OPEN ACCESS
Research Journal of Veterinary Practitioners

Research Article

Comparative Assessment of Productive and Reproductive Traits in Holstein Friesian, Jersey, Sahiwal, and Indigenous Dairy Cows of Bogura District in Bangladesh

Md. Sabbir Ahmed Shuvo[1], Mir Md. Iqbal Hasan[2], Mukim Mahmud[1], Md. Kamruzzaman Akimul[3]*

[1]Department of Animal Nutrition, Faculty of Veterinary, Animal and Biomedical Sciences, Sylhet Agricultural University, Bangladesh; [2]Department of Physiology, Faculty of Veterinary, Animal and Biomedical Sciences, Sylhet Agricultural University, Bangladesh; [3]Department of Microbiology and Public Health, Faculty of Animal Science and Veterinary Medicine, Patuakhali Science and Technology University, Babuganj, Barishal-8210, Bangladesh.

Abstract | This study was conducted to investigate the productive and reproductive performance of Holstein Friesian crossbred (HF), Jersey crossbred, Sahiwal crossbred, and indigenous dairy cows. A total of 63 cows were randomly chosen representing four genetic groups; indigenous breeds (8), Sahiwal crossbred (8), Jersey crossbred (10) and 37 HF crossbred due to their abundance in the study area. The investigation determined that HF crossbred cattle produced the largest milk quantity at 17.92 ± 3.30 liters/day while Jersey crossbred yielded 11.19 ± 1.70 liters/day and Sahiwal crossbred gave 8.63 ± 1.30 liters/day but indigenous cows gave the least at 2.06 ± 0.56 liters/day. HF crossbred cows produced milk at higher amounts than all other cow groups. The lactation period of HF crossbred cows was significantly longer than that of indigenous cows; however, no significant difference was observed between Jersey and Sahiwal crossbred cows. Voluntary waiting periods of HF crossbred, Jersey crossbred, Sahiwal crossbred and indigenous cows were 60.70 ± 10.50, 66.27 ± 10.05, 71.00 ± 10.82 and 75.88 ± 7.10 days, respectively pointing out to the shorter time in HF crossbred cows representing relatively higher reproductive efficiency. The gestation lengths recorded were 269.54 ± 7.60 days for HF crossbred, 268.27 ± 5.87 days for Jersey crossbred, 274.63 ± 6.00 days for Sahiwal crossbred, and 271.00 ± 4.21 days for indigenous cows. The research indicates that HF crossbred cows managed to produce better management results, especially in relation to increased productivity of milk and better reproductive power than other breeds.

Keywords | Holstein Friesian crossbred, Jersey crossbred, Sahiwal crossbred, Indigenous cows, Gestation lengths, Milk production

Received | July 24, 2025; **Accepted** | August 28, 2025; **Published** | September 28, 2025
***Correspondence** | Md. Kamruzzaman Akimul, Department of Microbiology and Public Health, Faculty of Animal Science and Veterinary Medicine, Patuakhali Science and Technology University, Babuganj, Barishal-8210, Bangladesh; **Email:** akimul315512@gmail.com
Citation | Shuvo MSA, Hasan MMI, Mahmud M, Akimul MK (2025). Comparative assessment of productive and reproductive traits in Holstein Friesian, Jersey, Sahiwal, and indigenous dairy cows of Bogura district in Bangladesh. Res J. Vet. Pract. 13(3): 63-69.
DOI | https://dx.doi.org/10.17582/journal.rjvp/2025/13.3.63.69
ISSN | 2308-2798

INTRODUCTION

Bangladesh is a densely populated, agriculture-based country. Approximately 20% of the population is directly involved in agriculture and liveestock rearing, while another 50% is partially involved. FAO (2022) indicates that the prevalence of livestock use in Bangladesh is 70% among rural households as their major source of income and livelihood. The total cattle population in Bangladesh is approximately 25.013 million, and the livestock

sector contributes 1.80% to the national GDP (DLS, 2023–2024). Dairy farming supports rural employment, enhances protein intake, strengthens food security, and helps reduce poverty in both rural and urban areas (Hamid *et al.*, 2016). Bogura is a key dairy region in Bangladesh, where sustainable development relies on knowledge of cow productivity and reproductive performance.

