Comparative Assessment of Concentration, Volume and Motility of Semen among Different Breeds of Dairy Bull

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ABSTRACT

The present study was undertaken to assess the semen quality of different breeding bulls reared in Central Cattle Breeding and Dairy Farm (CCBDF), Savar, Dhaka. Therefore, the main objective of this study was to determine the physical and chemical properties of different bulls. A total of 57 dairy bulls, Local cross (L×F(n=6)), Local (n=6), Red Chittagong Cattle (R.C.C (n=6)), Sahiwal (SL (n=6)), Sahiwal cross (SL×F(n=6)), Friesian cross (L×F×F(n=6)), Friesian (50% H.F (n=6)), Friesian (62.5% H.F (n=6)), and Friesian 75% (H.F (n=9)) were used. The semen of different crossbred and local bulls was examined for ejaculate volume, concentration, and motility percent of sperm. It was observed that the maximum average ejaculate volume was obtained from L×F×F (10.50 ±4.04) ml and the minimum from 62.5% H.F (6 ±0.89) ml. The maximum average sperm concentration was obtained from Local (1345.17±230.08 million/ml), and the minimum was SL×F (1057.67±286.74 million/ml). The maximum average motility was obtained from 75% H.F. (65.56 ± 5.27) % and the minimum was 62.5% H.F. (61.67 ± 4.08) %. These parameters are highly responsible for producing the best quality semen. Although the motility percentage of semen was highest in 75% H.F. cross, the local breed has the highest concentration of sperm in semen. It may be concluded that the performance of L×F Holstein Frisian crossbreeds was best based on their overall characteristics; conversely, SL×F crossbreeds showed comparatively less quality semen in overall characteristics in semi-intensive systems. Therefore, it is recommended that local breed upgradation is important for milk production, but introducing 100% HF induces calving ease.

Keyword: Semen; Motility; Sperm Concentration

INTRODUCTION

Bangladesh's livestock population is estimated to include about 25.17 million cattle, 1.5 million buffaloes, 3.9 million sheep, 27.2 million goats, along with roughly 336 million chickens and 70.5 million ducks (BBS, 2024-25). Livestock is playing an important role as a means of livelihood and protein source for human consumption. In most developing countries, often the number of livestock is quite high, but food from animal origin remains in deficit. Although livestock product increased at the rate of 5.4% and a stable Gross Domestic Production (GDP) contribution of 2.1–3.6%, the budget was limited to less than 1% (Rahman et al., 2014). The limited growth in the dairy industry is certainly due to a lack of breeding, feeding, and management facilities for cows (Steve Hatfield-Dodds, 2007). Artificial insemination has been practiced as a sound breeding tool to improve the genetics of adopted indigenous cattle (Rahman et al., 2014; Patel et al., 2017). Breed upgradation significantly relies on the quality of semen, the skill of the AI technician, and the time of AI (Islam et al., 2020). The Central Cattle Breeding and Dairy Farm (CCBDF), under the Department of Livestock Services

(DLS), acts as a pioneer of the artificial insemination program, and they established 15,389 AI subcenters to disseminate frozen semen all over Bangladesh (Hridoy et al., 2025).

According to recent data, a total of 14.1 million semen was used in 2022-23, where DLS supplied about 4.23 million, and the rest were supplied by private organizations, and studies indicated the conception rate varies from 50% to 72%. The conception rate is high near to the semen processing center because of short transportation time. Semen production is increasing, but the area coverage is low, around 70-75% (Saleque, 2023). Semen analysis and fertility of a bull are both highly important for selecting a breeding bull, and motility of sperm is a critical parameter that indicates the progressive movement of sperm towards the oocyte in the reproductive tract of a female (Hossain et al., 2022). Quality of semen of a breeding bull depends on some parameters like semen volume (ml), concentration of sperm (million/ml), viability (%), and mortality rate (Islam et al., 2018).

Physical and chemical properties of bull semen influence the quality of semen because during the process of semen analysis large numbers of physical and chemical changes occur, which may alter the properties of bull semen and impair herd fertility. In temperate zones low reproductive rates are significantly influenced by the quality of bull semen (Hossain et al., 2012). To meet rising demands for milk and meat, private organizations in Bangladesh have imported exotic breeding bulls and distributed their semen through AI programs around the country (Amy et al.,2022). However, research on semen evaluation in the country is limited, even though regular assessment of semen quality and quantity is crucial for improving breeding performance. Therefore, the current study aimed to observe the physical and chemical properties of different bull semen and to compare sperm motility, concentration, and volume and their effect on the production of quality semen.

