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Original article

Success rate of artificial insemination using sexed semen in dairy cows at the Setia Kawan dairy farmers cooperative, Pasuruan, Indonesia

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ABSTRACT

This study aimed to evaluate the success rate of artificial insemination (AI) using sexed semen in dairy cows, based on the parameters of services per conception (S/C), conception rate (CR), and calf sex ratio. A descriptive method was employed, utilizing both primary and secondary data. Primary data were collected through structured interviews with farmers using questionnaires, while secondary data were obtained from institutional records of the Setia Kawan dairy farmers cooperative, located in Tutur District, Pasuruan Regency, East Java, Indonesia. A total sample of 250 dairy cows was selected, representing 15% of the 1,669 cows that had undergone AI with sexed semen. All sampled cows had at least one prior calving and were owned by members of the cooperative, with AI performed between 2021 and 2022. Artificial insemination was conducted by certified inseminators with over five years of experience, within 6-12 hours of estrus detection. The results showed an S/C value of 1.308 (327 inseminations for 250 cows) and a CR of 81.60% (204 pregnancies from 250 inseminations). Of the 250 calves born, 85.2% (213) were female and 14.8% (37) were male, resulting in a female-to-male sex ratio of 5.76:1. These findings suggest that AI using sexed semen can significantly improve both reproductive efficiency and the production of female offspring in dairy herds.

Keywords: conception rate, female calves, male calves, services per conception, sex ratio

INTRODUCTION

Public awareness of the importance of animal protein consumption continues to grow, driven by global population growth and increasing nutritional consciousness among consumers. This heightened awareness prompts a need for sustainable solutions to meet the escalating demand for animal-derived nutrients, particularly dairy products, which are vital sources of high-quality protein, calcium, and other essential micronutrients (Gil *et al*., 2024). Developing robust dairy production systems thus becomes an essential strategy to enhance food security and improve nutritional status of populations worldwide. In response to these challenges, scientific and technological advancements offer powerful tools to optimize

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dairy cattle productivity and reproductive performance (Britt *et al*., 2018). The integration of innovative reproductive technologies, especially those that improve efficiency and genetic selection, has become a cornerstone in modern dairy cattle management, enabling farmers to capitalize on genetic potential more effectively and produce higher yields of desirable offspring (Meles *et al*., 2022). For dairy farmers, including those in the Setia Kawan dairy farmers cooperative in Pasuruan, Indonesia, the birth of female calves is particularly desirable, as they serve as replacements for milking cows and contribute directly to herd productivity (Wilson *et al*., 2023).

Artificial insemination using sexed semen represents a transformative strategy in this context. By enabling the preferential production of female calves, this technique facilitates herd expansion and enhances milk production capacity (Holden and Butler, 2018). Sperm sexing, which involves separating X- and Y-chromosome-bearing spermatozoa, has revolutionized reproductive management by significantly increasing the probability of producing female offspring. The success of this method depends on exploiting the biological differences between X and Y sperm, such as their size, shape, density, motility, and surface biochemical properties, which allow for their effective separation using advanced laboratory techniques (Álvarez Gallardo *et al*., 2024). This precision breeding approach not only boosts herd productivity but also aligns with the economic goals of dairy farmers, who seek to increase the proportion of milk-producing females in their herds to maximize profitability (Ule *et al*., 2024). To evaluate the effectiveness of such reproductive technologies, key indicators such as services per conception (S/C) and conception rate (CR) are commonly used. These metrics are essential for assessing reproductive efficiency and identifying areas for improvement in herd management practices, which in turn influence overall productivity and economic viability (Ulfah *et al*., 2022).

Additional indicators, including pregnancy rates, female calf proportions, and S/C ratios, further inform the success of AI with sexed semen. Effective applications of this technology typically yield female calf rates exceeding 70% (Reese *et al*., 2021; Meles *et al*., 2022). Given the significance of these outcomes, ongoing research and refinement of sperm sexing technologies remain crucial to improving both the accuracy and efficiency of female calf production. Such advancements are essential for promoting sustainable dairy herd development, optimizing resource utilization, and supporting the growing global demand for nutritious dairy products.

Therefore, continued investigation into the factors influencing the success of semen sexing, along with the development of enhanced reproductive management strategies, is imperative for researchers, industry stakeholders, and policymakers committed to the sustainable advancement of the dairy sector.

MATERIALS AND METHODS

This study employs a descriptive methodology based on both primary and secondary data sources. Primary data were collected through structured interviews with farmers using standardized questionnaires. Secondary data were obtained from the Setia Kawan dairy farmers cooperative, located in the district of Tutur, Pasuruan regency, East Java, Indonesia. Frozen sexed semen was obtained from the Singosari Center for Artificial Insemination, Indonesia. The sexed semen was produced using the Percoll Density Gradient Centrifugation method, with a post-thaw motility of 40% and a minimum concentration of 25 million spermatozoa per dose.

