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Research Article

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Study of Cattle Reproductive Performance and Map of Livestock Location in the North Sleman Region, Yogyakarta

Syahid Ksatria Suci[1], Muhammad Azriel Ramadhan[1], Syifaa Dea Faddlillah Sugiartono[1], Ahmad[1], Morsid Andityas[2], Muhammad Rosyid Ridlo[2]*

[1]Student of Veterinary Technology Bachelor Program, Department of Bioresources Technology and Veterinary, Vocational College, Universitas Gadjah Mada, Yogyakarta, Indonesia
[2]Department of Bioresources Technology and Veterinary, Vocational College, Universitas Gadjah Mada, Yogyakarta, Indonesia

*Corresponding author: rosyidridlo@ugm.ac.id

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ABSTRACT

Background: Reproductive efficiency plays a key role in determining the sustainability and economic viability of smallholder cattle farming. Sleman Regency has considerable cattle production potential; however, periodic evaluation of reproductive performance is essential to support effective management and development strategies.

Aims: This study aimed to assess reproductive efficiency, map its spatial distribution, and identify potential areas for improvement in smallholder cattle farms in North Sleman Regency.

Methods: A cross-sectional survey was conducted involving 117 cows owned by 86 smallholder farmers across seven sub-districts in North Sleman. Primary and secondary data were collected through questionnaires, interviews, and direct observation of reproductive records. Reproductive efficiency was evaluated using Service per Conception (S/C), Calving Interval (CI), Days Open (DO), and Litter Size (LS) as parameters. Data analysis employed quantitative descriptive statistics and spatial analysis using QGIS.

Results: The results indicated that overall reproductive performance was fairly good but remained below optimal levels. The average S/C was 2.16, CI was 13.78 months, and DO was 130 days. Although 51.8% of cows exhibited an ideal CI of 12 months, considerable variation in reproductive performance was observed among sub-districts. Spatial analysis revealed clusters of areas with lower reproductive efficiency.

Conclusion: It can be concluded that reproductive efficiency in smallholder cattle farms in North Sleman requires improvement, particularly through better estrus detection and feed management. Spatial mapping proved to be a valuable tool for identifying priority areas and can support the implementation of targeted assistance and intervention programs.

INTRODUCTION

The cattle farming sector plays an important role in driving economic growth in rural areas of Indonesia. In addition to meeting domestic demand for milk and meat, this industry is also a major source of livelihood for many families living in rural areas (Sulasmi and Sari, 2025). The success and sustainability of the cattle farming industry are highly dependent on the efficiency of livestock reproduction. Suboptimal reproductive performance is the main obstacle for farmers to achieve maximum profits, as it directly impacts population decline and productivity (Ishaq et al., 2021). Reproductive issues such as repeat breeding can cause economic losses by reducing income levels and farmer well-being, a phenomenon that inevitably affects the low annual population growth rate (Raynardia et al., 2021).

Fundamental problems in livestock farming in Indonesia often stem from low reproductive efficiency, which can be measured through several key parameters. One of them is service per conception (S/C), which is the number of artificial insemination (IB) services required until pregnancy occurs, with normal values ranging from 1,6 to 2,0 (Sari et al., 2016). Another important parameter is calving interval (CI), which is the period between two consecutive births, which ideally is 12-13 months or 365-400 days (Manhitu et al., 2020). Efficiency is also assessed by days open (DO) or empty period, which is the time from lambing to pregnancy, which normally lasts for 85-115 days (Tahjudin et al., 2021).

In addition to time-based parameters, litter size or the number or off spring per birth is also basic data in reproductive evaluation. In cattle, the normal litter size is one kid per birth. This data is usually used for mothers who have given birth more than once before (Paputungan et al., 2019). Recording this parameter is important to confirm the prevalent single birth as well as identify cases of multiple birth which, although rare, can have an impact on postpartum mother management and health. The potential for multiple birth is very low at around 4-10% in dairy cattle and 1% in beef cattle, influenced by the rate of inheritance (heritability) of the twin birth trait in cattle (Tiesnamutri, 2019).

Sleman Regency is one of the main centers of cattle development in the Special Region of Yogyakarta with the North Sleman area playing an important role in supporting the livestock population and has great potential for development (Sulasmi and Sari, 2025). The North Sleman area, which includes Mlati, Ngaglik, Sleman, Tempel, Turi, Pakem, and Cangkringan sub-districts, has a total cattle population of 15, 146 heads. Based on data from the Sleman Regency Central Bureau of Statistics (2023), Cangkringan Sub-district has the highest cattle population in the North Sleman area at 6,107 heads.

