Research Article

Reproductive Performance of Dairy Goats in Smallholder Farmers Affiliated with Dian Santosa and Pangestu Farmer Groups in Sleman Regency, Yogyakarta: A Descriptive Study

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Abstract | This pilot study aimed to describe and ascertain the reproductive performance of dairy goats on smallholder farms, focusing on the Dian Santosa and Pangestu Farmer Groups in Sleman Regency, Yogyakarta. Data collected encompassed farmer demographics, dairy goat maintenance, reproductive management, and reproductive performance. Data acquisition involved questionnaire completion by farmer group members, with data standardization achieved through purposive sampling. This was further substantiated by estrus cycle observations via vaginal smears performed on five representative farms. Descriptive analysis of farmer demographics, dairy goat maintenance, and reproductive management was performed using Excel 2021. Reproductive performance data was quantitatively analyzed using IBM SPSS 23. A bivariate Pearson correlation with a two-tailed test of significance was applied to correlate reproductive management data with reproductive performance data. Quantitative descriptive results from 45 questionnaires revealed that dairy goats reared by smallholder farmers exhibited normal average reproductive performance. Correlation analyses revealed a strong negative correlation between estrus cycle length and the implementation of estrus synchronization ($r = -0.617$, $p<0.01$), and also a negative correlation with the ability of farmers to detect estrus ($r = -0.311$, $p<0.05$). Furthermore, reproductive recording showed a negative correlation with weaning age ($r = -0.336$, $p<0.05$). The study's findings suggest opportunities to enhance the reproductive efficiency and production performance of dairy goats on smallholder farms through implementing estrus synchronization and providing training on reproductive event recording. These interventions are expected to shorten estrus cycle length and improve reproductive management efficiency on smallholder farms.

Received | May 08, 2025; **Accepted** | June 21, 2025; **Published** | June 28, 2025
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Citation | Widayati, D.T., S. Bintara, W. Asmarawati, R.N. Aji, K.D. Prihantoko, B.P. Widyobroto, Y.Y. Suranindyah, F.G. Padmawati and D.F.F. Diatmono. 2025. Reproductive performance of dairy goats in smallholder farmers affiliated with Dian Santosa and Pangestu farmer groups in Sleman Regency, Yogyakarta: A descriptive study. *Pakistan Journal of Agricultural Research,* 38(2): 72-83.
DOI | https://dx.doi.org/10.17582/journal.pjar/2025/38.2.72.83
Keywords | Dairy goats, Demographic profiles, Farmer groups, Reproductive management, Reproductive performance, Smallholder farmers

Introduction

Over the past ten years, the dairy goat farming business in Indonesia has shown positive results, both in terms of the number of crossbred dairy goat farms managed commercially and the goat population raised in each business unit based on the Directorate General of Livestock and Animal Health Services. The expanding dairy goat industry is bolstered by a favorable market reception for goat milk. However, the goat population, a key factor in this growth, experiences periodic fluctuations (BPS-Statistics Indonesia, 2024). Observations and research in the field, show that the demand for goat milk is quite high, especially from urban communities. The protein components contained in goat milk have a number of health benefits, including anti-inflammatory and immunomodulatory (Alkaisy *et al*., 2023), high in vitamins, minerals, and electrolytes (Abbas *et al*., 2014; Brito *et al*., 2011). Beyond its primary nutritional value, goat milk is also widely considered to possess health-promoting qualities, including medicinal efficacy, decreased allergenic potential compared to cow's milk, and improved digestibility (Sumarmono, 2022; Tesema *et al*., 2020; Liang and Paengkoum, 2019). The initial capital and relatively cheaper maintenance costs compared to cattle farming also make the dairy goat farming business increasingly attractive (Sumarmono, 2022).