According to BBS (2014), there are approximately 3.53 million milking cows in Bangladesh, accounting for 36% of the total cow population. In smallholder farming systems in Bangladesh, crossbred cows particularly Friesian × indigenous types have shown significantly higher milk yield and reproductive efficiency than native cattle. When appropriate management practices are applied alongside their genetic potential, these crossbred cows produce an average of 8.39 liters of milk per day, compared to only 2.38 liters from indigenous cows (Rokonuzzaman *et al.*, 2010). Crossbreeding approaches along with high-fertility sire programs improve agricultural performance and reproductive capacity (Islam *et al.*, 2017). The optimization of performance requires focus on nutritional intake and both heat stress reduction and reproductive health maintenance (Fodor *et al.*, 2018).

Despite recent progress, Bangladesh still faces a notable milk deficit, producing 13.07 million tonnes in 2021–22 against a demand of 15.61 million tonnes, with per capita availability at 208 ml below the recommended 250 ml posing significant challenges to nutritional security (Saha, 2023). According to DLS (2023–2024), Bangladesh's annual milk production stands at 15.044 million metric tons still below the national demand of 15.878 million while meat production exceeds demand; milk yield reflects both productivity and reproductive efficiency, which are key to farmer profitability and largely influenced by the genetic traits of both dam and sire. Maximizing profitability in dairy farming relies on optimizing lactation, dry, and service periods (Cilek and Tekin, 2005), with a 46–55 days dry period shown to enhance milk yield and reduce health issues in Holsteins (Safa *et al.*, 2013; Koyama *et al.*, 2024). Commercial farms use exotic breeds and intensive management to overcome low productivity of local cattle, but profitability is often limited by reproductive inefficiencies, including long calving intervals, early embryonic loss, and heat stress-related low conception rates (Riecka and Candrak, 2011; Diskin and Morris, 2008; García-Ispierto *et al.*, 2007).

Crossbreeding Bos taurus dairy breeds with tropical cattle is widely practiced to enhance milk production, with studies showing that F_1 hybrids offspring of indigenous females and exotic males significantly outperform indigenous l breeds by producing up to three times more milk, exhibiting longer lactation periods, and shorter calving intervals (Singh, 2016). Crossbreeding between native and European breeds has shown limited success, with minimal gains or even declines in milk yield and a significant drop in fertility, as many European breeds struggle in tropical climates (Syrstad, 1989). However, crossbred cows generally exhibit longer lactation periods and higher milk production (Rokonuzzaman *et al.*, 2010; Alam *et al.*, 2010). Indigenous cattle have low genetic potential, poor productivity, and weak reproductive performance, whereas proper nutrition and care significantly enhance the outcomes of exotic crossbreds, which also reach reproductive maturity earlier particularly Friesian-cross cows (Alam *et al.*, 2010).

The genetic enhancement project for native cows through crossbreeding started in the 1970s (Bhuiyan, 2011). According to our knowledge the selected research site contains native and crossbred dairy cows yet no extensive studies have been performed. This study evaluates dairy cow performance in Bogura to identify gaps and improve local dairy productivity amid limited regional research.

Objectives

- To evaluate the productive and reproductive performance of different breeds of dairy cows.
- To estimate the correlation between conception rate and selected traits of dairy cows.

MATERIALS AND METHODS

Study area and study period

It is a cross-sectional observational study carried out in different dairy areas of the Bogura region, northern Bangladesh. Five specific dairy zones of Bogura were selected for the study: (i) Kahalo, Bogura sadar, (ii) Mohipur, Sherpur, (iii) Noymile, Shajahanpur, (iv) Pirgasa, Gabtali, (v) Chamrul, Dupchachia (Figure 1). This study was conducted from March 2022 to July 2022.

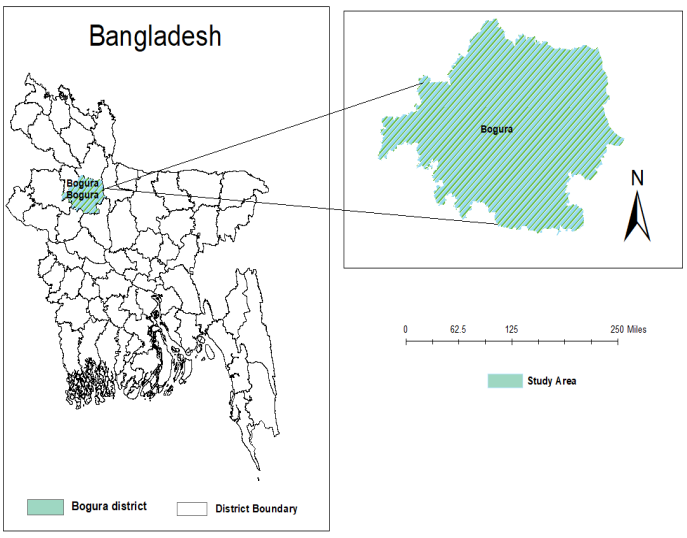

Figure 1: Study area (Bogura District, Bangladesh).

