Productive and reproductive performances of dairy animals at Bangladesh Agricultural University Dairy Farm

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Abstract: This research aimed to assess the herd performance of dairy cows as well as to analyze the production and reproduction performance of Bangladesh Agricultural University Dairy Farm (BAUDF) for the period of July 2021 to June 2022. To achieve these objectives, productive and reproductive performances (daily milk yield, lactation length, lactation yield, age at first heat, age at first calving, and calving interval) of 100 dairy cows within the five genetic groups (Holstein Friesian cross (HFC), Sindhi- Sahiwal cross (SSC), Red Chittagong Cattle (RCC), Jersey cross and buffalo) were evaluated. The feeding and management system in this farm was almost uniform as possible throughout the year. The disease management strategies were mainly based on disease prevention measures vaccination and deworming. Although milk can help meet nutritional needs, the present availability in Bangladesh is just 126ml per person per day, which falls short of the World Health Organization (WHO) recommended consumption of 250ml per person per day.The highest average milk production (kg/day) was observed in Holstein cross (4.28±1.03) and lowest in Red Chittagong cows (2.54±0.13). Lactation length was highest in the Holstein cross (193.9±28.2 days) and lowest in Red Chittagong Cattle (104.8±46.3 days). The highest lactation yield was observed in Holstein Friesian cross cows (890±273.0 days), whereas the lowest was in Red Chittagong Cattle (267.7±125.7 kg). The average age at first heat for crossbreed cows was 1399.1 ± 486.1 days, and the first calving was 177.4 ± 474.3 days. Additionally, the average interval between the 1stand 2ndcalving of crossbreeds at the BAUDF was 566.7 ± 245.5 days. Similarly, the average interval between the 2ndand 3rdcalving of crossbreeds was 507.9 ± 221.7 days. Daily herd yield in the last 4 years increasing trend from November to April of the year especially 2020-21 & 2021-22. Age at first heat (days) of the heifer is about 3.85 years Interval between 2nd and 3rd calving 135 days more than standard. Statistical analysis showed that it was significant ($P<0.01$). From the result of this study, it is concluded that average milk is low in all types of exotic genotypes. Lactation length and lactation yield are highest in HFC cows, buffalo is better than SSC, and RCC. It interpreted that the Holstein cross was the best performer than other cross-bred cows in dairy potentialities.

Keywords: Indigenous, Crossbred, Productive, Reproductive, Dairy cows

INTRODUCTION

Dairy farming is a branch of agriculture focused on sustainable milk production over the long term which is processed either on-site at the farm or a dairy plant or for the eventual sale of a milk and dairy product (Britt et al., 2018; Martin et al 2017). Dairy farming has a long history, dating back to the early Neolithic era around the seventh millennium BC in various regions of Europe and Africa (Scanes, C. G. 2018; Dunne et al., 2018). Earlier in the 20th century, Milking was primarily led down manually on small-scale dairy farms. However, during the early 20th century significant amounts of advancements in technology termed rotary parlors, the milking pipeline, and automatic milking systems were discovered. Commercial development of automatic milking systems later occurred in the early 1990s (Bieleman, J. 2005; Cropp, B., & Graf, T.2001). These innovations have significantly transformed the dairy farming industry by enhancing efficiency, productivity, and sustainability. The dairy sector of Bangladesh offers a good opportunity for entrepreneurs.

In 2020, research was conducted on the cost of milk production, which was increased by 19.10 percent for households and 10.9 percent for farms, respectively, resulting in a negative impact on farm income and accounting for a national economic loss of 4.43 million USD/day from dairy farms in Bangladesh (36.84 corers BDT). Due to a combination of COVID-19, flood, and seasonality effects on lowering milk production, this loss has fluctuated since April and was highest in June (3.83 million USD/day) (Uddin *et al.*, 2020).The expected milk output in Bangladesh in 2019 is 10.47 million tons. As projected demand has been forecasted, it will take at least 10 additional years to achieve self-sufficiency in milk production. Following the forecast, milk output is projected to reach 18.1 million tons in 2030, while the demand is expected to increase by 17.22 million tons (Hossain et al., 2022).Furthermore, According to milk production data DLS 2024, people consume only 221.89 ml of milk per day instead of 250 ml of milk for their nutritional requirements, and the share of Livestock in Agricultural GDP is 16.52 %.In addition, The DLS (2024), the livestock subsector offers full-time employment to 20% of the population and part-time employment to 50%. This gives opportunities for unemployed individuals, particularly vulnerable groups such as youth, women, and landless farmers, to escape poverty. High milk production, elevated parity, and winter calving were identified as potential risk factors for various reproductive disorders; Subsequently, these disorders were found to contribute to delayed insemination and conception in dairy cattle, with certain disorders also accelerating the risk of cattle culling (Gröhn, Y. T., & Rajala-Schultz, P. J. 2000).