The goat population in Indonesia in 2022, based on data from the Statistics Indonesia is 18,560,835 heads (BPS-Statistics Indonesia, 2024). This number has generally increased over the past five years leading up to 2018, with the goat population in Indonesia recorded at approximately 18,306,476 million individuals in 2018. Some of the dairy goat breeds that are widely farmed in Indonesia include Etawah Crossbred (PE), Saanen-Etawah Crossbred (Sapera), Anglo Nubian, and Senduro goats (Sumarmono, 2022). Among the diverse dairy goat breeds, Sapera goats, developed from crossbreeding male Saanen with female PE goats, demonstrate the highest average milk production (Sumarmono, 2022; Suranindyah *et al*., 2018). However, the production of Saanen goats in tropical countries, which reached 1.17 to 2.58 kg daily (Khandoker *et al*., 2018), remains comparatively low when contrasted with Saanen goats in subtropical climates, which produce around 1.86 to 4.80 kg daily (Gökdai *et al*., 2020). This is due to feed management, suboptimal maintenance, and inefficient reproductive management, such as: Failure to detect estrus, high cases of repeat breeding, and early embryonic death in smallholder farms (Diatmono *et al*., 2024a; Widayati *et al*., 2017). These challenges are also encountered by several smallholder farmers, who are members of farmer groups in the Sleman Regency, Special Region of Yogyakarta, Indonesia.

The Dian Santosa and Pangestu Farmer Groups, both located within Sleman Regency, primarily concentrate on dairy goat and sheep farming. The majority of their members are engaged in diverse occupations, including crop farming, private sector employment, and civil service, all of whom reside in the Sleman area. A significant proportion of farmer group members demonstrate limited understanding of reproductive management, livestock breeding practices, and the application of assisted reproductive technology (ART). These knowledge gaps are critical factors impeding increased dairy goat production (Luo *et al*., 2019; Paramio and Izquierdo, 2014). These limitations significantly impede the success and sustainability of farm groups (Diatmono *et al*., 2024b; Suranindyah *et al*., 2018). Ultimately, reproductive performance directly and indirectly influences overall livestock productivity (Warman *et al*., 2023). The reproductive performance of female dairy goats is an indicator of productivity, adaptability, and economic viability of farmers (Tesema *et al*., 2020). Moreover, this pilot study assessed the reproductive performance of dairy goats within the Dian Santosa and Pangestu Farmer Groups. Concurrently, it gathered data on smallholder farmer operational profiles to characterize farming practices and address field-level challenges. The findings from this study are intended to inform recommendations for future counseling, training, research, and ART implementation programs, all aimed at enhancing the reproductive efficiency of dairy goats in smallholder farms.

Materials and Methods

Research location and period

This study was carried out in the Dian Santosa and Pangestu Farmer Groups. This study involved 45 smallholder farmers from the Dian Santosa Farmer Group and 20 smallholder farmers from the Pangestu Farmer Group. Data collection, encompassing surveys, questionnaires and estrus observation was conducted over a six-month period, from June to November 2024. The geographical distribution of farms within

these groups across Sleman Regency, Special Region of Yogyakarta, is presented in Figure 1.

Figure 1: *Geographical distribution of Dian Santosa and Pangestu Farmer Groups members across Sleman Regency, Special Region of Yogyakarta.*

Data collection

Data were collected through direct visits to smallholder farmers. The primary method for data acquisition was a self-administered questionnaire. Purposive sampling was employed to select respondents based on the following criteria: Membership in either the Dian Santosa or Pangestu Farmer Groups, engagement in dairy goat farming, with breeding as a primary objective, possession of a multiparous doe, willingness and consent of the farmer to provide information during the study. To find the correlation with dairy goat reproductive performance data, reproductive management variables were scored on a scale of 1 to 2 (Table 1).