Despite having a very large population and strategic role, comprehensive and up to date data on the status of reproductive efficiency, especially on key parameters such as service per Conception (S/C), Calving Interval (CI), Litter Size (LS) at the level of smallholder farmers in this region is still very limited so that it needs to be improved to improve the livestock breeding cycle to estimate future livestock populations (Riyanto et al., 2015). Therefore, this study aims to capture and map the level of reproductive efficiency, as well as identify potential improvements in smallholder cattle farming in North Sleman.

MATERIALS AND METHODS

Research Design and Location

This research was designed as a survey study with a cross-sectional approach (Tresnanda and Rimbawan, 2022). To capture the condition of cattle reproductive efficiency at the smallholder level. The study was conducted in the North Sleman area, which administratively covers seven sub-districts namely Mlati, Ngaglik, Sleman, Tempel, Turi, Pakem, and Cangkringan, Sleman Regency, Yogyakarta Special Region. The primary data collection process in the field was conducted intensively for one week, starting from July 20 to July 27, 2025.

Research Animals and Respondents

The research animals used in this study were 117 mother cows owned by smallholder farmers in the research locations. Data was obtained through a survey of farmers. The cows consisted of various breeds including Brahman, Friesian Holstein (FH), Limousin, Peranakan Ongole (PO), and Simental. Samples were selected using a technique that had complete reproduction record criteria. This would certainly cause selection bias because farmer data tended to have a fairly good population compared to the general population in North Sleman. Based on the inclusion criteria that had been set, namely: (1) cows that have gone through at least one full reproductive cycle, characterized by at least one pregnancy, and (2) have complete reproductive and mating history records. Reproductive history records include first time giving birth, mating status, age of menarche, breastfeeding, history of hormone use (Ahsani and Machmud, 2019). Respondents were farmers who were the owners of the cows sampled.

Data Collection and Research Parameters

Data collection was conducted by combining two methods. Primary data was obtained through structured interviews directly with respondent farmers using a prepared questionnaire. Secondary data were collected through observation and re-recording from cattle cards or reproductive records owned by farmers and local artificial insemination (IB) officers. Parameters measured in this study include service per conception (S/C), which is the number of artificial insemination (IB) services required until pregnancy occurs (Sari et al., 2016). Another important parameter is Calving Interval

(CI) which is the time period between two consecutive births (Manhitu et al., 2020). The efficiency of this value can be assessed from Days Open (DO) or empty period, namely the time distance from lambing to pregnancy (Tahjudin et al., 2021). In addition to the parameters related to time, there is Litter Size (LS), which is the number of offspring per birth, which is normally one offspring per birth (Paputungan et al., 2019). This study was conducted with a total of 117 cows, but the S/C and CI data analysis only used 83 cows because they had a minimum reproductive history of one pregnancy, while the LS data analysis only used 86 cows because they had calving data, so the data was adjusted accordingly.

Data Analysis

Quantitative data obtained from the four reproductive performance parameters were tabulated and analyzed using Microsoft Excel software. The analysis was done descriptively quantitatively to obtain the mean and standard deviation (SD) of each parameter. The results of the analysis are presented in summary tables and narratives in the result and discussion section to provide a comprehensive picture of the level of cattle in North Sleman. In addition, the data that has been processed in Excel is then mapped using the QGIS application to visualize the distribution of areas based on the Service per Conception (S/C) and Calving Interval (CI) value, both of which are categorized into three efficiency scales, namely low, medium and high. The determination of the range for each category was based on the mean value and standard deviation found in this study. This classification was intended to describe relative performance within the study population and does not represent absolute reproductive performance standards. Established benchmarks from previous literature were used only for interpretative comparison.

RESULTS AND DISCUSSION

The S/C values varied among breeds. Peranakan Ongole cattle showed the lowest average S/C (1.67), which was within the optimal range, while Brahman and Limousin reached the upper limit of the recommended value (2.00). Simmental and Friesian Holstein, which dominated the sample, showed slightly higher S/C values (2.17 and 2.25, respectively). Overall, 83 pregnancies resulted from 179 inseminations, giving a mean S/C of 2.16 (Table 1).

