The Effect of Inseminator Performance on The Success of Artificial Insemination in Friesian Holstein Crosbred Cows

Ayatullah Rohul Mahbubiy[1], Aulia Puspita Anugra Yekti[1*], Habib Asshidiq Syah[1] and Trinil Susilawati[1]

[1]Faculty of Animal Sciences, Universitas Brawijaya, Malang 65145, Indonesia

Abstract. The study aims to determine the effect of inseminator performance on the success of artificial insemination of Friesian Holstein crossbred cows. In this study, the eight inseminators were observed with the criteria: at least 1 year of AI experience, a minimum of 30 AI doses, an official inseminator certificate, and adequate skills in performing AI. The parameters observed were Conception Rate (CR), Pregnancy Rate (PR), Inseminator Success Rate, Service per Conception (S/C), Calving Rate (CvR), and Sex Ratio. The data were analysed descriptively and using the chi-square and Kruskal-Wallis methods. The results showed that the highest conception rate (CR) was recorded for inseminator 7 (48.78%), whereas the lowest was observed for inseminator 8 (6.66%). The highest pregnancy rate (PR) was observed for inseminator 6 (57.77%), while the lowest was observed for inseminator 8 (13.33%). Overall, insemination success was also greatest for inseminator 6 (50.94%) and lowest for inseminator 8 (12.12%). The lowest service per conception (S/C) value was achieved by inseminator 7 (1.04). The highest calving rate (CvR) was found in inseminator 6 (51.58%), whereas the lowest was recorded for inseminator 3 (14.65%). These findings indicate that pregnancy success is strongly influenced by inseminators' experience, technical ability, and skills in performing artificial insemination.
Keywords: Artificial insemination, Friesian Holstein, Inseminator, Service per Conception, Conception rate

1 Introduction

Indonesia's population growth has driven steady increases in milk demand, supported by growing public awareness of milk's nutritional importance for human health. National milk production reached 808.35 tons in 2024, increasing from 787.37 tons in 2023 [1]. This trend highlights the need for sustained improvements in dairy productivity to meet increasing domestic demand. Artificial insemination (AI) is a key technology for maintaining and enhancing reproductive efficiency and productivity in dairy cattle. The success of AI is influenced by several factors, including inseminator skill, semen quality, accuracy of estrus detection, and timing of insemination. Among these factors, the inseminator's skill and

* Corresponding author: auliapay@ub.ac.id
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experience play a critical role, as higher levels of technical competence, experience, and age are associated with improved AI success rates [3].

Inseminator skills include the ability to recognise reproductive characteristics of livestock, ensure proper equipment sanitation, apply correct semen thawing techniques, and perform AI procedures accurately [4]. In addition, the precise timing of insemination and the appropriate semen deposition location significantly affect conception success. Semen deposition in the cornua uteri has been reported to result in higher conception rates (87.5%) compared with deposition in the corpus uteri [5]. Based on these considerations, research evaluating inseminators' skills and experience in performing artificial insemination is necessary to support AI success and improve pregnancy rates in Friesian Holstein crossbred cows.

2 Materials and methods

2.1 Research materials

This study was conducted in Malang Regency, East Java. Eight inseminators participated, each meeting the following criteria: at least 1 year of AI experience, at least 30 insemination doses and 30 acceptors, possession of an official inseminator certificate, and age 20–65 years. Initially, 904 Friesian Holstein crossbred cows were selected as acceptors, with 1,455 AI doses. Based on the observations, the numbers of qualified acceptors and AI doses were 828 and 1,302, respectively. Each cow was inseminated by only one inseminator. These criteria were established to ensure that data collection reflected standardized levels of skill, experience, and capacity in AI, enabling precise identification of factors influencing AI success.

2.2 Research methods

This study employed an observational, quantitative method. Observations were conducted directly by monitoring inseminators performing artificial insemination (AI). Data were collected using both primary and secondary data. Primary data were obtained through recordings, interviews with inseminators, and interviews with farmers to gather information on inseminators' experience, age, qualification level, AI techniques, calf birth records, body condition score (BCS), and animal feeding. Secondary data were obtained from AI records from 2023–2024 and pregnancy records from 2023–2025.