Sample and sample size

The study sample consisted of lactating dairy cows that had previously calved and were inseminated with sexed semen. These cows were owned by members of the Setia Kawan dairy farmers cooperative. Artificial insemination was

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carried out by trained inseminators with more than five years of experience. Insemination was performed 6-12 hours after farmers reported visible signs of estrus. Semen deposition was conducted at the uterine corpus.

Data were obtained from insemination records maintained by cooperative officers for the period of 2021–2022. The sample size was determined as 15% of the total population (Stevenson, 2021), which consisted of 1,669 cows that underwent AI with sexed semen, resulting in a sample of 250 dairy cows.

Services per conception

Services per conception (S/C) refers to the average number of inseminations required for a cow to become pregnant. It was calculated by dividing the total number of insemination events by the number of confirmed pregnancies (Atabany *et al*., 2011).

Conception rate

Conception rate (CR) was defined as the proportion of cows that became pregnant following the first insemination attempt. It was calculated as the number of confirmed pregnancies after the first AI divided by the total number of cows inseminated (Souames and Berrama, 2020).

Calving percentage

The percentage of female and male calves born was determined by calculating the sex ratio of offspring resulting from AI with sexed semen.

Data analysis

The data collected included reproductive performance indicators such as S/C, CR, and calf sex ratio. These data were tabulated and analyzed using Microsoft Excel and analyzed descriptively to determine averages and proportions.

RESULTS

According to inseminator records, 250 cows underwent 327 insemination procedures, resulting in a S/C value of 1.308 (Table 1). Among these, 204 cows were confirmed pregnant, yielding a CR of 81.60% (Table 2). A total of 250 calves were born, of which 213 (85.2%) were female and 37 (14.8%) were male, resulting in a female-to-male sex ratio of 5.76:1 (Table 3).

Table 1 Services per conception (S/C) in dairy cows inseminated with sexed semen

number of AI	number of pregnant dams	S/C	normal value *	description*
327	250	1.308	1.6-2.0	very good

* (Ulfah *et al*., 2022)

Table 2 Conception rate (CR) in dairy cows inseminated with sexed semen

Number of pregnant cows after the first AI	Total number of inseminated cows	CR	normal value*	description
204	250	81.6%	>60%	very good

* (Howlader *et al*., 2019)

Table 3 Calf sex ratio following AI with sexed semen

	number of pregnant dams	female calves	male calves
sexed semen	250	312 (85.2%)	37 (14.8%)

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DISCUSSION

In this study, the S/C value was recorded at 1.308, based on 327 artificial insemination (AI) procedures performed on dairy cows using sexed semen. Typically, an optimal S/C value for dairy cattle ranges from 1.6 to 2.0 (Ulfah *et al*., 2022). However, values below 1.5 are indicative of very good reproductive performance, particularly in the context of AI using sexed semen. This finding aligns with the report by Novita *et al*. (2022), which states that the Directorate General of Animal Husbandry of Indonesia considers an S/C value of less than 1.5 as a standard of AI success rate. Several factors contribute to achieving a low S/C value, which reflects high fertility efficiency. These include the body condition score at the time of insemination, the accuracy and timing of estrus detection by both farmers and inseminators, and the timeliness of insemination itself (Kim et al., 2019). Delays or inaccuracies in detecting estrus can result in suboptimal timing of AI, leading to reduced CR and increased S/C values. As such, understanding and managing these variables is essential for improving reproductive outcomes in dairy cattle (Ayantoye *et al*., 2025). Importantly, the S/C value is influenced not only by the inseminator's skill but also by the quality of on-farm reproductive management. The farmer's ability to recognize estrus signs and coordinate timely AI directly impacts reproductive efficiency. According to Jemal and Lemma (2015), three primary factors contribute to the S/C outcome: the inherent fertility of the dam, the technical skill of the inseminator, and the accuracy of estrus detection by the farmer. Collaborative efforts between experienced inseminators and well-trained farmers in estrus detection can substantially improve AI outcomes and optimize the S/C ratio.

In addition to S/C, CR is a critical indicator of reproductive performance, representing the proportion of cows that become pregnant following the first insemination, and serves as a key indicator of reproductive performance (Fukaya *et al*., 2024). In this study, the CR was 81.6%, which exceeds commonly accepted benchmarks and indicates a very high success rate. Typically, a CR of 60-70% is considered indicative of good reproductive performance (Kuswati *et al*., 2022). Howlader *et al*. (2019) also suggest that a CR above 60% reflects successful AI implementation.