Livestock development depends mainly on the genetic potential referred to reproductive traits and feeding of the animal. Another study by Meena, B. S., et al., 2015 has shown that milk production predominantly depends on feeding, breeding, health care, and management practices of these 4 types of traits. A cow with full reproductive efficiency should have calved first at about two years of age and then again, every 12-13 months' interval to make the herd economic and profitable (Wiltbank, 1970). The reproductive performance is determined based on puberty, early calving, high milk yield, and shorter calving intervals (Krpálková, L., et al., 2014).

The Bangladesh Agricultural University Dairy Farm (BAUDF) was established in 1964 with the primary objectives of teaching, research, and extension; it also plays a crucial role in the production of nutritious milk, the sale of culled animals, and the generation of manure for fuel or organic fertilizer, contributing significantly to the progressive development of the farming system. There are no pure dairy breeds on this farm, but most are crossbred locally with Sindhi, Sahiwal, Holstein, and Jersey or each other. On the other hand, Red-Chittagong nondescript native breeds are available on this farm. The total milk production of the farm is about 31,540 liters per year, and the total livestock of the farm is 353, among them approximately 250 cows, of which 50 are dairy cows. Most of at present, the first service conception rate is 44% (Annual report, BAUDF, 2009- 2010).

The study's main objectives are to measure the productive and reproductive parameters (milk yield, lactation length, gestation length, service per conception, calving interval, daily herd yield, age at first heat, age at first calving, and post-partum heat period) of different genotype groups of cow and buffalo reared at BAUDF Mymensingh. These parameters depend on the quality of supplied feed and fodder quality which affects the productive and reproductive performance of dairy cattle. So, the productive and reproductive performance of different genotype groups (cattle and buffalo) should be studied for their better improvement.

MATERIALS AND METHODS

Experimental site and duration of the study

The study was conducted at the Bangladesh Agricultural University Dairy Farm (BAUDF) Mymensingh, Bangladesh (Figure1) and the QGIS site map refers to 24°43'46.5"N, 90°25'22.8"E. The data were collected from the BAUDF records maintained from July 2021 to June 2022.