Table 1: *Determination of the variables for this study.*

Variables	Definition
Demographic profile of farmers	
Gender	Gender of farmer (respondent)
Age	Farmer's age (respondent)
Education	Farmer's highest educational attainment
Informal education	Farmer participation in animal husbandry training
Marital status	Farmer's marital status
Family members	Number of family members in the household
Reasons for farming	Principal motivation for animal husbandry engagement
Livestock ownership status	Ownership status of the dairy goats
Farming experience	The accumulated knowledge and practical understanding gained through active involvement in farming practices
Dairy goat maintenance	
Number of goats raised	Number of goats raised by the farmer
Animal feed types	Dietary composition (forage or concentrate) of feed administered to goats
Feeding frequency	Temporal frequency of feed provision, expressed as the number of feeding episodes per 24-hour period
Total feed given	Daily feed quantity (farmer-provided)
Reproductive management	
Applied mating system	Application of goat mating protocols by farmers (scored: 1 for farmers using natural mating and 2 for farmers using AI)
Estrus synchronization	Application of estrus synchronization by farmers (scored: 1 farmers without prior estrus synchronization experience and 2 for farmers with prior estrus synchronization experience)
Recognizing estrus signs	Farmers can identify the estrus cycle in goats by observing estrus symptoms (scored: 1 for farmers unfamiliar with estrus detection methods and 2 farmers capable of detecting estrus based on vulva morphology and behavioral changes in does)
Knowing the essential breeding records	Farmer understanding of essential reproductive performance data for accurate record-keeping (scored: 1 for farmers who perform simple recording and 2 for farmers who perform complete recording)
Reproductive performance	
First age of estrus	Chronological age at which a doeling reaches puberty, as evidenced by the onset of first estrus
First age of mating	Age at which a female goat reaches sexual maturity and is first bred or mated
Age at first kidding	Chronological age at which a doe gives birth for the first time
Estrus cycle length	Interval between successive ovulatory events, characterized by recurring hormonal and physiological fluctuations
Litter size	Number of kids born to a doe in a single kidding
Post-partum estrus (PPE)	Occurrence of first estrus following kidding
Post-partum mating (PPM)	Practice of breeding or mating following kidding
Weaning age	The age at which kids are separated from their does, while still receiving milk (from the doe or a substitute) or transitioning offspring from a milk-based diet to solid food
Kidding interval	The span of time from one kidding to the subsequent kidding of a doe

Table continues on next column.....

In addition to analyzing existing reproductive records from farmers, vaginal smear analysis based on Magistrama *et al.* (2024) was performed to corroborate and strengthen data on dairy goat reproductive performance. This sampling was conducted in five representative farms within the Dian Santosa and Pangestu Farmer Groups to observe and determine estrus cycle length and post-partum estrus (PPE). The specific dairy goat breeds reared by the smallholder farmers are presented in Figure 2, while the variables collected and their definitions are detailed in Table 1.

Figure 2: *Dairy goats raised by smallholder farmers; (a) Saanen, (b) Etawah Crossbred (PE), and (c) Saanen-Etawah Crossbred (Sapera).*

Statistical analysis

Data collected, which included the percentage of demographic and farmer profiles, dairy goat maintenance, and reproductive management practices, were analyzed using Excel 2021. Reproductive performance data were analyzed using a quantitative descriptive method. However, to determine the relationship between reproductive management and reproductive performance, a bivariate Pearson correlation with a two-tailed test of significance was performed using IBM SPSS Statistics 23. Farmer demographic and reproductive management data are presented as percentages (%), while reproductive performance data are expressed as Mean ± standard deviation (SD).

Results

Demographic and social profiles of smallholder farmers

This study included smallholder dairy goat farmers affiliated with the Dian Santosa and Pangestu Farmer Groups. While a total of 65 farmers participated, only 45 questionnaires fulfilled the established criteria for inclusion in the research data. This exclusion was due to 20 farmers primarily raising sheep and/or failing to complete the questionnaire adequately, necessitating their removal from the dataset to prevent data bias. The findings from 45 questionnaires (Table 2) revealed that all smallholder farmers who participated in this study are male. In addition, it is known that smallholder farmers are predominantly aged 40–60 years and have attained higher education, though most have never participated in informal education such as workshops or training related to animal farming. From the data (Table 2), it is also evident that the majority of farmers in this study were married and had four to six family members. Dairy goats farming serves as a secondary income or savings for these farmers, who privately own their dairy goats. Furthermore, most farmers are "new" to farming, with one to five years of experience.