Table 1: Methods for Recording Cow-Level Data.

Variables	Methods of recording
Breed of the cows	Breed was determined by phenotypic traits, interviews with the farmers, and farm documentation but not through genetic authentication.
Age (months) of cows	Age of cows was determined by interviewing to the farm owners and inspection of farm record book or by using the dentistry.
No. of parity in cows	Number of parity in cows was determined by interviewing to the farm owners and inspection of farm record book.
Body grade of cows on the basis of LVP as described by Rahman (1996)	Grade-1: Cows had so much muscle that LVP not only invisible but also difficult to palpate.
	Grade-2: LVP not visible but easily palpable.
	Grade-3: Only head of the LVP visible from close distance and easily palpable.
	Grade-4: LVP clearly visible even from long distance with rough hair coat and thin back muscle.
Average milk production (L/day)	Average milk production was determined by interviewing to the farm owners and inspection of farm record book. It was estimated the average production daily.
Lactation length (days)	It was defined as the period from calving to dry off of the cow, which was determined by interviewing to the farm owners and inspection of farm record book.
Age of sexual maturity (months)	The period when a cow first expresses the signs of estrus along with producing mature ova. It was determined by interviewing to the farm owners and inspection of farm record book.
First calving age (months)	It indicates the age when a cow give birth a calf for first time, which was determined by interviewing to the farm owners and inspection of farm record book.
Time of breeding after onset of estrus (hours)	Time of breeding after onset of estrus was determined by interviewing to the farm owners and inspection of farm record book.
No. of services in previous conception	No. of services in previous conception was determined by interviewing to the farm owners and inspection of farm record book.
Gestation length (days)	The period of intra uterine development of embryo and fetus was considered as gestation length, which was calculated as the interval from fertile service to parturition. The duration of gestation was determined by interviewing to the farm owners and inspection of farm record book.
Status of suckling	Status of suckling was recorded by interviewing to the farm owners.
Voluntary waiting period (VWP: days)	The VWP was defined as the interval during the postpartum period in which farm owners decide not to breed cows even if estrus occurs. It was calculated from the date of last calving to the date of next breeding, which was determined by interviewing to the farm owners and inspection of farm record book.
Calving interval (days)	Calving interval is the interval between the date of one calving to the date of next calving, which was determined by interviewing to the farm owners and inspection of farm record book.
Season of last calving	Season of last calving was recorded by interviewing to the farm owners and inspection of farm record book.
Status of vaginal mucus	Status of vaginal discharge was recorded by interviewing to the farm owners and inspection of farm record book.

Data collection

Cow-level data were collected from the selected dairy zones in the Bogura district using a structured questionnaire through direct observation and interviews with farm owners during the field survey (Table 1). A total of 63 crossbred dairy cows from 40 farms across five dairy zones were included in the study. Data for each individual cow were recorded using the questionnaire. The quantitative cow-level variables and definitions of qualitative indicators are presented previously, which also outlines the methods used for recording cow-level data. Figure 2 shows the study layout, Figure 3 presents the data collection sheet format, and Figure 4 depicts a milch cow used for data collection.

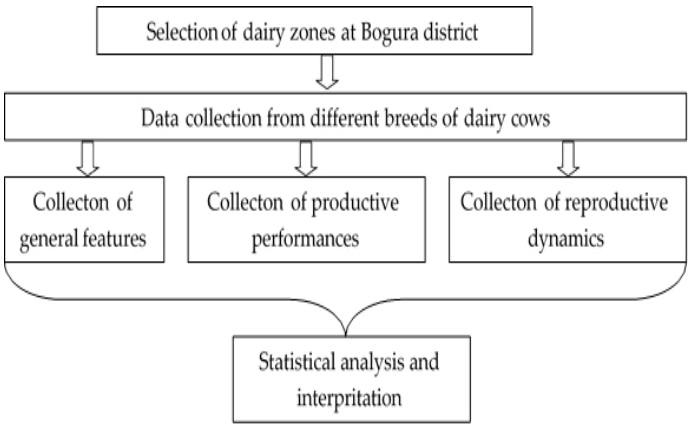

Figure 2: Schematic presentation of layout of the study.

