility of the livestock. The results of the descriptive analysis regarding the Service per Conception value in Bali cattle can be seen in the following table.

$$\frac{s}{c} = \frac{Number\ of\ IB\ until\ pregnant}{Number\ of\ expectorants\ until\ pregnancy}$$

$$\frac{173}{45} \times 100$$

$$= 3{,}84$$

The research results showed a S/C ratio of 3.84 for 173 acceptor animals. A high service per conception results in a longer calving interval compared to animals with a normal 12-month interval. According to Muslimiah [10] A good S/C ratio is 1.6 to 2.0 services. The average S/C ratio in Borong District, which is 45, indicates that only 1 to 2 inseminations will the animal become pregnant. This indicates that the S/C in the study area is not yet satisfactory, as it is higher than the established standard.

The S/C value itself is intended to indicate the fertility level of livestock. The higher the S/C value, the lower the fertility rate. High S/C values are caused by several factors, such as delays in detecting heat by breeders and inseminators and inappropriate timing of insemination, as delays in insemination can lead to pregnancy failure.

3.4 Conception Rate (CR)

Conception rate Good fertility reflects sound reproductive management, including timely AI, semen quality, and the physiological and health conditions of the cattle. The following table shows conception rate data as a measure of fertility in a population of female cattle that have undergone AI.

$$CR = \frac{\sum Number\ of\ female\ cows\ pregnant\ with\ the\ first\ IB}{\sum Number\ of\ exeptors} \text{X } 100\%$$

$$\frac{45}{173} \times 100\%$$

$$= 26,\ 0\ \%$$

The success rate of AI in Borong District was poor, with only 26.01% of the animals being pregnant, with 45 animals. Research results showed that the conception rate (CR) was below the established standard. Fanani [11] states that the ideal value for a cattle population ranges from 60% to 75%. A higher CR value indicates a better fertility rate for the cattle. Conversely, a low CR value indicates a less than optimal fertility rate in the cattle. According to Fanani, *et al.* (2013) states that the CR value is determined by male fertility, female fertility, and insemination technique. Male fertility is partly the responsibility of the Artificial Insemination Center (BIB), which produces frozen semen, in addition to storage management at the inseminator level.

Female fertility is the responsibility of the farmer, assisted by a veterinarian who monitors the health of the breeding cows. Meanwhile, AI implementation is the responsibility of the inseminator. The level of fertility is influenced by the condition of the herd, heat detection, and reproductive management, which in turn impacts the herd's fertility and conception rate. According to Dirgahayu [12] The conception rate value is influenced by several factors, including re-estrus after giving birth and re-mating after giving birth.

3.5 Factors Affecting the Success of Artificial Insemination

According to Ardhani [7], good characteristics of breeders and inseminators will guarantee the success of artificial insemination. The higher the level of knowledge and skills of breeders and inseminators, the higher the success of artificial insemination. Widiyaningsih [13] also stated that breeders and inseminators play a significant role in the success of artificial insemination. Characteristic factors, the level of knowledge of signs of estrus, the estrus cycle, and the right timing of artificial insemination by breeders play a significant role in the success of artificial insemination. The characteristics, experience, and skills of inseminators show significant results in the success of artificial insemination.

The skills of the inseminators sampled in this study in depositing semen at the research site demonstrated good quality and results, as they were experienced in performing Artificial Insemination. The inseminators' skills were categorized as high, with a percentage of 86.8%. The inseminators' skills in recognizing signs of estrus were high, as they were able to identify more than three signs of estrus. Common signs of heat include clear mucus discharge, restlessness, and the 3A signs of heat (abang, aboh & anget). Other signs of heat include mounting and remaining still when mounted by other livestock, and decreased appetite. This role is supported by the characteristics of high-quality inseminators and high levels of knowledge. According to Labetubun [14], good inseminator characteristics will guarantee successful AI. Inseminators have also undergone training in skills to become inseminators and already have SIMI (Insemination Permit) which supports their ability to perform AI.

Failure to detect estrus can lead to pregnancy failure. Accurate estrus detection is a crucial factor in a mating program to ensure timely fertilization. Research shows that breeders detect estrus through symptoms such as visible mucus discharge from the vulva, decreased appetite, restlessness, and frequent mounting of mates, a reddened vagina, and a swollen vulva. Breeders are already skilled at recognizing the signs of estrus. This demonstrates the significant role breeders play in the success of AI. This is in line with research by Widiyaningsih [13], which shows a correlation between the role of breeders and the success of AI.