2.3 Parameters observed

Artificial insemination (AI) success was evaluated using several reproductive performance parameters:

a. Conception Rate (CR), The percentage of cows confirmed pregnant following artificial insemination relative to the total number of inseminations performed.
b. Pregnancy Rate (PR), The proportion of inseminated cows diagnosed as pregnant within a defined observation period.
c. Service per Conception (S/C), The average number of inseminations required to achieve one confirmed pregnancy.
d. Inseminator Success Rate, The percentage of pregnancies successfully achieved by each inseminator relative to the total number of inseminations conducted.
e. Calving Rate (CvR), The percentage of cows that successfully calved relative to the number of confirmed pregnancies.

f. Sex Ratio, The proportion of male to female calves born as a result of artificial insemination.

2.4 Data Analysis

The data obtained were then statistically analysed, both descriptively and analytically, using the chi-square test and the Kruskal–Wallis test.

3 Results and discussion

3.1 Conception rate, pregnancy rate, and service per conception

Conception Rate (CR), Pregnancy Rate (PR), and Service per Conception (S/C) are key indicators for evaluating reproductive efficiency following artificial insemination. CR reflects the percentage of cows that become pregnant after the first insemination, PR represents the overall proportion of inseminated cows that achieve pregnancy within a defined period, and S/C indicates the average number of inseminations required to obtain one pregnancy. Higher CR and PR values, together with lower S/C values, indicate better reproductive performance. The results of CR, PR, and S/C for Friesian Holstein crossbred cows observed in this study are presented in Table 1.

Table 1. Conception rate, pregnancy rate, and service per conception of Friesian Holstein crossbred cows

Inseminator	Conception rate (%)	Pregnancy rate (%)	Service per conception (S/C)
1	29.05	49.84	1.69
2	18.3	32.67	1.84
3	19.69	27.27	1.28
4	19.35	27.41	1.32
5	13.46	17.3	1.55
6	44.44	57.77	1.22
7	48.78	51.21	1.04
8	6.66	13.33	1.5

Based on Table 1, the average conception rate (CR) and pregnancy rate (PR) across all inseminators were 24.96% and 34.6%, respectively, indicating that reproductive efficiency following artificial insemination (AI) remained suboptimal. Inseminators 6 and 7 achieved the highest CR (44.44–48.78%) and PR (51.21–57.77%), whereas inseminator 8 consistently recorded the lowest CR (6.66%) and PR (13.33%). This parallel pattern confirms a strong relationship between successful conception at the first AI and overall pregnancy outcomes. Chi-square analysis showed that CR and PR values for inseminators 6 and 7 did not differ significantly ($p > 0.05$), whereas most other inseminators exhibited significantly lower values ($p < 0.01$). Higher CR and PR in inseminators 6 and 7 were closely associated with experienced technical performance, accurate AI timing, and precise semen deposition. Semen placement in the cornua uteri (position 4+) resulted in higher PR because its position is closer to the fertilization site compared with the corpus uteri (position 4) [5]. Similar findings indicate that inseminators with greater experience and technical skills achieve higher CR values than those with less experience [3,8].

Conversely, the low CR and PR, particularly in inseminator 8, were largely attributed to inaccurate AI timing due to limited estrus observation. Insemination performed too early