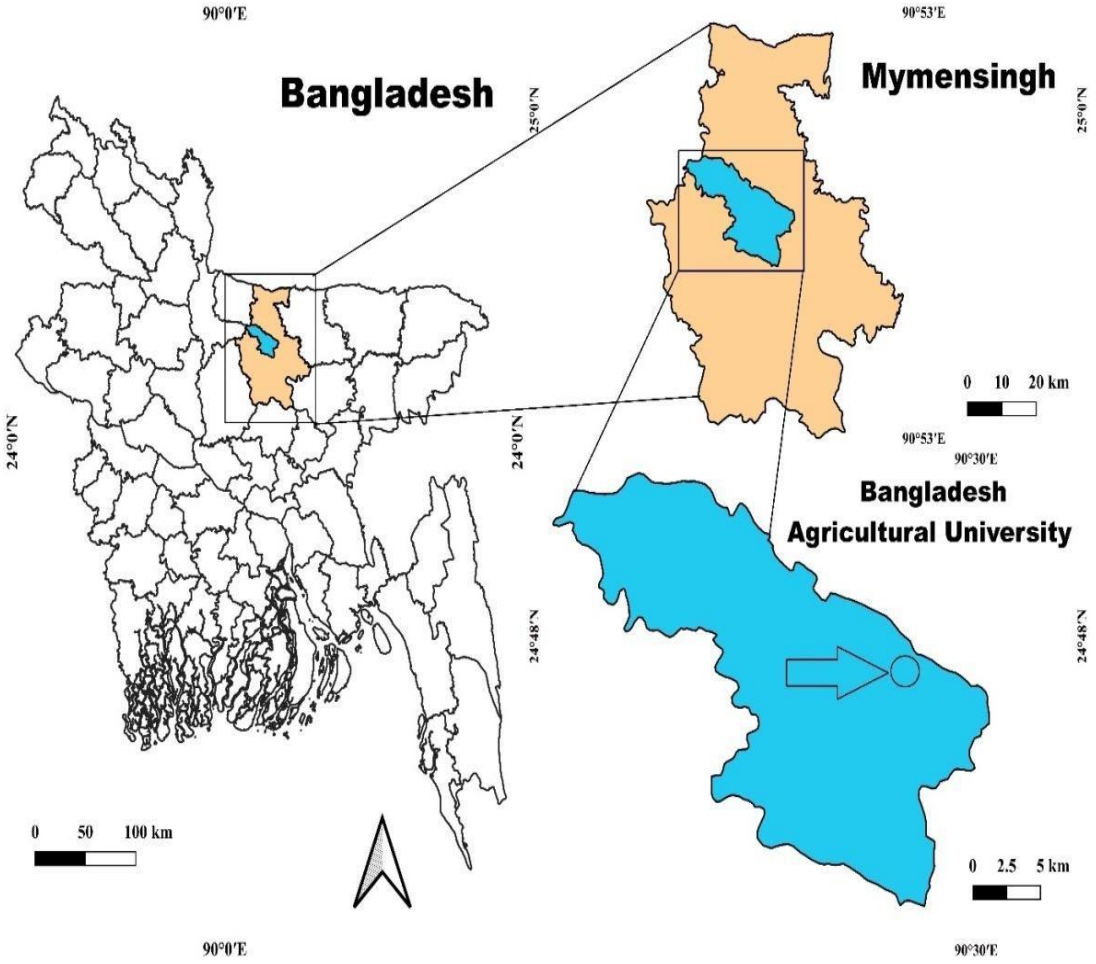

Figure 1. Location of the experiment (Bangladesh Agricultural University Dairy Farm, Mymensingh, Bangladesh).

Method of data collection and data use

The information on the daily milk production rates of 70 productive cows and the reproductive data of 30 cows, based on the performances of different genotypes, was collected from the records maintained at BAUDF.The experimental animals were divided into several genetic groups according to their genetic composition such as Sindhi, Sahiwal, Jersey cross, Holstein Friesian cross, and Red Chittagong Cattle.

The following characteristics were used to measure the productive and reproductive performances of several genetic groups in this study. Daily milk yield was calculated bythe sum of the amount of milk obtained in the morning and the evening of the day. Lactation length was calculated from the date of starting milking after calving up to the beginning of the dry period which was measured in days. Gestation length counted to the interval from fertile service to parturition; and was associated with twinning, sex of calf, and parity of cow. According to authors Payne, 1970; Salisbury and Ven Demark, 1961 service per conception was measured by the average number of services or inseminations required per conception or fertility. The calving interval is calculated between two successive calving. The dates of the first calving to the date of the second calving accomplish the first calving interval. Similarly, the dates of the second calving to the date of the third calving accomplish the second calving interval. The post-partum heat period is the interval between the date of calving and the date of first insemination or first heat show after parturition.

Statistical analysis

This study data analysis by IBM SPSS version 22.0, performed by analysis of variance (ANOVA) in Completely Randomized Design (CRD) along with standard error of the difference (SED) values were tested to find the statistical difference between the productive and reproductive traits of different breeds.

RESULTS and DISCUSSION

For productive performance, the feeding management strategy in BAUDF is as almost uniform as possible throughout the 4-year. Despite the genetic selection for higher milk production potentially impacts feeding and husbandry management (Sammad, Abdul, et al., 2022). Stall feeding, cultivated green grasses including Napier, Para, Maize, German and Oats, etc., and concentrated feeds like Wheat bran, Till1 oil cake, Mustard oil Cake, Rice Bran, Salt, and DCP are provided two times a day, in the morning before milking and the afternoon for the production of milk and enhance of reproductive performance.In Bangladesh, the breeding method now in use only considers milk volume (Islam et al., 2014). The farm maintained a strong breeding policy by breeding with superior such genotypic bulls with Sahiwal cross cows (Sc), heifers cross (Hc), Sindhi (Si), Jersey cross (Jc), Holstein Friesian cross (HFc), Red Chittagong cattle (RCC) according to dam body weight and body condition score (BCS).In addition, BAUDF also strictly manages the vaccination schedule against the diseases of Anthrax, Hemorrhagic Septicemia, Foot and mouth Disease (FMD), and Black Quarter.