Table 2: *Demographics of dairy goat farmers in the Dian Santosa and Pangestu farmer groups.*

Variables	Number of farmers (person)	Percentage (%)
Gender		
Man	45	100.00
Woman	0	0.00
Age (years)		
20 – 40	14	31.11
40 – 60	25	55.56
More than 60	6	13.33
Education		
Primary school	5	11.11
Junior High School	8	17.78
Senior High School	18	40.00
Bachelor	12	26.67
Master	2	4.44
Informal education (training/courses)		
Yes	16	35.56
No	29	64.44
Marital status		
Married	37	82.22
Unmarried	8	17.78
Other	0	0.00
Family members (people)		
2 – 3	13	28.89
4 – 6	32	71.11
More than 6	0	0.00
Reasons for farming		
Main jobs	11	24.44
Side hustle/savings	34	75.56
Livestock ownership status		
Private property	39	86.67
Share-farming agreement	6	13.33
Farming experience (years)		
1 – 5	22	48.89
6 – 10	8	17.78
More than 10	15	33.33

Dairy goat maintenance and reproductive management

The questionnaire results (Table 3) indicated that farmers, on average, raised 6–10 goats. The primary feed provided was a mixture of forage and concentrate. Farmers reported feeding their goats twice daily, with the total daily feed exceeding 1.5 kg per animal per day. Among the farmers who completed the questionnaire (Table 4), the majority utilized natural mating and had performed estrus synchronization. Furthermore, it was observed that more than half of the farmers recognized the signs of estrus and could detect estrus effectively. Nearly all farmers also maintained reproductive data records.

Table 3: *Dairy goat maintenance implemented by farmers.*

Variables	Number of farmers (person)	Percentage (%)
Number of goats raised (animal)		
1 – 5	7	15.56
6 – 10	23	51.11
More than 10	15	33.33
Animal feed types		
Forage	13	28.89
Concentrate	4	8.89
Mixtures	28	62.22
Feeding frequency (times per day)		
2	35	77.78
3	8	17.78
More than 3	2	4.44
Total feed given (kg per animal per day)		
Less than 1.5	6	13.33
1.5	16	35.56
More than 1.5	23	51.11

Table 4: *Reproductive management implemented by farmers.*

Variables	Number of farmers (person)	Percentage (%)
Applied mating system		
Natural mating	39	86.67
Artificial insemination (AI)	6	13.33
Estrus synchronization		
Never	17	37.78
Once	28	62.22
Recognizing estrus signs		
Unfamiliar	12	26.67
Familiar and capable	33	73.33
Knowing the essential breeding records		
Simple recording	8	17.78
Complete recording	37	82.22

Reproductive performance of dairy goats

Reproductive performance data were compiled from two sources: Information provided by farmers in the questionnaire (Table 5) and direct observation of estrus cycle length and PPE from vaginal smears. From these data, it was determined that the reproductive performance of does was normal, with the average first estrus age for goats recorded at 7.36 months. Goats raised by farmers had an average age of 9.42 months for first mating and 14.60 months for first kidding. The average estrus cycle length was 23.57 days, with a litter size of 1.64 per kidding. Does exhibited an average PPE of 47.33 days and PPM of 74.11 days. Furthermore, the average weaning age was 2.57 months and the kidding interval was approximately 8.07 months.

Table 5: *The average of reproductive performance of dairy goats on smallholder farms.*

Variables	Min. value	Max. value	Mean±SD
First age of estrus (months)	5.00	9.25	7.36±1.09
First age of mating (months)	7.00	13.50	9.42±1.64
Age at first kidding (months)	12.00	18.50	14.60±1.60
Estrus cycle length (days)	19.00	34.00	23.57±3.76
Litter size (kids)	1.00	3.00	1.64±0.67
Post-partum estrus (days)	39.00	65.00	47.33±6.54
Post-partum mating (days)	60.00	95.00	74.11±10.03
Weaning age (months)	1.00	4.00	2.57±0.94
Kidding interval (months)	6.00	12.00	8.06±1.44

Relationship between reproductive management and reproductive performance of dairy goats