reduces sperm viability before ovulation, whereas delayed insemination leads to oocyte degeneration and fertilization failure [9]. Environmental stress also contributed to low reproductive performance, as the average temperature (31.5 °C) and humidity (60%) in the study area resulted in a temperature-humidity index (THI) of 82, which may induce heat stress and disrupt reproductive function. In addition, physiological disorders such as fertilization failure, implantation failure, early embryonic mortality, repeat breeding, and silent heat further suppressed CR and PR. Nutritional inadequacy played a major role, as insufficient feed intake fails to support ovarian activity, hormonal balance, and pregnancy maintenance, thereby increasing the risk of repeat breeding and early embryonic death [10]. These patterns were further reflected in the Service per Conception (S/C) values, with an overall mean of 1.43. Inseminator 7 achieved the lowest S/C value (1.04), indicating high reproductive efficiency with most cows conceiving after a single insemination, whereas inseminator 2 showed the highest S/C value (1.84), reflecting repeated insemination attempts. Statistical analysis confirmed significant differences in S/C among inseminators ($p<0.05$). Lower S/C values were associated with greater inseminator experience, which tends to improve AI accuracy and reduce the number of services required per pregnancy [3]. In contrast, higher S/C values were associated with inaccurate estrus detection, improper AI timing, and insufficient evaluation of semen quality, thereby limiting effective decision-making during AI procedures [2].

3.2 Inseminators Success

Inseminator Success rate is a parameter used to measure the skill of inseminators in performing AI. The experience and skills of inseminators influence the success of AI. The skill, experience, and age of inseminators significantly affect the success of AI [3]. Inseminator success is influenced by accurate estrus detection, AI timing, AI equipment sanitation, thawing methods, and proper AI implementation [4]. The inseminator success rate observed in this study are shown in Table 2.

Table 2. Artificial Insemination Success Rate of Inseminators

Inseminator	Number of doses (straw)	Inseminator success rate (%)
1	628	25.95
2	282	17.73
3	175	20.57
4	177	19.2
5	61	14.75
6	53	50.94
7	46	45.65
8	33	12.12

Based on Table 2, inseminator 6 achieved the highest success rate (50.94%), followed by inseminator 7 (45.65%), while inseminator 8 recorded the lowest success rate (12.12%). Chi-square analysis indicated that inseminator 6 met the expected standard for AI success ($p>0.05$), whereas inseminator 7 approached the standard ($p<0.05$). In contrast, inseminators 1, 2, 3, 4, 5, and 8 showed significantly lower success rates ($p<0.01$), indicating suboptimal AI performance. Most inseminators involved in this study had substantial work experience ranging from 8 to 20 years, with only one inseminator having limited experience. Extensive

experience is closely associated with improved technical proficiency in estrus detection, accurate semen deposition, and assessment of cows' reproductive conditions. Repeated field practice allows inseminators to refine their skills, ultimately enhancing the success of artificial insemination (AI). Previous studies have consistently shown that longer working experience significantly improves AI outcomes, as evidenced by better technical accuracy and decision-making during insemination procedures [6]. In addition, continuous training and skill development further strengthen inseminator competence and contribute to higher pregnancy success under field conditions [7]. All inseminators applied a standardized semen thawing method using warm water for 30 seconds. However, variation was observed in insemination techniques, particularly semen deposition sites. Most inseminators deposited semen in the corpus uteri (position 4), whereas a limited number used position 4+ (cornua uteri). Semen deposition in the cornua uteri resulted in higher inseminator success, because it's closer to the fertilization site in the ampulla compared with the corpus uteri [5]. The high success rate of inseminator 6 was strongly associated with precise semen placement using the 4+ position, in which semen was evenly deposited into both uterine horns, thereby increasing the probability of fertilization [5].

Conversely, the low success rate observed for inseminator 8 was primarily due to inaccurate AI timing. Estrus was recorded only once, during morning milking, which hindered accurate estimation of the optimal insemination time. Errors in AI timing led to fertilization failure: insemination performed too early reduces sperm viability before ovulation, whereas delayed insemination results in oocyte degeneration [9]. In addition, AI performed at midday to accommodate inseminators' work schedules, which contributed to lower success rates, as high temperatures and humidity at noon can negatively affect fertility. AI conducted in the morning or late afternoon has been reported to result in higher pregnancy rates compared with insemination performed during the day [11]. Beyond inseminator-related factors, AI success is also influenced by the physiological status of cows, semen quality, disease presence, and adequacy of nutrition, all of which play critical roles in supporting successful conception and pregnancy maintenance [12].