Productive performance

Daily milk yield

The productive performance of milk production milk can have significant impacts on commerce, market access, productivity, human health, livelihoods, and ultimately serve as a fundamental driver of economic growth (C. Leone, et al., 2022). The average milk production along with standard error for different genetic groups are presented in **Table 1 and Figures 2 & 3**. It was found that the average milk yield of Holstein Friesian Cross (HFc), Jersey Cross, Sindhi-Sahiwal Cross, Red Chittagong and buffalo were 4.28±1.03, 4.05±0.74, 3.48±0.39, 2.54±0.13 and 3.26±0.74 kg/day, respectively. On the other hand, in Uddin 2008, the average milk yield of Indigenous, Sindhi cross, Holstein cross, and Sahiwal cross cows were 2.35±0.04, 4.03±0.05, 7.36±0.11, and, 4.78±0.08 liters per day. So, to date, milk production increased from the past and it is estimated that current production is near 140.68 lakh metric tons (DLS, 2024). The analysis of variance showed that in winter the genotype had a significant ($P<0.01$) effect on milk production (Table 2). The highest milk yield was observed in Holstein Friesian Cross (4.28±1.03 kg/d) whereas the lowest was in Red Chittagong Cows (2.54±0.13 kg/d).In contrast, Bag et al.,2010 study on dairy cows of different breeds, including Red Chittagong, reported lower milk yield in Red Chittagong cows compared to Holstein crossbreds, with the lowest milk yield recorded at 2.46 liters per day Studies have shown**(Figure 4)** that seasonal variation significantly impacts milk production, quality as well as changes in milk composition are influenced by factors such as cow nutrition, stage of lactation, and environmental conditions.

For daily herd yield, the yield increased from November to April each year over the past four years. However, the period of 2021-22 showed (Figure 4) the highest production during the months of March and April. In contrast, the past year February 2020-21 was the top herd yield compared to the 2018-19 and 2019-20. Throughout the period from 2020-21 and 2021-22 maintained the rising parallel trend over the months between January and February. Yasmin, Adeela, et al., 2012 explained that seasonal variations in milk composition, such as fat and protein content, are well-documented, with higher levels in autumn and winter and lower levels in spring and summer as well as Poulsen, Nina A., et al., 2015 highlighted that riboflavin content in milk showed variation, with higher levels during winter compared to summer in the organic dairy. Research on Murrah buffaloes revealed that high Temperature Humidity Index (THI) in summer negatively affects milk production, leading to decreased fat, protein, and solid-not-fat (SNF) content compared to winter (Kalyan et al., 2022). Additionally, the calving season plays a crucial role in milk output, with differences observed between stall and loose-housing systems, affecting the peak daily milk output of first-calving cows (Oleksandr admin et al., 2022; Mahdi et al., 2016). The BAUDF has been taken concerned buffalo milk yield and also identified that buffalo milk production is approximately 1kg higher than indigenous RCC.