The correlation results presented in Table 6 indicate significant interrelationships among several reproductive management and does reproductive performance variables. The implemented mating method was positively correlated with estrus synchronization, which, in turn, correlated with the farmers' estrus detection ability and implementation of reproductive recording. The first estrus age showed a strong positive correlation with both first mating age and first kidding age. Additionally, PPE and PPM were positively correlated, as were weaning age and kidding interval, both exhibiting strong positive correlations. Conversely, several variables demonstrated negative correlations. Notably, estrus synchronization was negatively correlated with estrus cycle length, which also showed a negative correlation with farmers' estrus detection ability. Furthermore, the implementation of reproductive recording exhibited a negative correlation with weaning age.

Table 6: *Relationship between reproductive management and reproductive performance of dairy goats in Dian Santosa and Pangestu farmer groups.*

r	AMS	ES	RES	BR	FAE	FAM	AFK	ECL	LS	PPE	PPM	WA	KI
AMS	1	0.306*	0.237	0.182	0.018	-0.021	-0.004	-0.254	0.086	-0.061	0.035	0.178	-0.119
ES	0.306*	1	0.774**	0.597**	-0.233	0.075	0.063	-0.617**	0.188	0.069	-0.167	-0.157	-0.108
RES	0.237	0.774**	1	0.771**	-0.155	0.079	0.038	-0.311*	0.172	0.078	-0.171	-0.274	-0.201
BR	0.182	0.597**	0.771**	1	-0.030	0.067	-0.007	-0.287	0.045	0.132	0.035	-0.336*	-0.243
FAE	0.018	-0.233	-0.155	-0.030	1	0.552**	0.453**	0.128	0.128	0.215	0.220	-0.087	0.099
FAM	-0.021	0.075	0.079	0.067	0.552**	1	0.957**	0.051	0.102	0.039	-0.026	0.177	0.146
AFK	-0.004	0.063	0.038	-0.007	0.453**	0.957**	1	0.099	0.008	0.042	-0.040	0.224	0.179
ECL	-0.254	-0.617**	-0.311*	-0.287	0.128	0.051	0.099	1	-0.216	-0.212	0.010	0.109	0.051
LS	0.086	0.188	0.172	0.045	0.128	0.102	0.008	-0.216	1	-0.038	-0.171	0.105	-0.084
PPE	-0.061	0.069	0.078	0.132	0.215	0.039	0.042	-0.212	-0.038	1	0.414**	-0.010	0.096
PPM	0.035	-0.167	-0.171	0.035	0.220	-0.026	-0.040	0.010	-0.171	0.414**	1	0.280	0.227
WA	0.178	-0.157	-0.274	-0.336*	-0.087	0.177	0.224	0.109	0.105	-0.010	0.280	1	0.759**
KI	-0.119	-0.108	-0.201	-0.243	0.099	0.146	0.179	0.051	-0.084	0.096	0.227	0.759**	1

**: Superscripts mark correlations that are statistically significant (p<0.05, 2-tailed), **: Superscripts mark correlations that are statistically significant (p<0.01, 2-tailed), r: Sample correlation coefficient, AMS: Applied matting system, ES: Estrus synchronization, RES: Recognizing estrus signs, BR: Breeding records, FAE: First age of estrus, FAM: First age of mating, AFK: Age at first kidding, ECL: Estrus cycle length, LS: Litter size, PPE: Post-partum estrus, PPM: Post-partum mating, WA: Weaning age, and KI: Kidding interval.*