Table 2 presents details of the frequency distribution of Calving Interval (CI) of 83 sample cows, grouped by breed and interval duration in months. The results show significant variation in the inter-calving period of cows in North Sleman.

This distribution is mainly influenced by the Simental and Friesian Holstein (FH) breeds, which constitute the majority of the sample. Both breeds show a wide CI distribution, ranging from 12 months to more than 20 months, indicating diversity in management practices at the farmer level. Calving interval values ranged from 12 to 24 months, with most cows concentrated in the 12–16 month categories. Longer intervals (>18 months) were observed in a smaller proportion of animals,

Table 1. Results of the service per conception and litter size survey in cows in the North Sleman area

Breed of Cattle	Number of females (%)	Total Artificial Inseminations (AI)	Pregnant Cows	Service per Conception (S/C) per Breed	Litter Size		Total Dams	Off-spring (%)
					1	2		
Brahman	1 (1,2)	2	1	2,00	1		1	1 (1,16)
FH	32 (38,6)	72	32	2,25	31		31	31 (36)
Limosin	3 (3,6)	6	3	2,00	4		4	4 (4,7)
PO	6 (7,2)	10	6	1,67	7		7	7 (8,1)
Simental	41 (48,4)	89	41	2,17	39	2	39	43 (50)
Total	83 (100)	179	83	2,16	82	2	84	86 (100)

particularly among Simmental and Friesian Holstein cattle.

Based on the data obtained, the average calving interval of cows in the North Sleman area is close to the recommended range of 12–13 months. However, a proportion of cows still show longer intervals, which may be associated with factors such as inadequate nutrition, reproductive health problems, and suboptimal management practices.

Most locations were classified as having normal calving intervals (12–14 months), especially in Pakem, Cangkringan, and parts of Tempel. Subnormal (15–18 months) and long intervals (≥19 months) were observed in several areas, including Ngaglik, Seyegan, and Mlati, although their proportions were relatively small.

The average Days Open (DO) ranged from 130 to 140 days, corresponding to a mean calving interval of 13.78 months. This extended open period indicates suboptimal reproductive efficiency, as repeated conception failure prolongs the calving interval and reduces annual productivity.

The results of this study indicate that the average Service per Conception (S/C) in cattle in the North Sleman region is 2.16. This value is slightly above the ideal range of 1.6-2.0 (Sari et al., 2016), indicating sub-efficiency in the breeding program. For comparison, a study by Yohana et al (2018) in Probolinggo District, a highland area, found an average S/C value of 2.49, while a study in another highland area by Rusadi et al. (2015) reported an S/C of 2.12. This places the S/C performance in North Sleman in the moderate category, similar to conditions in other farms in Java, but still has room for improvement

Next, the average Calving Interval (CI) was found to be 13.78 months (approximately 413 days). This figure also slightly exceeds the ideal standard upper limit of 12-13 months or 400 days (Manhitu et al., 2020). The length of the CI is a direct result of the suboptimal S/C ratio, which causes the Days Open (DO) period to extend to an average of 140 days, exceeding the normal range of 85-115/days (Tahjudin et al., 2021). This finding is in line with the statement by Fahmi and Agustiani (2022) that every failure to conceive in one serum cycle will prolong the CI, which cumulatively reduces the annual productivity of a cow.

Managerial Factors at The Farm Level

Farmers' knowledge of estrus signs is good, but not yet optimal, so that conception failure is often not due to undetected estrus, but rather because insemination is performed too early or too late. Educational factors also influence farmers' thinking patterns, so that the higher the farmer's education level, the more developed their understanding of the signs of estrus in livestock (Ilahi et al., 2021). Factors influencing the success of artificial insemination include fertility levels, accuracy of estrus detection, and timing of insemination. One of the most important aspects is intensive cattle management using a barn system to facilitate farmers in observing estrus signs (Putri et al., 2020). According to technical guidelines for cattle breeding, the ideal time for Artificial Insemination (AI) is 10–22 hours after estrus signs are observed in the cow. If estrus is detected in the morning, AI can be performed in the afternoon; if detected in the

Table 2. Results of the Calving Interval survey on cows in the North Sleman area

Breed of cattle	Calving Interval period (months)										Total (%)
	12	13	14	15	16	17	18	19	21	24	
Brahman	1										1 (1,2)
FH	18	3		3	3	1				2	30 (37)
Limosin	1										1 (1,2)
PO	2	1		1	2		1				7 (8,6)
Simental	21	3	5	3	5	2	1	1	1		42 (51,9)
Total	43	7	5	7	10	3	2	1	1	2	83 (100)

afternoon, AI can be performed the following day (Ardhani et al., 2021).