3.3 Calving Rate

Calving rate is the percentage of cows that give birth within a certain period, a parameter often used to monitor and determine the reproductive efficiency of a farm. Calving rate is influenced by several factors, including fertility, health, livestock genetics, inseminator skills, feed management, and environmental and livestock maintenance conditions. A low calving rate can occur due to cases of abortion in livestock, which causes a decrease in the calving rate in a region. This condition also has a financial impact on farmers [10]. The CVR results for the Friesian Holstein crossbred cow are shown in Table 3.

Table 3. Calving rate of Friesian Holstein crossbred cows

Inseminator	Calving Rate *(%)*
1	49.84
2	32.67
3	27.27
4	27.41
6	57.77

7	51.21

The average calving rate (CvR) among all inseminators was 32.12%, indicating moderate calving performance following confirmed pregnancies. The highest CvR was recorded for inseminator 6 (51.58%), followed by inseminator 7 (51.21%) and inseminator 1 (49.84%), whereas the lowest CvR was observed in inseminator 3 (14.65%). Chi-square analysis showed that CvR values for inseminators 1, 6, and 7 did not differ significantly from the expected standard of 60% ($p>0.05$), while inseminators 2, 3, and 4 exhibited significantly lower CvR values ($p<0.01$), indicating suboptimal calving outcomes. A decline from pregnancy rate (PR) to CvR was observed, with an average reduction of 8.9%. This decrease reflects pregnancy losses due to abortion and fetal mortality. Abortion in dairy cows is commonly associated with reproductive infectious diseases such as brucellosis, leptospirosis, and listeriosis [13]. In addition, inadequate nutritional intake during gestation contributes to pregnancy failure by reducing progesterone levels, thereby impairing the ability of cows to maintain pregnancy [10].

3.4 Sex Ratio of Calves

Sex ratio is an important aspect of dairy cow reproductive management, as the proportion of female to male calf births greatly affects farm productivity and efficiency, particularly on dairy farms focused on producing replacement stock. The sex ratios on each inseminator are present in Table 4.

Table 4. Sex Ratio of Calves by Each Inseminator

Inseminator	Deposition Semen	Male calves (%)	Female calves (%)
1	4+	63.77	36.22
2	4	64.86	35.13
3	4	58.82	41.17
4	4	50	50
6	4	70	30
7	4	86.66	13.3

Overall, male calves were higher across inseminators, with an average proportion of 65.68%, while female calves accounted for 34.30%. This result may be associated with the insemination technique, timing of artificial insemination (AI), and cervical mucus conditions. The inseminator plays a key role in influencing calf sex outcomes through semen deposition strategy and AI timing. Differences in the biological characteristics of X and Y spermatozoa also contribute to these outcomes, as X spermatozoa are larger, move more slowly, and survive longer, whereas Y spermatozoa are smaller, move faster, and have shorter survival times [14]. In this study, most inseminators deposited semen at position 4 (corpus uteri) during early estrus, increasing the likelihood that Y spermatozoa reached the fertilization site at the optimal time, resulting in an increased proportion of male calves. Semen deposition in the corpus uteri approximately 6–8 hours before ovulation has been reported to increase the opportunity of male calf births [15].

4 Conclusion

The results demonstrate differences in artificial insemination success among inseminators, as reflected by conception rate (CR), pregnancy rate (PR), services per conception (S/C), inseminator success, calving rate (CvR), and sex ratio. Inseminators 6 and 7 showed superior performance, achieving the highest CR (48.78%), PR (57.77%), inseminator success (50.94%), CvR (51.58%), and the lowest S/C value (1.04), indicating greater reproductive efficiency. These findings highlight the importance of improving inseminator performance through targeted training in estrus detection, optimal insemination timing, and accurate semen deposition techniques. Standardizing artificial insemination procedures and promoting continuous skill development are essential to enhancing reproductive efficiency, increasing pregnancy and calving rates, and supporting sustainable dairy cattle production under field conditions.

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