Discussion

The dominance of men in the field of animal husbandry is related to the patriarchal culture in the Special Region of Yogyakarta which is still strong. Men are considered dominant and obliged to earn a living (Satiti *et al*., 2022; Wahdiniwaty and Rustam, 2019). The age range that dominates smallholder farmers is the productive age which is still in the range of 15 to 64 years (BPS-Statistics Indonesia, 2025). The demographic profile of smallholder farmers, particularly those dominated by younger individuals, is associated with high work performance, effective cognitive function, and enhanced problem-solving capabilities (Andarwati *et al*., 2018), more creative, and more open to new knowledge (Ibrahim *et al*., 2021). This is because the age factor affects adaptability and work proactivity (Karanika-Murray *et al*., 2024). The high educational attainment among farmers (senior high school and bachelor's degrees) presents a positive opportunity for the implementation of ART. This aligns with several previous studies indicating a positive correlation between farmers' educational levels and their increased knowledge, broader perspectives, and a more rational mindset (Warman *et al*., 2023). Other studies also demonstrate that informal education, such as training and workshops, has a significant effect on improving farmers abilities, aligning with enhanced livestock yields (Santra *et al*., 2020). In general, the level of education, both formal and informal, has a significant effect on the level of adaptation and implementation of farmers to the latest technology and knowledge that will increase overall productivity (Paltasingh and Goyari, 2018).

Prior studies have shown that marital status has both a negative and positive correlation with work performance, a phenomenon often associated with the fulfillment of family responsibilities (Aslam *et al*., 2020). Consequently, family involvement also positively influences livestock-related activities and their overall development (Sudrajat *et al*., 2024; Ibrahim *et al*., 2021). Family members have a direct role in farming activities, where wives and children usually help raise livestock on smallholder farms (Sudrajat *et al*., 2024; Satiti *et al*., 2022; Tadesse, 2019). Subsequently, it is evident that the present findings align with prior studies which report that small-scale farmers typically employ livestock for savings or insurance purposes (Budisatria *et al*., 2019). The predominance of crop farming and private sector employment among farmers contributes to the sustained prevalence of private goat ownership. This can be attributed to the comparatively low investment and maintenance costs associated with goat farming, coupled with its less demanding management requirements (Liehr *et al*., 2024) consequently, these factors lead farmers to prefer acquiring goats over

cattle or buffaloes. This finding further elucidates that greater farming experience directly corresponds to increased practical knowledge and more judicious decision-making (Sulfiar *et al*., 2020). Farmers who have longer experience have the opportunity to improve business development (Sudrajat *et al*., 2024). The observed dominance of farmers with relatively short farming experience (one to five years) likely contributes to their participation in livestock groups. Farmers' groups are instrumental in enhancing breeder capabilities, functioning as vital forums for knowledge exchange and collaborative problem-solving, which, in turn, supports the cultivation of self-reliant farming enterprises (Warman *et al*., 2023; Widyastuti *et al*., 2023).

The findings (Table 3) indicate that the number of goats owned per farmer is relatively high. This result aligns with previous study suggesting that the number of animals owned can serve as an indicator of farming business scale (Andarwati *et al*., 2018). It is further elucidated that a reduced animal holding size may consequently diminish farming motivation (Warman *et al*., 2023; Ibrahim *et al*., 2021), while the high animal population is in line with the increase in farming motivation and the acceleration of the acceptance of farming innovation (Warman *et al*., 2023; Ibrahim *et al*., 2022). In terms of animal maintenance management (Table 3), reveals that many farmers primarily utilize a mixed diet of forage and concentrates. Providing a combination of forage and concentrate is crucial for the success of dairy farming, enabling the maintenance of milk quality and the increase of milk production (Akbar *et al*., 2024). The crude fiber component contained in forage can maintain the digestive process of ruminant animal so that it continues to run normally, while the nutrients contained in the concentrate can be used as a reinforcement and complement to nutrients that have not been obtained from forage (Akbar *et al*., 2024; Budisatria *et al*., 2018; Widyobroto *et al*., 2016). Based from the results, farmers typically adjust feeding times and quantities based on the specific nutritional requirements of their livestock, as enhanced animal productivity is directly linked to the adequate fulfillment of goat nutrient needs (Kumala *et al*., 2022; Widayati *et al*., 2024). Furthermore, factors such as age, sex, breed, and body size are known to influence both the amount of feed offered and consumed by the animals (Arias-Islas *et al*., 2020). The composition of dietary nutrients is fundamental to reproductive outcomes and overall animal productivity, with crucial involvement in aspects like reproductive hormone synthesis, follicular maturation, successful gestation, and subsequent milk yield (Kumala *et al*., 2022; Widyobroto *et al*., 2016; Wu *et al*., 2014).