Feeding Factors and BCS

At the time of the study, farmers were already using forage and concentrate feed, but the nutritional value of the feed was not optimal. This can be seen from the average Body Condition Score (BCS) of the cattle during the study, which was quite low at only a BCS score of 2. Low-nutrient feed causes energy to be prioritized for maintenance rather than reproductive functions, and low BCS also affects the reproductive cycle and performance, potentially leading to silent heat or anestrus., and low BCS also affects the reproductive cycle and performance, which can lead to silent heat or even anestrus (Fatmawati et al., 2023). A decrease in BCS values in cattle is one the factors contributing to reduced reproductive performance. If cattle are thin, it is detrimental to their growth and reproductive health. When cattle lack fat, it affects the anestrus period, reduces the number of eggs ovulated, and may result in repeated breeding (Desiona et al., 2023).

Cows that lack fat in their rumen will suppress estrus and ovulation or even reduce the number of cells that will be ovulated (Prayogi et al., 2020). In cows with low Body Condition Scores (BCS) due to inadequate feed, there may be a decrease in the release of LH and estrogen hormones. This condition has the potential to cause the absence of estrus symptoms, disruption of the ovulation process, obstacles to fertilization, increased risk of embryo death, and a decrease in pregnancy success rates (Ohee et al., 2024). BCS significantly influences reproductive performance; Cows with optimal reproduction. (BCS 3-4) have good reproductive cycles, healthy ovaries, and higher conception rates compared to those with low BCS below 2 (Ginting and Negara, 2025). The effect of Body Condition Score (BCS) on the Service per Conception (S/C) ratio indicates that cows with either very thin (BCS ≤1) or very fat (BCS ≥5) body conditions have an S/C ratio greater than 2. This suggests that cows with extremely thin or extremely fat body conditions tend to have less efficient reproductive processes (Supriyanto, 2016).

Environmental Factors and Stress

Environmental conditions such as temperatures in the northern Sleman region range between 27-29°C, which can cause heat stress in livestock, particularly in certain subtropical cattle breeds such as FH and Simental. Heat stress can disrupt the estrus cycle, reduce egg quality, and increase early embryo mortality rates. This is why breeds like FH have an S/C ratio of 2.25 and Simental have an S/C ratio of 2.17, as these two breeds are the majority population and tend to have higher ratios than other cattle breeds. The ideal environmental temperature for cattle should not exceed 27°C, as higher temperatures can cause discomfort, characterized by increased respiratory rate, heart rate, and body temperature (Santoso et al., 2023). Environmental factors such as temperature and humidity can influence livestock reproductive performance, as gestation length can be affected by season and geographical location. Stress caused by temperature can lead to irregular estrus cycles and

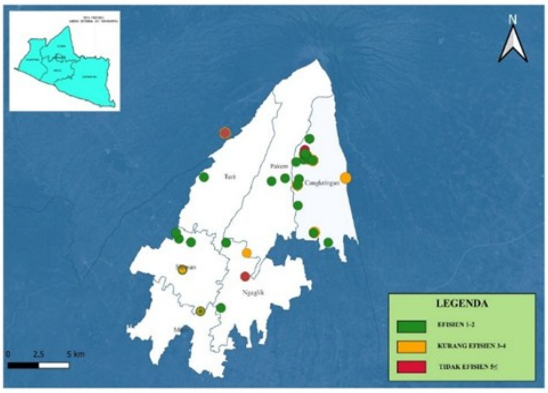

Figure 1. Map of Service Efficiency Levels per conception (S/C) Distribution in North Sleman Region.