Data for Veterinary Internship Report
Sylhet Agricultural University, Sylhet-3100

Md. Sabbir Ahmed Shuvo; ID No: 1701015; Reg. No: 3468 Supervised By: DR. Mir Md. Iqbal Hasan

An Assignment on Reproductive Dynamics in Dairy Cows

Sl. No	Farmers Name and address	Breed	Age (M)	Body Grade	Sexual maturity	Estrus duration	1st calving age	Parity	No. of service/ conception	Gestation length	Calving interval	Voluntary waiting period	Milk production

Body Grade: 1=Very Fatty, Lumber transverse process & spine are not palpable
2=Lumber transverse process & spine are palpable
3=Lumber transverse process & spine are seen in close inspection and also palpable
4=(Cachectic); Lumber transverse process & spine are seen from a far inspection and also palpable

Figure 3: Data collection sheet.

Figure 4: Milch cow used for data collection.

Statistical analysis

The analysis of data was done with SAS (1998). The means and standard deviations were determined, and one-way ANOVA contrasted the productive and reproductive characteristics of all four breeds. The p level of significance was $p \leq 0.05$, with Tukey HSD post hoc test.

RESULTS AND DISCUSSION

General features in different breeds of dairy cows

The comparison of general characteristics among different breeds of dairy cows is presented in Table 2. The average ages of HF X cows, Jersey X cows, Sahiwal X cows, and indigenous cows were 85.22±16.12 months, 68.36±15.11 months, 70.88±11.46 months, and 70.63±14.90 months, respectively. The body condition scores (based on LVP) for HF X cows, Jersey X cows, Sahiwal X cows, and indigenous cows were 2.00±0.91, 2.09±1.04, 1.7±0.46, and 2.13± 0.83, respectively (Table 2).

The results showed that the age of HF X cows was significantly higher ($P < 0.01$) than that of the other groups, while the age of Jersey X cows was significantly lower ($P < 0.01$). The differences in body condition scores among the groups were not statistically significant ($P > 0.05$), although Sahiwal X cows had slightly lower scores, which may indicate a favorable trait for dairy production.

Table 2: General features in different breeds of dairy cows.

	Mean ± SD				
Parameters	**HF X cows (n=37)**	**Jersey X cows (n=10)**	**Sahiwal X cows (n=8)**	**Indigenous cows (n=8)**	**P value**
Age (months)	85.22±16.12[a]	68.36±15.11[b]	70.88±11.46[c]	70.63±14.90[c]	0.003*
Body grade (LVP)	2.00±0.91[a]	2.09±1.04[a]	1.75±0.46[a]	2.13±0.83[a]	0.823

a,b,c Values within the row differ significantly with 95% confidence interval. N.B.: p ≤ 0.05 is statistically significant (*).

Table 3: Production features in different breeds of dairy cows.

	Mean ± SD				
Parameters	**HF X cows (n=37)**	**Jersey X cows (n=10)**	**Sahiwal X cows (n=8)**	**Indigenous cows (n=8)**	**P value**
Parity	4.92±1.30[a]	3.27±1.27[b]	3.25±1.04[b]	2.88±1.13[b]	0.000*
Milk production (L/ day)	17.92±3.30[a]	11.91±1.70[b]	8.63±1.30[c]	2.06±0.56[d]	0.000*
Lactation length (days)	299.46±15.71[a]	293.18±11.68[a]	275.63±12.94[b]	241.25±6.41[c]	0.000*

a,b,c,d Values within the row differ significantly with 95% confidence interval. N.B.: p ≤ 0.05 is statistically significant (*).

Table 4: Reproduction features in different breeds of dairy cows.