Based on the results presented in Table 4, it is evident that farmers favor natural mating using their own or fellow group members' bucks over artificial insemination (AI). This finding aligns with previous research indicating that natural mating is perceived to have a higher success rate and is considered simpler and more economical (Warman *et al*., 2023). The average cost of AI services, ranging from IDR 75,000–100,000 (approximately US$5–6.5), coupled with a high service per conception (S/C) rate, is still considered economically burdensome and ineffective by some farmers. Conversely, some breeders utilize AI due to its potential to enhance offspring quality, and they believe it can mitigate disease transmission (Warman *et al*., 2023; Verma *et al*., 2012). A correlation between reproductive management (Table 4) and dairy goat performance (Table 5) indicates that farmers adopting AI commonly synchronize estrus. Based on the correlation results (Table 6), it is known that farmers performing AI and estrus synchronization have maintained good reproductive records and can effectively detect estrus based on visible symptoms. This finding is presumably related to the farmers' level of understanding and experience. Previous studies indicates farmers widely adopt estrus synchronization to maximize estrus response and precisely time AI (Arya *et al*., 2023; Wondim *et al*., 2022). The results (Table 6) indicate that farmers who implement estrus synchronization and understand the importance of recording reproductive events have a negative correlation with estrus cycle length. This aligns with previous studies demonstrating that estrus synchronization can manipulate the estrus cycle and accurate reproductive recording facilitates precise mating times, which, in turn, minimizes the incidence of imprecise breeding events (Magistrama *et al*., 2024; Arya *et al*., 2023; Sitaresmi *et al*., 2019).

Reproductive performance is contingent upon the implementation of reproductive management, which in turn is influenced by several factors, including maintenance management, the nutritional components of the feed, and the health conditions of the animals (Diatmono *et al*., 2024a; Budisatria *et al*., 2019). The reproductive performance of dairy

goats demonstrated normal results, likely due to their successful adaptation to Indonesia's climate (Sumarmono, 2022; Suranindyah *et al*., 2018). However, it exhibited a considerable range between its minimum and maximum values (Table 5). The average first estrus age observed remains relatively normal, as goats generally begin estrus at approximately seven months of age (Khalil *et al*., 2019; Lubis, 2016) Goats reaching puberty subsequently establish a reproductive rhythm known as the estrus cycle (Diatmono *et al*., 2024b; Magistrama *et al*., 2024; Sitaresmi *et al*., 2019). It was further determined that first age of estrus positively correlates with both first mating age and first kidding age (Table 6). These results suggest that an earlier onset of estrus in goats leads to earlier mating and kidding. Delayed estrus onset in goats can occur due to nutritional deficiencies during growth and development (Khalil *et al*., 2019). Furthermore, delayed mating and a prolonged first kidding age in dairy goats can decrease production and economic viability, while increasing production costs (Penev *et al*., 2014). The observed estrus cycle length and litter size align with previous studies indicating that the normal estrus cycle in goats lasts 17–25 days, with estrus duration ranging from 20 to 35 hours and an estimated ovulation time of 30 to 36 hours from estrus onset (Alves *et al*., 2018; Khandoker *et al*., 2018), with the birth rate of single offspring in dairy goats is higher compared to twin births, with a range of 1.30 to 2.37 kids (Khandoker *et al*., 2018).