METHODOLOGYS

Study Area:

The study was conducted at the Artificial Insemination (AI) laboratory of the Central Cattle Breeding Station (CCDBF), Savar, Dhaka. The farm was situated adjacent to the Dhaka-Aricha highway and 30 km northwest of Dhaka city. The farm was established in 1982, and it is covered with land area of 792 acres. In the Central Cattle Breeding and Dairy Farm (CCBDF), the Byre section has 1308 dairy cattle of different breeds. On the other hand, the AI section has 230 dairy bulls. AI section, CCBDF has been contributing almost 55% of semen production in Bangladesh.

Experimental Animals

Among 230 breeding bulls of the AI section, 57 were selected according to quality and quantity of semen production based on recorded data of that farm. In this study, 57 dairy bulls of Friesian cross, Local, Red Chittagong Cattle, Sahiwal, and Sahiwal cross were used, where L×F (n=6), L×F×F (n=6), 50% H.F (n=6), 62.5% H.F (n=6), 75% H.F (n=9), SL (n=6), SL×F (n=6), Local (n=6), and R.C.C (n=6) were used. According to the bull register, the age of the bulls ranged from 24 to 120 months, body weight ranged from 390 to 1070 kg, BCS ranged from 4.0 to 4.5, motility was 60%, and concentration per dose was approximately 25 million.

Ration of Breeding Bull

Table-1: Ration for breeding bulls at the central cattle breeding and dairy farm

Ingredients	Amount (kg)	DM (kg)	DCP (kg)	TDN (kg)	Ca (kg)	P (kg)
Maize grain	10.0	8.9	0.89	7.7	-	-
Wheat bran	52.0	46.3	6.76	36.4	-	-
Khesari	15.0	13.4	3.6	10.5	-	-
Gram	16.0	14.2	4.48	11.2	-	-
Soybean meal	06.0	5.3	2.52	4.2	-	-

Bone meal	0.75	0.7	-	-	0.18	0.09
Common salt	0.25	0.2	-	-	-	-
Total	100	89.0	18.4	70	0.18	0.09

Collection of Semen

Before semen collection, the AV set was assembled and maintained at a temperature of 37.5°C. During semen collection, a dummy bull was tied into a chute, and the semen-collecting bull was brought near to the dummy bull. One person stimulated the bull whistling with his lips, and the bull jumped over the dummy. But the 1st jump was avoided for the better quality of semen, while semen was collected on the 2nd and 3rd jumps, while the amount of semen per ejaculation was 7-8 ml. Semen was collected twice in a week, and the time was in the morning, from 7 to 9 a.m. Immediately after collection, the collecting tube was detached from the AV, taken to the laboratory, and placed at 37°C in a water bath until evaluation and processing of semen.

Processing and Preservation of Semen

The egg yolk-tris-fructose-citric acid-glycerol extender was used as a diluent for the preservation of semen in frozen conditions. Briefly, a stock solution was prepared by dissolving tris (297.6 mmol), fructose (82.6 mmol), citric acid (105.3 mmol), penicillin G sodium (1000 I.U./ml), and streptomycin sulfate (1 mg/ml) in glass-distilled water. The fresh yolk was added with the buffer at a concentration of 20% (v/v).

Volume of total diluter

$$=\left[\frac{volume\ of\ semen(ml)\times Concentrationof\ Semen\ (million)}{200}-\frac{Volume\ of\ Semen(ml)}{2}\right]_{\times 2}$$

Number of doses calculated = $(Volume\ of\ total\ Diluter + Semen\ Volume)_{\times 4}$

The volume of the extender was divided into two equal parts. Thereafter, glycerol was added to one part of the extender at two times the desired concentration (12.8%). The other part of the diluent was used to make the initial dilution of semen that contained two times the desired concentration of spermatozoa. The initial dilution of semen was made at +37°C. The equal parts of initially diluted semen and double-concentration glycerol-containing extender were mixed in four steps during a 2- to 3-hour cooling process. Individual insemination doses were sucked in 0.25 ml. French straws on the open ends of the straws were sealed by using an automatic filling and sealing machine. After loading, the straws were left for equilibration at +40ºC for an hour. The cooling and equilibration operation was done in a cold handling cabinet. After equilibration, the freezing operation was conducted in a semen freezer (HN, Mini tub, Germany) to cool the semen from +4 to -14°C during a period of 20-30 min, and then the straws were directly plunged into liquid nitrogen (-196°C).