	Mean ± SD				
Parameters	**HF X cows (n=37)**	**Jersey X cows (n=10)**	**Sahiwal X cows (n=8)**	**Indigenous cows (n=8)**	**P value**
Age of sexual maturity (months)	25.86±1.11[d]	29.45±0.82[c]	31.00±1.20[b]	34.88±0.99[a]	0.000*
Estrus duration (hours)	15.14±3.33[a]	14.82±2.82[a]	16.00±1.77[a]	15.50±2.20[a]	0.838
First calving age (months)	35.41±1.24[c]	39.00±1.10[b]	40.25±1.28[b]	44.00±1.31[a]	0.000*
No. of service per conception	1.38±0.49[a]	1.36±0.50[a]	1.25±0.46[a]	1.00±0.00[a]	0.206
Gestation length (days)	269.54±7.60[a]	268.27±5.87[a]	274.63±6.00[a]	271.00±4.21[a]	0.208
Calving interval (days)	359.19±16.56[a]	354.09±41.70[a]	371.88±13.87[a]	368.13±9.61[a]	0.262
Voluntary waiting period (days)	60.70±10.05[b]	66.27±10.67[a,b]	71.00±10.82[a,b]	75.88±7.10[a]	0.001*

a,b,c,d Values within the row differ significantly with 95% confidence interval N.B.: p ≤ 0.05 is statistically significant (*).

Production features in different breeds of dairy cows

The comparison of production characteristics among different breeds of dairy cows is presented in Table 3. The average parity for HF × cows, Jersey × cows, Sahiwal × cows, and indigenous cows was 4.92±1.30, 3.27±1.27, 3.25±1.04, and 2.88±1.13, respectively. Parity was significantly higher (P < 0.01) in HF × cows compared to the other groups. The average daily milk production was 17.92±3.30 L for HF × cows, 11.91±1.70 L for Jersey × cows, 8.63±1.30 L for Sahiwal × cows, and 2.06±0.56 L for indigenous cows. In comparison, Rokonuzzaman *et al.* (2010) reported daily milk yields of 8.36±2.01 L, 4.53±0.96 L, and 2.23±0.73 L for HF × cows, Sahiwal × cows and other indigenous l cows, respectively. Islam *et al.* (2017) reported values of 6.65±0.19 L, 5.92±0.18 L, and 1.64±7.55 L, while Alam *et al.* (2010) reported 6.3±1.2 L, 5.1±1.0L, and 1.7±0.6 L, respectively. Milk production differed significantly (P < 0.01) among the groups, with HF X cows showing the highest yield, followed in descending order by Jersey X cows, Sahiwal X cows and indigenous cows (Table 3).

Lactation lengths were recorded as 299.46±15.71 days for HF × cows, 293.18±11.68 days for Jersey X cows, 275.63±12.94 days for Sahiwal X cows, and 241.25±6.41 days for indigenous cows. In comparison, Rokonuzzaman *et al.* (2010) reported lactation length of 262.0±24.15, 250.4±28.06, 227.8±32.50 days for HF × cows, Sahiwal × cows and other indigenous cows, respectively. Islam *et al.* (2017) reported values of 274.80±2.79, 279.61±3.37 and 274.00±3.78 days while Alam *et al.* (2010) reported 253.8±21.9, 240.8±15.7 and 217.9±18.7 days respectively. Lactation length was significantly higher (P < 0.01) in HF X and Jersey X cows compared to Sahiwal X and indigenous cows.

Reproductive features in different breeds of dairy cows

The comparison of reproductive features among different breeds of dairy cows is presented in Table 4. The age of sexual maturity for HF X cows, Jersey X cows, Sahiwal X cows and indigenous cows was 25.86±1.11 months, 29.45±0.82 months, 31.00±1.20 months, and 34.88±0.99 months, respectively. In comparison, Islam *et al.* (2017) reported values of 24.64±.33, 25.66±.51 and 28.94±.48 months for HF × cows, Sahiwal × cows and other indigenous cows, respectively while Alam *et al.* (2010) reported 23.9±2, 26.2±2.4 and 27.4±2.7 months, respectively. The results

showed that the age of sexual maturity was significantly higher (P<0.01) in local cows, followed by Sahiwal X cows, Jersey X cows, and HF X cows, in descending order (Table 4).

The estrus duration was 15.14±3.33 hours in HF X cows, 14.82±2.82 hours in Jersey X cows, 16.00 ± 1.77 hours in Sahiwal X cows and 15.50 ± 2.20 hours in indigenous cows.

The age of first calving was 35.41 ± 1.24 months for HF X cows, 39.00 ± 1.10 months for Jersey X cows, 40.25 ± 1.28 months for Sahiwal X cows, and 44.00 ± 1.31 months for indigenous cows. In comparison, Rokonuzzaman *et al.* (2010) reported age of first calving 34.12±3.78, 35.48±3.64 and 40.48±4.54 months for HF × cows, Sahiwal × cows and other indigenous cows respectively while Islam *et al.* (2017) reported values of 36.96±.40, 38.32±.44 and 38.84±.60 months, respectively. The age of first calving was significantly higher (P<0.01) in local cows compared to the other groups. It was also significantly higher (P<0.01) in Sahiwal × cows than in HF × cows, and non-significantly higher (P>0.05) in Sahiwal × cows than in Jersey × cows.