The CR is primarily determined by three factors: male fertility, female fertility, and insemination technique (Haile-Mariam and Pryce, 2021). Male fertility is influenced by the quality of semen, including the processing and handling of sexed semen by the Singosari Center for Artificial Insemination, as well as by the inseminator's adherence to proper semen storage and handling protocols (Yekti *et al*., 2024). Female fertility, on the other hand, is affected by overall herd health, nutritional management, and timely veterinary or paramedical support. The success of AI also depends heavily on the technical competence of the inseminator. Key aspects include accurate detection of estrus, proper sanitation of instruments, appropriate handling and thawing of frozen semen, and precise deposition of semen within the reproductive tract (López-Gatius, 2022). These procedural details are especially critical when using sexed semen, which may be more sensitive to handling and environmental factors. The high CR observed in this study was significantly influenced by the farmers' ability to accurately detect estrus behaviors. Observable signs such as restlessness, signs of insecurity, reduced appetite, vulvar mucus discharge, and physical changes like swelling, redness, and increased moisture are key indicators of estrus (Ali *et al*., 2024). The farmers' skill in recognizing these signs, coupled with timely communication with inseminators, facilitated prompt AI implementation, reflecting a proactive and well-coordinated reproductive management system.

Efficient reproductive performance in AI programs is highly dependent on the farmers' capability to detect estrus and time insemination correctly. Even if inseminators are highly skilled, failure to detect estrus accurately can significantly compromise AI success (Hamid *et al*., 2021). Thus, effective collaboration between farmers and inseminators, supported by strong

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farm management practices, is essential to optimize reproductive outcomes. The success of AI using sexed semen is typically evaluated through key reproductive indicators such as pregnancy rate and the accuracy of sex determination in calves born. In this study, a total of 250 calves were born, comprising 213 females (85.2%) and 37 males (14.8%), resulting in a female-to-male sex ratio of 5.76:1. This outcome is notably higher than that reported by Gunawan *et al*. (2015), who observed a female birth rate of 77.88%. Susilawati *et al*. (2023) reported a 78.95% male calf rate using double-dose sexed semen treatments, highlighting variability in outcomes depending on protocols and semen processing methods. In the current study, the proportion of female calves (85.2%) closely aligns with findings by Bayril *et al*. (2023), who reported female and male calf proportions of 88% and 12%, respectively, in heifers inseminated with sexed semen. In contrast, the use of non-sexed (conventional) semen typically yields a near 1:1 sex ratio. For example, Mendes *et al*. (2022) reported 47.1% female and 52.9% male calves, while average outcomes for conventional semen were approximately 51.3% female and 48.7% male. In comparison, Joezy-Shekalgorabi *et al*. (2017) reported 91.1% female calves and only 8.9% male calves when using sex-sorted semen, demonstrating the effectiveness of this technology under optimal conditions.

The application of AI with sexed semen represents a major advancement in dairy cattle breeding, primarily aimed at increasing the number of female calves, future replacement heifers essential for sustaining and expanding milk production (De Vries *et al*., 2005). The high percentage of female calves achieved in this study is attributable to the use of reproductively sound multiparous cows from the Setia Kawan dairy farmers cooperative, which minimizes the risk of infertility-related failures.

The sexed semen used was produced by the Singosari Center for Artificial Insemination, Malang, processed using the Percoll Density Gradient Centrifugation method. The semen met the Indonesian National Standard (SNI 4869-2:2021) for frozen bovine semen, with a post-thaw motility (PTM) of 40% and a minimum concentration of 25 million spermatozoa per dose. According to Safa *et al*. (2025), the sexed semen from Holstein-Friesian (HF) bulls processed using this method at Singosari contained a proportion of X:Y spermatozoa of 78.0:22.0, which supports the high female calf outcomes observed. The strategic use of X-bearing sperm through sexed semen not only increases the number of replacement heifers but also improves the economic viability of dairy farms by accelerating genetic gains and enhancing milk production capacity (Maher *et al*., 2023). Moreover, the accuracy of calf sex outcomes can be further improved through the integration of advanced reproductive technologies, robust nutritional management, consistent health monitoring, and strict adherence to best reproductive practices (Mikkola *et al*., 2024). Therefore, AI with sexed semen is a valuable tool for improving reproductive efficiency, expanding female calf populations, and ultimately contributing to sustainable dairy herd development (Quelhas *et al*., 2023).

CONCLUSIONS

The results of this study indicate that the S/C and CR achieved through AI using sexed semen meet or exceed national standards for reproductive performance in dairy cattle. The use of sexed semen enriched with X-chromosome-bearing spermatozoa significantly increased the proportion of female calves born, with 85.2% of the offspring being female. These findings highlight the effectiveness of sexed semen technology in supporting herd expansion and enhancing milk production potential in dairy operations.

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AUTHOR'S CONTRIBUTIONS

Tsaniya Atikahani Shabirah (TAS), Tri Wahyu Suprayogi (TWS), Sri Hidanah (SH), Tita Damayanti Lestari (TDL), Tatik Hernawati (TH), Rimayanti Rimayanti (RR).

TAS, TWS, SH: conceived the idea, designed the mainframe of this manuscript, acquisition, analysis and interpretation of data, TDL, TH, RR: critically read and revised the manuscript for intellectual content. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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