Accurate and precise detection of estrus is one of the keys to successful artificial insemination in cattle. After ovulation, the lifespan of oocytes is very short, only surviving for 10-12 hours in the female reproductive tract, so this time must be carried out at the right time and utilized optimally [15]. The right time for AI is when the cow is in estrus in the morning,

and the cow should be inseminated in the afternoon. Conversely, if the cow is in estrus in the afternoon, the cow should be inseminated the following morning. Inaccurate insemination timing in Borong District often occurs due to a lack of observation of estrus detection by the farmers themselves, resulting in insemination officers experiencing problems in timely insemination. If signs of estrus in cattle are not detected, then the inseminator has no basis for performing artificial insemination. Research results show that farmers have a good understanding of the signs of estrus (heat) in their livestock. This understanding facilitates the implementation of artificial insemination (AI), so that the timing of AI can be carried out precisely according to the livestock's fertile period, which ultimately increases the chance of a successful pregnancy. Putri [15] stated that signs of perfect estrus include a swollen, red vulva, moaning sounds, mucus discharge, and restlessness of the animal. The timing of insemination depends on the detection of estrus, to determine the right time for insemination [16].

The quality of frozen semen can be a key determinant of successful artificial insemination (AI). Artificial insemination (AI) is a reproductive technology program implemented in the livestock sector with the aim of improving the genetic quality of livestock offspring, increasing livestock populations evenly, and preventing the transmission of sexually transmitted diseases [17]. The main indicator of frozen semen quality is post-thawing motility (PTM), which reflects the ability of sperm to remain active and move progressively after undergoing the freezing and thawing process. Quality frozen semen for use in artificial insemination (AI) must meet Indonesian National Standards (SNI). One of the main indicators of this quality is post-thawing sperm motility, which must be greater than 40%. Furthermore, frozen semen that meets SNI standards must also have a minimum concentration of 25 million sperm cells per straw. This parameter indicates that the semen has good fertilization potential and is suitable for use in reproductive programs. Frozen semen used in artificial insemination (AI) in Borong District is imported from Kupang. To ensure the quality and suitability of the semen, the East Manggarai Regency Animal Husbandry and Agriculture Office conducts regular evaluations of the frozen semen before field use. These evaluations include post-thawing motility testing, sperm cell concentration per straw, and membrane integrity and sperm morphology. These tests are crucial to ensure that the semen meets Indonesian National Standards (SNI) standards, thereby supporting the success of the AI program and increasing the productivity of Bali cattle in the region. There was a decrease in the quality of sexed sperm compared to unsexed sperm during the four-hour extension period after thawing. This indicates that sexed sperm experienced a decrease in motility below the 40% threshold.

Recipient or donor cows are females used as breeding stock, so selecting productive cows is crucial. Artificial insemination is often performed successfully with proper technique. However, using unproductive cows can result in infertility because the cows are unable to produce eggs. Herd genetics, BCS Body Condition Score (BCS)/oversized/undersized body condition, reproductive organ condition, hormonal levels, and the presence of certain diseases are all factors that need to be considered [15]. After successful artificial insemination, Bali cattle in Borong District showed a slight decrease in their Body Condition Score (BCS) from 4 on a scale after calving. This decrease in BCS is common due to increased energy requirements during pregnancy and lactation. To address this, farmers in Borong District implement nutritional interventions by providing high-quality supplemental feed, such as fresh, protein-rich forage, concentrates, and mineral and vitamin supplements tailored to the physiological needs of lactating cows. The aim of this strategy is to accelerate the recovery of the mother cow's body condition, increase milk production, and support the next reproductive cycle to remain optimal.

4 Conclusion

The evaluation results show the success of AI based on the Service Per Conception (S/C) value of 3.84, and the Conception Rate (CR) of 26.01, which is not yet included in the good category. The implementation of AI in Borong sub-district is influenced by several factors, namely the body condition of the livestock (Body Condition Score/BCS), the skills of the inseminator, detection of estrus, time of insemination, quality of frozen semen and the condition of the livestock itself.

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