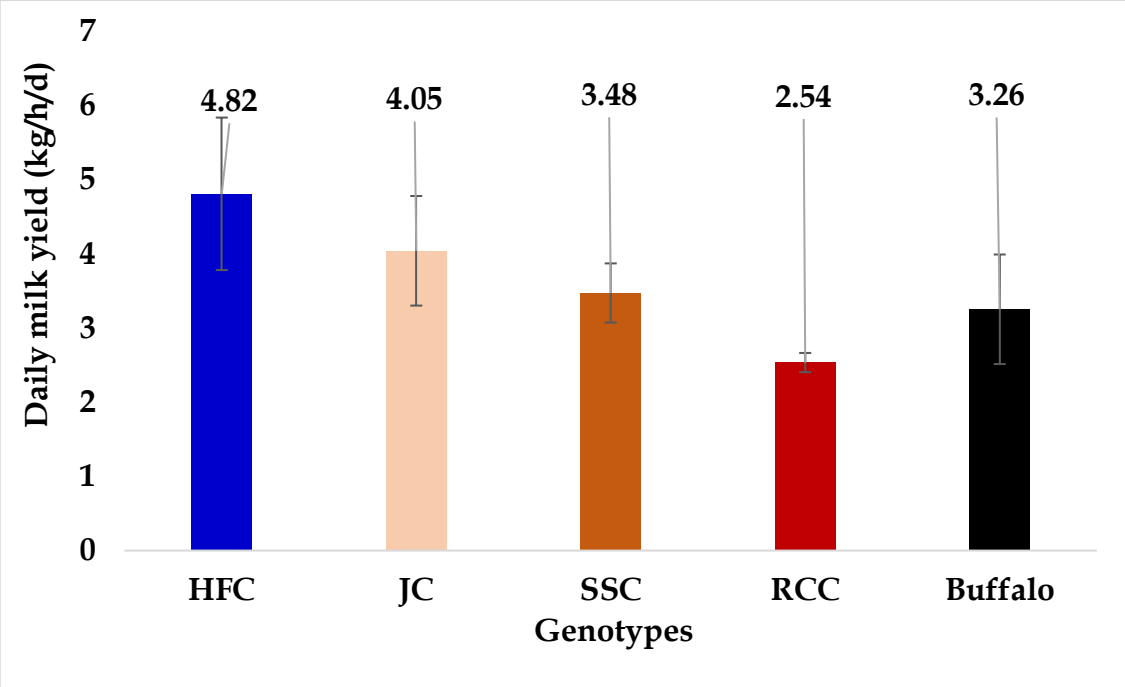

Figure 2: Average daily milk yield of different genotypes at BAU Dairy farm

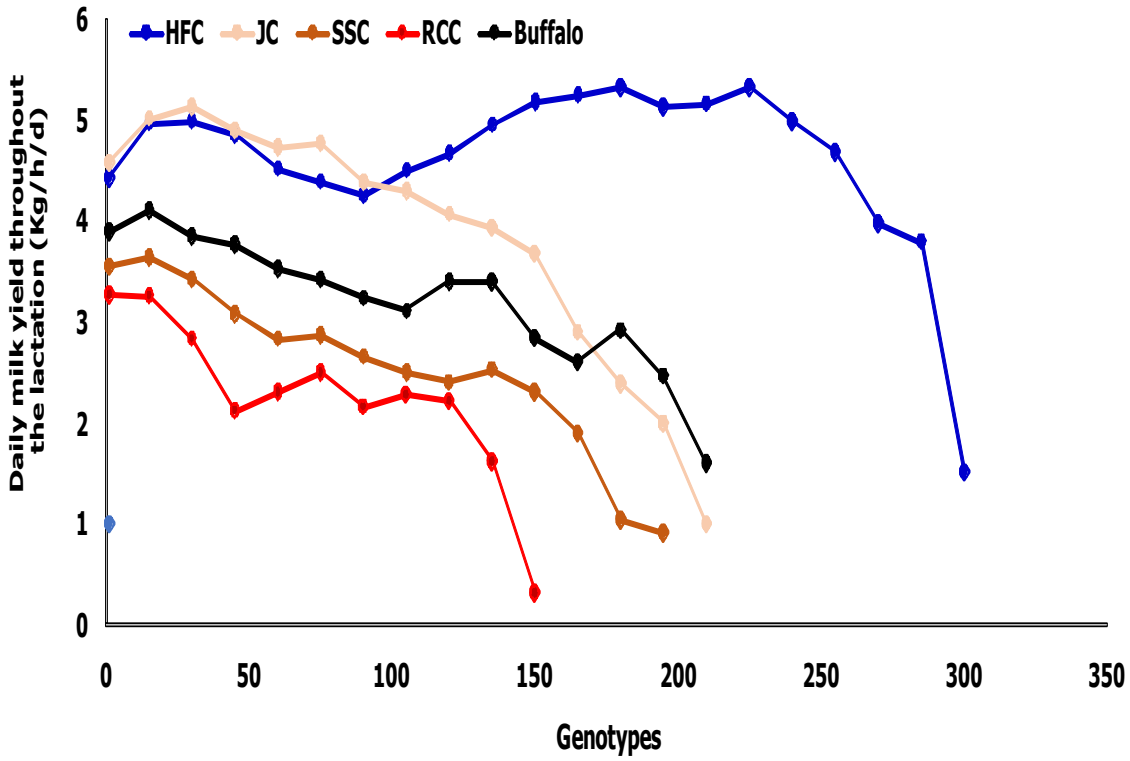

Figure 3: Daily average milk yield of different genotypes (n=70)