The average number of services per conception was 1.38±0.49 for HF X cows, 1.36±0.50 for Jersey X cows, 1.25±0.46 for Sahiwal X cows, and 1.00±0.00 for indigenous cows. Gestation lengths were recorded as 269.54±7.60 days for HF X cows, 268.27±5.87 days for Jersey X cows, 274.63 ± 6.00 days for Sahiwal X cows and 271.00 ± 4.21 days for indigenous cows. In comparison, Rokonuzzaman *et al.* (2010) reported number of services per conception 1.84ab ±0.80, 1.32b ±0.48, 1.92a ±0.91 for HF × cows, Sahiwal × cows and other indigenous cows, respectively. Islam *et al.* (2017) reported values of 1.54±5.48, 1.31±6.07 and 1.50±8.08 while Alam *et al.* (2010) reported 1.6 ± 0.6, 1.6 ± 0.5 and 1.3± 0.5, respectively.

Calving intervals were 359.19±16.56 days for HF X cows, 354.09±41.70 days for Jersey X cows, 371.88±13.87 days for Sahiwal X cows, and 368.13±9.61 days for indigenous cows. In comparison, Islam *et al.* (2017) reported values of calving intervals 395.77±3.16, 398.88±5.92 and 404.40±5.61 days for HF × cows, Sahiwal × cows and other indigenous cows while Alam *et al.* (2010) reported 487.5± 17.4, 493.3±16.2 and 494.8±27.3 days, respectively.

The voluntary waiting periods were 60.70 ± 10.05 days, 66.27±10.67 days, 71.00±10.82 days, and 75.88±7.10 days for HF X, Jersey X, Sahiwal X, and indigenous cows, respectively. The voluntary waiting period was significantly higher (P<0.01) in local cows compared to the other groups, while it did not differ significantly (P>0.05) among Sahiwal X, Jersey X, and HF X cows.

Estrus duration, number of services per conception, gestation length, and calving interval did not differ significantly (P > 0.05) among the cow groups.

CONCLUSIONS

This study on 63 crossbred dairy cows in Bogura, Bangladesh, found that Holstein Friesian (HF) crossbreds outperform Jersey X, Sahiwal X, and indigenous breeds in milk production, lactation length, and reproductive maturity. While estrus duration and calving interval showed no significant differences among breeds, the superior genetic potential of HF crossbreds highlights the benefits of crossbreeding combined with proper management. These findings support the use of HF crossbreds, particularly in areas with riverbank grazing, to improve sustainable dairy production. Implementing such strategies is vital to meeting Bangladesh's growing national milk demand.

Limitations of the study

- The sample size was relatively small (63 cows) with uneven distribution among breeds, especially higher numbers of Holstein Friesian crossbreds.
- Breed identification was based on phenotypic traits and farmer information rather than molecular or genetic authentication.
- Data collection relied on farmer interviews and farm records, which may contain recall bias or inaccuracies.
- The cross-sectional study design limited the ability to observe long-term seasonal or management-related variations.
- Environmental, nutritional, and management practices were not fully standardized across farms, which may have influenced the results.

ACKNOWLEDGEMENT

The authors would first like to express their profound gratitude to Almighty Allah. They also wish to express their mutual thankfulness to the local farmers and veterinary staff of the Bogura District whose invaluable support and cooperation in the fieldwork was vital in the process. Without their support and involvement, this research would not have been completed successfully.

NOVELTY STATEMENT

The research is the first comparative study of productive and reproductive characteristics of Holstein Friesian, Jersey, Sahiwal and indigenous dairy cows in the Bogura District, Bangladesh. The results indicate breed-specific benefits, which are highly useful evidence to maximize breeding and management practices towards sustainable dairy production in the area.

AUTHOR'S CONTRIBUTION

Conceptualization: MSAS, MMIH, MKA.
Data curation: MSAS, MMIH, MM.
Data analysis: MSAS, MMIH.
Wrote the original draft: MSAS, MM, MKA.
Review and editing: MMIH, MKA.
All authors read and approved the final manuscript.