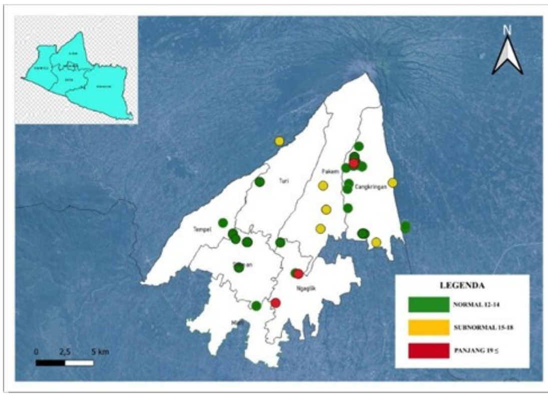

Figure 2. Map of Calving Interval (CI) Efficiency levels in North Sleman Region.

shorter estrus periods (San et al., 2015). In addition, temperature factors, especially in subtropical livestock, can cause reproductive disorders because they cannot adapt to tropical environments, leading to gonadotropin and steroid hormones not being produced perfectly, resulting in more severe reproductive disorders such as silent heat (Desiona et al., 2023).

Spatial Analysis and Managerial implications

Spatial research in Malang, East Java, shows that the proximity between farmers and animal health services will affect the success of disease-free livestock programs and other reproductive issues (Widyadhari et al., 2024). The results of this study indicate that the sample studied is related to farmer management factors as one of the potentials for intervention to improve reproductive efficiency in the region. This results in low success rates for artificial insemination in both large and small ruminants (Kentjonowaty et al., 2023). The low success rate of artificial insemination will trigger a decline in the livestock population produced each year, so it is necessary to increase farmer's understanding of artificial insemination technology (Dawit et al., 2021). In addition, areas identified as low priority should be prioritized by the relevant agencies for regular assistance and management improvement programs.

Based on the spatial map of the success rate of Service per Conception (S/C) in cows in the North Sleman region, which includes Turi, Pakem, Cangkringan, Ngaglik, and Seyegan. According to the legend, there are three categories: efficient (S/C 1-2) marked in green, less efficient (S/C 3-4) marked in orange, and inefficient (S/C ≥5) marked in red. This is in accordance with Sabaruddin et al. (2022), who explain that the normal value of Service per Conception (S/C) isbetween 1.6 and 2.0. If the value is above 2.0, it will cause the calving interval to be less than optimal, resulting in suboptimal livestock reproduction efficiency. This is supported by Lase et al. (2021), who state that if the Service per Conception (S/C) value is greater than 3.0, reproduction disorders will occur. Most locations are dominated by the green category, indicating relatively better reproductive performance compared to other areas. However, several locations still show lower Service per Conception (S/C) efficiency, suggesting the need for targeted management improvements.

Based on the spatial map of Calving Interval (CI) success rates in cattle in the North Sleman region, which includes the subdistricts of Tempel, Turi, Pakem, Cangkringan, Ngaglik, Mlati, and Seyegan. According to the legend, there are three categories: normal (12-14 month) marked in green, subnormal (15-18 month) marked in yellow, and long (≥19 month) marked in red. This is accordance with Rosa et al. (2020), which states that the normal Calving Interval (CI) for cows is 12 months. A longer interval will result in very low pregnancy success rates and decreased livestock production. This is supported by Ramadhanty (2021), who states that the normal Calving Interval (CI) is around 12-13 months. If the Calving Interval (CI) is 18-24 months, repeated mating will occur, resulting in losses for farmers. Overall, this spatial distribution shows that the majority of the region are still in the normal category, although there area some region with longer Calving Interval (CI) success rates.

This study has several limitations, including the use of a cross-sectional design that only captures conditions during a short period (July 2025). The data is highly dependent on the accuracy of farmers' records and their recall ability (recall bias). In addition, this study did not conduct direct clinical or reproductive diagnostic examinations by veterinarians, so reproductive disease factors were not identified in depth.

CONCLUSION

In conclusion, while the majority of the studied areas in North Sleman fall within the normal range for reproductive parameters, the identified managerial gaps provide potential, rather than definitive, targets for intervention. These results should be interpreted within the context of the specific study period and sample, serving as a preliminary guide for more targeted livestock management improvements in the region.

AUTHORS CONTRIBUTION

S.K.S., M.A.R., S.F.S., and A.H.M. contributed to the research idea, conceptualization, figure design, data collection, and manuscript drafting. M.A.N. contributed to the conceptualization, experimental design, data analysis, interpretation of results, and manuscript review. M.R.R. contributed to the conceptualization, experimental design, data analysis, interpretation, project funding acquisition, and manuscript review. All authors read and approved the final manuscript.

"The author declares that there is no conflict of interest with parties involved in this research".

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