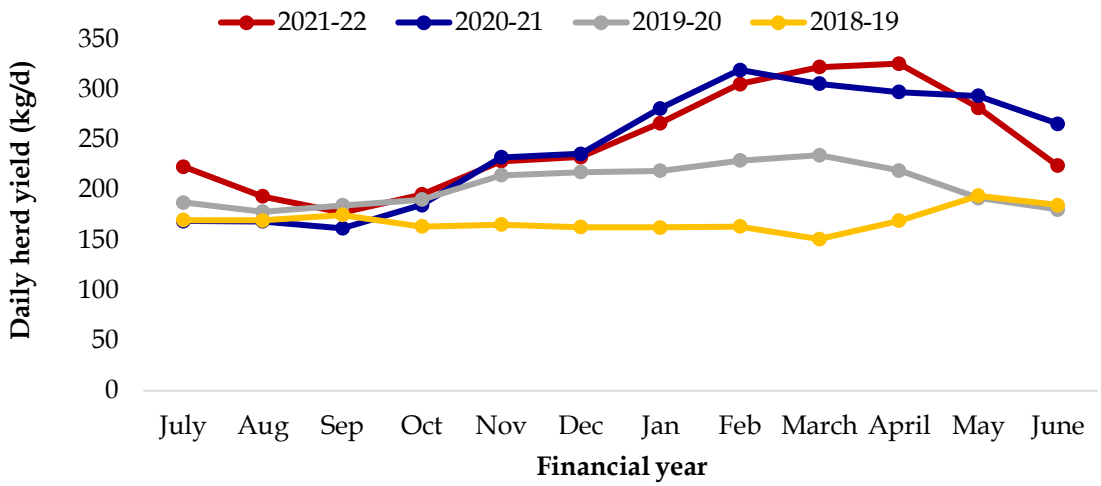

Figure 4: Daily herd yield in last 4 years (n=110)

Lactation length

The lactation length and lactation yield of various dairy breeds can significantly impact milk yield. Research indicates that lactation length plays a crucial role in milk production, with linear and quadratic regressions on lactation length explaining 28% of the variation in milk yield **(F. Ruvuna et al., 1984).** The significant differences in lactation length among genetic groups were observed in Figure 4 along with standard error for different genetics. It was found that the average lactation length or error for different genetic groups were 193.9±28.2, 166.0±38.3, 123.5±55.0, 104.8±46.3 and 168.5±49.8 days against the genotypes Holstein Friesian Cross, Jersey Cross, Sindhi-Sahiwal Cross, Red Chittagong and buffalo respectively. Moreover, **Uddin et al., 2008** found that the crossbreeds and indigenous cattle performances have similar significance to the present one. For instance, the highest lactation length was observed in the Holstein Friesian cross at 193.9±28.2days whereas the lowest was observed in Red Chittagong Cattle at 104.8±46.3 days maintained with significant($P<0.01$) difference. Non-genetic factors (period, season, and parity) and sire influence lactation length **(Singh, Simran, et al., 2013)**. However, this study also observed that HF × Local (Indigenous) had the longest mean lactation length, and consistently Local × Local had the shortest mean lactation length. Therefore, understanding the lactation length of Holstein Friesian Cross, Jersey Cross, Sindhi-Sahiwal Cross, Red Chittagong, and buffalo is essential for maximizing milk production and overall herd management.