The PPE data obtained are still relatively fast when compared to the PPE range of 45–180 days reported in the previous study in Jawarandu goats (Tanjung *et al*., 2015). Correlation results (Table 6) indicate a strong positive correlation between PPE and PPM, where the length of PPE affects the length of PPM. Previous studies have shown that several factors influence the duration of PPM, including inaccurate estrus detection, feed nutrition, and delayed mating due to unweaned kids (Warman *et al*., 2023; Budisatria *et al*., 2019). Based on the results, the weaning period is relatively fast, this is possible because farmers want to optimize milk production, besides that weaning also aims to save feed and maintain a regular reproductive cycle (Baliarti *et al*., 2020). The negative correlation (Table 6) between weaning age and reproductive event recording suggests that farmers are not weaning the kids according to the recommended period of three to five months, likely due to insufficient recording of reproductive events, particularly parturition dates (Budisatria *et al*., 2018). Results presented in Table 6 also revealed a strong positive correlation between weaning age and kidding interval. This suggests that a longer weaning period directly leads to a more extended kidding interval (Warman *et al*., 2023). The observed kidding interval is also largely consistent with previous research on PE goats (Budisatria *et al*., 2018). That study reported a birth interval of 274 days (±9 months) for PE goats raised by smallholder farmers, compared to 225 days (±7 months) for those raised intensively. Furthermore, it's known that kidding interval in goats is influenced by S/C, pregnancy duration, weaning time, and PPM (Khalil *et al*., 2019; Budisatria *et al*., 2018).

Conclusions and Recommendations

This study reveals significant interrelationships between reproductive management practices and the reproductive performance of does. Key findings include positive correlations of mating method with estrus synchronization, estrus synchronization with farmers' estrus detection ability and the use of reproductive recording. Furthermore, negative correlations were observed between the implementation of estrus synchronization and estrus cycle length, estrus cycle length and estrus detection ability, and also negative correlation between reproductive recording and weaning age (suggesting potential for a shorter estrus cycle length and weaning period). These findings highlight a clear opportunity to enhance dairy goat reproductive performance in the Dian Santosa and Pangestu Farmer Groups. This can be achieved through the strategic implementation of ART, particularly estrus synchronization, and comprehensive training in reproductive event recording.

Acknowledgments

The authors would like to acknowledge the smallholder farmers affiliated within the Dian Santosa dan Pangestu Farmer Groups for the participation and facilities provided. Furthermore, the authors acknowledge the Faculty of Animal Science, Universitas Gadjah Mada for supporting this study, facilitated through the Community Service Grant Laboratory (No. 2309/UN1/PT/PM.01.03/2024), and the Ministry of Higher Education, Science, and Technology for the partial financial contribution via the PMDSU program (No. 048/E5/PG.02.00. PL/2024).

Novelty Statement

This study uniquely quantifies the intricate network of relationships between specific reproductive management practices and key performance indicators in smallholder dairy goat farming, particularly within the understudied context of the Dian Santosa and Pangestu Farmer Groups in Sleman, Yogyakarta. By identifying direct and inverse correlations between factors like mating methods, estrus synchronization, reproductive event recording, and outcomes such as estrus cycle length and weaning age, this research provides actionable, data-driven insights for targeted interventions. This depth of correlation analysis within this specific smallholder setting offers a novel foundation for developing tailored strategies, emphasizing the strategic role of ART and reproductive recording training, to measurably enhance dairy goat reproductive efficiency and productivity in similar community-based farming systems.

Author's Contribution

Diah Tri Widayati: Conceptualization, data curation, formal analysis, methodology, validation, investigation, project administration, writing–original draft, and review.
Sigit Bintara: Conceptualization, methodology, validation, investigation, and review.
Widya Asmarawati, Riyan Nugroho Aji, Kurniawan Dwi Prihantoko and Yustina Yuni Suranindyah: Conceptualization and investigation.
Budi Prasetyo Widyobroto: Validation and review.
Fransisca Gani Padmawati: Formal analysis, software, and investigation.
Dio Fico Felsidan Diatmono: Data curation, formal analysis, software, investigation, writing–original draft, and editing.

Ethical approval

Data collection, which involved the use of vaginal smears to corroborate reproductive performance results obtained from questionnaires, received approval from the Research Ethics Committee of the Faculty of Veterinary Medicine, Universitas Gadjah Mada, Yogyakarta (No. 3/EC-FKH/int./2024). This ethical clearance remained valid for the entire duration of the study.

Conflict of interest

The authors states that there is no conflict of interests related to the publication of this article.

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