Generative AI and AI-assisted technology statement

The authors state that no generative AI or AI-related technologies were involved in data, analysis, or conclusion generation of this paper. The authors have only used AI tools to help them refine their language and check the grammar and accept complete responsibility of what is in the article.

Conflict of interests

The authors have declared no conflict of interest.

REFERENCES

Alam M, Sarder M, Ferdousi Z, Rahman M (2010). Productive and reproductive performance of dairy cattle in Char areas of Bangladesh. Bangladesh Vet., 25(2): 68–74. https://doi.org/10.3329/bvet.v25i2.4620

BBS (2014). Bangladesh Bureau of Statistics. Dhaka, Bangladesh.

Bhuiyan AKFH (2011). Proven bull production for dairy cattle development in Bangladesh. Seminar Paper, BIAM Foundation.

Cilek, Tekin ME (2005). The environmental factors effecting milk yield and fertility traits of Simmental cattle rose at Kazova State Farm and phenotypic correlations between these traits. Turk. J. Vet. Anim. Sci., 29: 987-993.

Department of Livestock Services (2023–2024). Ministry of Fisheries and Livestock. Government of the People's Republic of Bangladesh.

Diskin MG, Morris DG (2008). Embryonic and early foetal losses in cattle and other ruminants. Reprod. Domest. Anim. Zuchthyg., 43(Suppl 2): 260–267. https://doi.org/10.1111/j.1439-0531.2008.01171.x

FAO. (2022). Livestock, food security and poverty reduction. Retrieved from https://www.fao.org/4/i0680e/i0680e03.pdf

Fodor I, Abonyi-Tóth ZS, Ózsvári L (2018). Management practices associated with reproductive performance in Holstein cows on large commercial dairy farms. Animal, 12(11): 2401–2406. https://doi.org/10.1017/S1751731118000101

García-Ispierto I, López-Gatius F, Bech-Sabat G, Santolaria P, Yániz JL, Nogareda C, De Rensis F, López-Béjar M (2007). Climate factors affecting conception rate of high producing dairy cows in northeastern Spain. Theriogenology, 67(8): 1379–1385. https://doi.org/10.1016/j.theriogenology.2007.02.009

Hamid MA, Ahmed S, Rahman MA, Hossain KM (2016). Dairy industry in Bangladesh: Present scenario, major constraints and strategies for development. A review. Bangladesh Open Univ. J., 3(1): 17–27.

Islam MA, Sarder MJU, Jahan SS, Islam MH (2017). Evaluate the productive and reproductive performance considering genotypes of dairy cows. Int. J. Nutr. Food Sci., 5(6): 10.

Koyama H, Ogawa S, Terawaki Y, Morita S (2024). Optimal dry period length for maximizing milk yield and minimizing postpartum health disorders in Holstein cows in Hokkaido, Japan. Anim. Sci. J., 95(2): e13912. https://doi.org/10.1111/asj.13912

Riecka Z, Candrak J (2011). Analysis of relationship between production and reproduction traits of Holstein cattle population in the Slovak Republic. Anim. Sci. Biotechnol., 44: 332-336.

Rokonuzzaman M, Hassan M, Islam S, Sultana S (2010). Productive and reproductive performance of crossbred and indigenous dairy cows under smallholder farming system. J. Bangladesh Agric. Univ., 7(1): 69–72. https://doi.org/10.3329/jbau.v7i1.4801

Safa S, Soleimani A, Moussavi AH (2013). Improving productive and reproductive performance of holstein dairy cows through dry period management. Asian-Australas. J. Anim. Sci., 26(5): 630–637. https://doi.org/10.5713/ajas.2012.12303

Saha PS (2023). Milk shortage despite increased production in the country. Prothom Alo. Retrieved from https://en.prothomalo.com/bangladesh/ov80iqrj1e

SAS Institute. (1998). SAS/STAT® user's guide, version 6, 4th edition, volume 1 and 2. Cary, NC: SAS Institute.

Singh CV (2016). Cross-breeding in cattle for milk production: Achievements, challenges and opportunities in India. A review. Adv. Dairy Res., 4: 158. https://doi.org/10.4172/2329-888X.1000158

Syrstad O (1989). Dairy cattle cross breeding in the tropics. Performance of secondary crossbred populations. Livest. Prod. Sci., 23: 97-106. https://doi.org/10.1016/0301-6226(89)90008-0