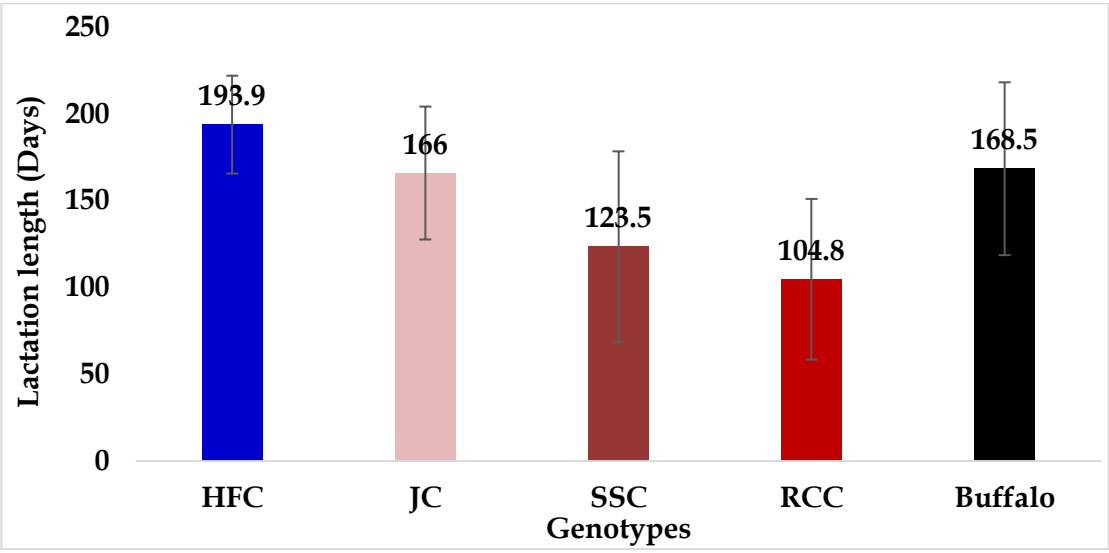

Figure 4: Average lactation length of different genotypes at BAUDF

Lactation yield

The average lactation yields, accompanied by standard errors for different genotypes are meticulously presented in **Table 1** and visually depicted in **Figure 6.** This comprehensive analysis encompasses five distinct genetic groups: Holstein Friesian cross (HFC), Jersey cross, Sindhi-Sahiwal cross, Red Chittagong, and buffalo. The five genetics groups figures stand at 890±273.0 kg for the Holstein Friesian cross, 691.0±256.0 kg for the Jersey cross, 481.0±293.0 kg for the Sindhi-Sahiwal cross, 267.7±125.7 kg for the Red Chittagong, and 564.0±243.0 kg for the buffalo, respectively. These statistics underscore the diversity in milk production capabilities across different bovine breeds in the BAUDF. A closer examination of the data reveals that Holstein Friesian cross cows experience the highest lactation yield averaging at 890±273.0 kg per lactation which was near the 899.02±132.68 kg among the Holstein Friesian crossbreed studies in Ethiopia **(Birhanu, Tadese, et al., 2015).**Holstein Friesian crossbreed demonstrated positive genetic correlations between growth rates at different ages and first lactation milk yield, indicating the potential for early breeding and high milk production in heifers with superior growth potentials **(Julie et al., 2001).**On the contrary, the Red Chittagong Cattle show the lowest lactation yield, with an average of 267.7±125.7 kg per lactation. This statistical significance (P<0.01) underscores the importance of genetic factors in determining milk productivity and performance of the group of animals. There were significant differences ($p < 0.05$) among the BAUDF buffaloes 564.0±243.0 kg to Bhola district buffaloes 576.59±112.0 kg **(Omar, Abdullah Ibne, et al., 2024)**

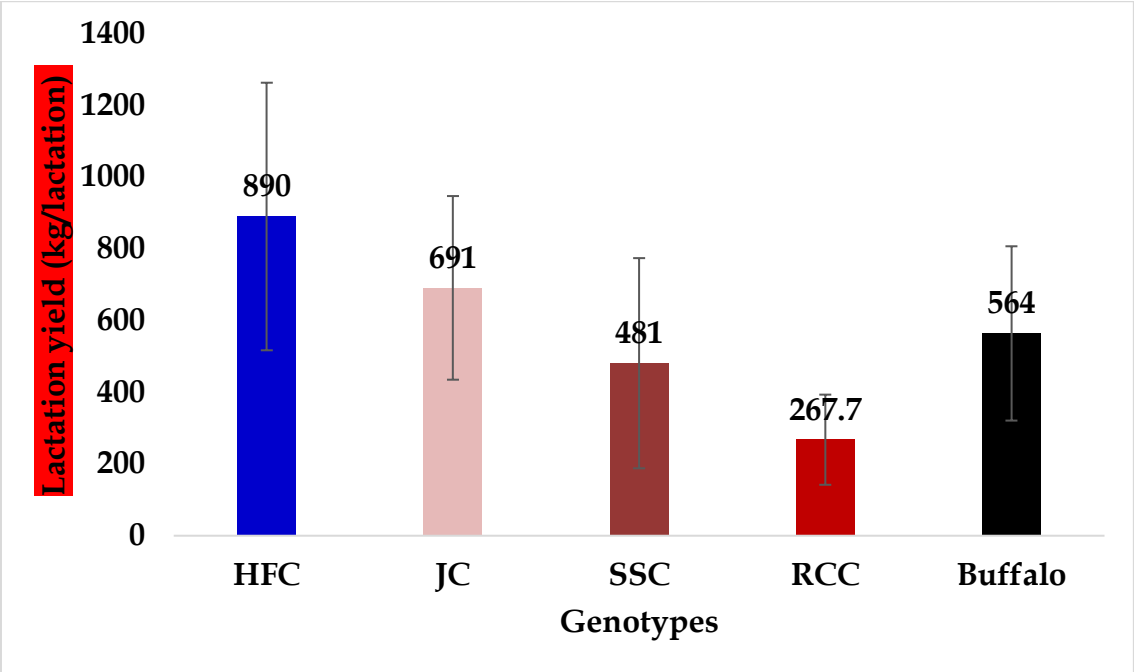

Figure: Lactation yield of different genotypes at BAUDF

Table 1: Summary of different parameters measured (Mean±SE) from different types of dairy breeds

Genotype	Holstein Friesian Cross (No.)	Jersey Cross (No.)	Sindhi Sahiwal Cross (No.)	Red Chittagong Cross (No.)	Buffalo (No.)	p-value	Level of significant
Daily milk yield (Kg)	4.28^{a}±1.03	4.05^{a}±0.74	3.48^{ab}±0.39	2.54^{b}±0.13	3.26^{ab}±0.74	0.019	**
Lactation length (Days)	193.9±28.2	166.0±38.3	123.5±55.0	104.8±46.3	168.5±49.8	0.074	**
Lactation yield (Kg)	890±273.0	691.0±256.0	481.0±293.0	267.7±125.7	564.0±243.0	0.055	**

HFC=Holstein Friesian Cross, JC=Jersey Cross, SSC=Sindhi-Sahiwal, RCC=Red Chittagong
**=Significant at 1% level (p<0.01)
a, b, c=Value with different superscripts in a row differ significantly.