Evaluation of Semen

Individual fresh ejaculates were evaluated for volume, sperm motility, sperm concentration, total spermatozoa per ejaculation, and proportion of spermatozoa with normal acrosome, mid-piece, and tail. The volume of fresh semen was recorded from the graduated mark of the semen collecting tube. To evaluate the sperm motility, a small drop (10 µl) of semen was placed on a clean, pre-warmed glass slide and covered with a cover slip. Motility was assessed visually by estimating the proportion of spermatozoa actively moving forward under medium magnification (200x) and expressed as a percentage. Semen volume and sperm concentration were measured immediately after collection. Different motility patterns of spermatozoa (progressive, fast, slow, local, and immotile) were measured by the Computer Assisted Semen Analyzer (CASA).

Grading of semen according to motility

Scale	Grade	Characteristics
5	(+++++) Excellent	More than 80% of the spermatozoa are in vigorous motion. The swirling and eddying caused by sperm movement occurs rapidly and continuously. Movements are so vigorous that it is impossible to observe individual spermatozoon in undiluted semen.
4	(++++) Very good	About 70-80% of the spermatozoa are in vigorous motion. Waves and eddies are formed rapidly but not so vigorous as in excellent grade.
3	(+++) Good	About 50-75% of the spermatozoa are in motion. Motion is vigorous but waves and eddies formed slowly across the field.
2	(++) Fair	About 30-50% of the spermatozoa are in motion. Movements are vigorous. No waves and eddies.
1	(+) Poor	Less than 30% of the spermatozoa are in motion. The motion is mostly weak and oscillatory, not progressive.
0	(O) Zero	No motility found.

Source: (Mandal et al., 2020)

Thawing of Semen

To check the post-thaw motility and taking sample for formol-saline fixation, the frozen semen straws were thawed at +37°C warm water for 12 sec at 24 hours post freezing.

Data analysis

The data related to ejaculate volume; sperm concentration and motility were collected and compiled by using Microsoft Excel 2010. All the data collected from the central cattle breeding and dairy farms are gathered and compared with different result of the crossbreed semen and their physical and chemical characteristics.

RESULTS AND DISCUSSION

Physical and chemical properties, particularly volume of ejaculate, concentration of sperm and motility of sperm have been investigated in this study.

Table-2: Comparison among different crossbreed semen based on volume, concentration and motility

Cross Breed	Volume (ml)	Concentration (million/ml)	Motility
L×F	6.83 ±0.76	1312.00 ±156.43	65.00 ± 5.48
L×F×F	10.50 ±4.04	1187.17 ±288.99	65.00 ± 5.48
50% H.F	6.33 ±1.63	1079.17 ±356.93	63.33 ± 5.16
62.5% H.F	6.00 ±0.89	1099.00 ±305.29	61.67 ± 4.08
75% H.F	8.78 ±2.54	1162.44 ±342.60	65.56 ± 5.27
SL	7.50 ±3.27	1232.00 ±404.94	63.33 ± 5.16
SL×F	10.00 ±2.28	1057.67 ±286.74	63.33 5.16

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Local	7.00 ±1.67	1345.17 ±230.08	65 ± 5.47
R.C.C	7.00 ±2.45	1270.33 ±280.88	63.34 ± 5.16

Volume of semen

Assessment of freshly drawn bull semen is crucial for the efficacy of artificial insemination. Therefore, volume, concentration, and motility were investigated in this study. Average volume of semen among 57 breeding bulls didn't differ too much, and the mean values were (6.83 ±0.76), (10.50 ±4.04), (6.33 ±1.63), (6.00 ±0.89), (8.78 ±2.54), (7.50 ±3.27), (10.00 ±2.28), (7.00 ±1.67), and (7.00 ±2.45) for L×F, L×F×F, 50% H.F., 62.5% H.F., 75% H.F., SL, SL×F, Local, and R.C.C., respectively (Table 2). Based on this study, the highest volume of semen per ejaculation (10.50±4.04) was found in (LxFxF) bulls and the lowest (6.00±0.89) in (62.5% H.F) bulls, as illustrated in Figure 2. In similar studies Hasan (2020) indicated that the semen volume of H.F. was (6.13 ±0.28), whereas for SL it was (5.26 ±0.17), which is significantly different from our findings. Shaha et al. (2010) documented that the volume of semen ranges from 4.1 to 7.6 ml for Holstein Friesian Zebu cattle. According to Murphy (2018), the differences in semen volume among bulls may result from random effects of breed.

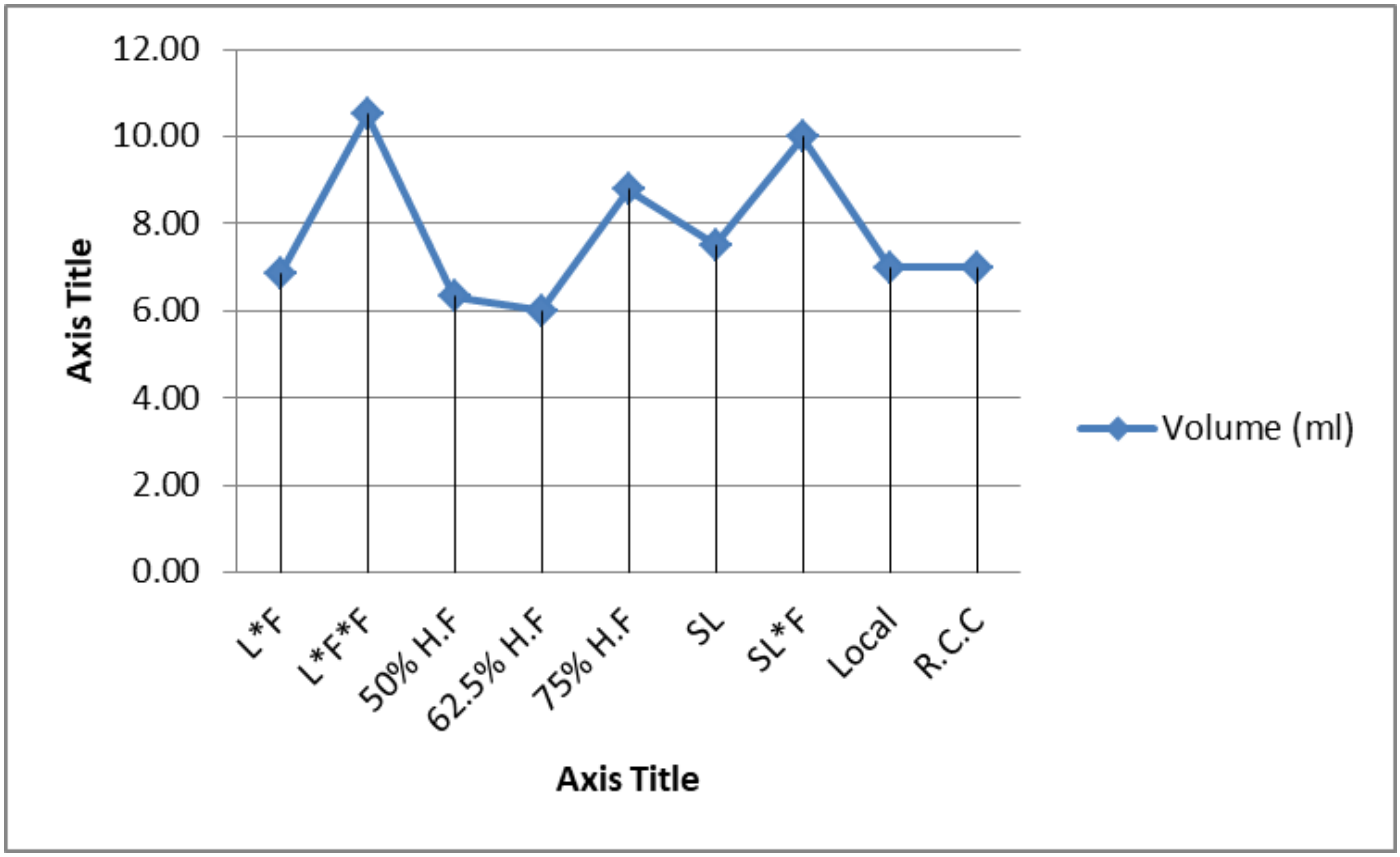

Figure 1: Volume of semen of different cross breed

Mass motility

Figure 2 stated that average mass Motility (%) in fresh ejaculate ranged between 60% and 65%. The motility rate is highest in the 75% H.F cross (65.56 ± 5.27) % and the lowest is in 62.5% H.F cross (61.67 ± 4.08) %. (Rahman et al., 2014; Shaha et al., 2010) stated similar assumptions on motility of breeding bull were 66.64± 0.50% and 56.6 to 76% respectively. In contrast (Islam et al., 2018) found that motility of Holstein Friesian cross breed breeding bull was (74.73±0.76%) which significantly differ from our result. The variation of motility might be resulted from the effect of age, breed or random effect associated with the individual bulls (Nasrin et al., 2008).