Table 2: Summary of different reproductive parameters measured (Mean±SE) from different types of dairy breeds (HFC, JC, SSC, RCC, and buffalo)

Parameter	(Mean±SE) Days
Age at first heat	1399.1±486.1
Age at first calving	1771±474.3
Interval between 1st and 2nd calving	566.7±245.5
Interval between 2nd and 3rdcalving	507.9±221.7

Reproductive Performance

Age at first heat, calving, and calving interval

Dairy animals are thought to perform better at a lower age at first calving (Eastham, Neil T., et al. 2018; Knaus et al., 2009). There were significant differences (P<0.01) among the different dairy breeds and their crossbred (Table 2) age at first heat, first calving, calving Interval between 1st and 2nd calving, and Interval between 2nd and 3rd calving were 1399.1±486.1 days, 177.4±474.3 days, 566.7±245.5 days and 507.9±221.7 days in BAUDF, respectively. Holstein Friesian crossbreed performed the maximum number of services per conception 3.21 ± 0.61 which was somewhat close to Islam et al., 2017 around 3.36 ± 0.31, and the service per conception was higher in indigenous cows. Uddin 2008 added that the reproductive performances of indigenous cows need minimum (1.81± 0.048) services per conception. These types of crossing followed in BAUDF Sc×Hc, Si×Sc, Jc×Si, HFc×Jc, HFc ×Si, HFc×Sc, and indigenous (Local) breeding were held with superior among. It has been demonstrated in earlier research that a healthy temperate heifer can conceive between the ages of 14 and 15 months and reach the target weight of two-thirds of her body weight at 10 to 12 months (Hafez et al., 2013).

The age at first calving was similar among crossbreds but significantly higher in indigenous cows, and birth weight was significantly lower in indigenous cows compared to crossbreds. Additionally, the study on ovsynch estrus synchronization highlighted that Holstein Friesian-Jersey crossbred cows had significantly higher estrus response, intensity of estrus signs, and estrus duration compared to pure Holstein Friesian cows, indicating better cyclic activities and fertility rates in the crossbreeds (Gokarna et al.,2022). These findings suggest that while Jersey crossbreds may mature early, indigenous RCC and Holstein Friesian-Jersey crossbreds demonstrate superior reproductive performance and fertility traits under different management conditions. The proportion of cows pregnant to first service was significantly higher for the Jersey×Holstein Friesian crossbreed compared to pure Holstein Friesian and Jersey cows**(Bjelland et al., 2011).**In a study conducted by **Buckley et al., 2024**, the researchers compared Jersey×Holstein cows with Holstein cows found that Jersey×Holstein cows consistently had a shorter time period until the first observed heat (9 days less; statistically significant at P<0.05), a higher rate of conception during the first service (23 percentage units higher; statistically significant at P<0.01), and a higher pregnancy rate at the end of the breeding season (16 percentage units higher; statistically significant at P<0.05). No disparity in milk solids production was detected between the two genotypes when a moderate amount of concentrate was provided, according to this investigation.

There was no significant difference (P>0.05) in the average age of calving interval and lactation length between the crossbred and indigenous cows. Nevertheless, the Shahiwal x Local, Friesian x Local, and Jersey x Local breeds exhibited a considerably (P<0.01) reduced average age at puberty compared to the local breed. The crossbred cows exhibited a considerably (P<0.01) reduced age at puberty compared to the native cows. There was no significant difference (P>0.05) in the postpartum heat period and service per conception between different crossbred and local cows. The mean gestation duration for Local, Shahiwal x Local, Friesian x Local, and Jersey x Local was 289.88±1.44, 285.0±0.0, 285.0±4.18, and 282.08±2.42 days, respectively (Miazi et al., 2007). The Friesian x Local cows exhibited superior productive and reproductive performance compared to the other breeds analyzed. The Sahiwal cross had a shorter gestation length of 277.64±1.99 days but it varies within other crossbreds the Friesian

and Sindhi cross roughly 278.77±1.38 to 279.31±1.00 days (Uddin et al., 2008). The analysis indicates that the Friesian crossbreed best performed both other crossbred and indigenous cows in terms of dairy potential.

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