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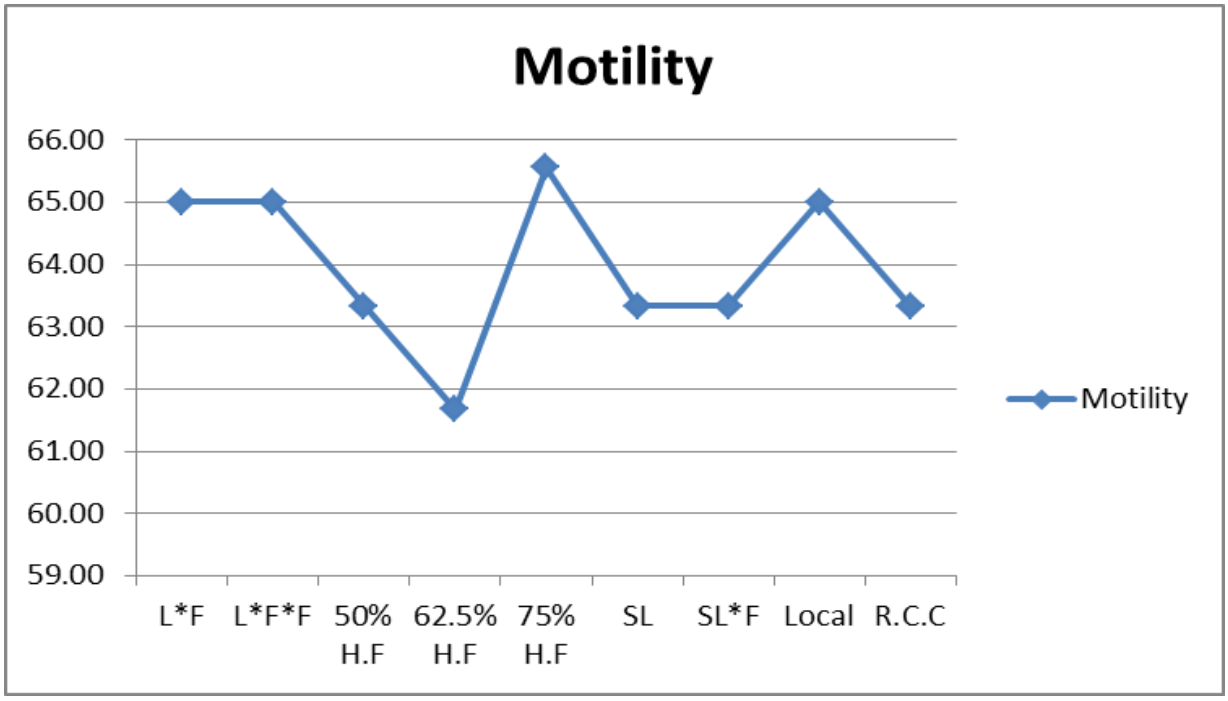

Figure 2: Motility of semen of different cross breeds

Sperm concentration

Regarding sperm concentration, the highest number of sperm counts (1345.17 ±230.08 million/ml) obtained from the local breed and the lowest (1057.67±286.74 million/ml) in Sahiwal and H.F. cross. Sperm concentration in ejaculate is one of the important criteria of semen characteristics to qualify fertile males for breeding purposes. According to Shaha et al. (2008), Friesian-cross-Zebu cattle have comparatively low sperm concentration (1000 million/ml), but our findings (1345.17 ±230.08) are moderately higher than this. On the contrary, Hasan et al. (2020) stated that sperm concentration in Holstein Friesian breeding bulls and Sahiwal was 1664.28±62.41 and 2036.00±43.99, respectively, which significantly differs from our study. Sperm concentration in semen considered as an initial indicator of semen quality in semen used for cryopreservation. The higher the concentration of semen, the more likely it will increase the success of AI.

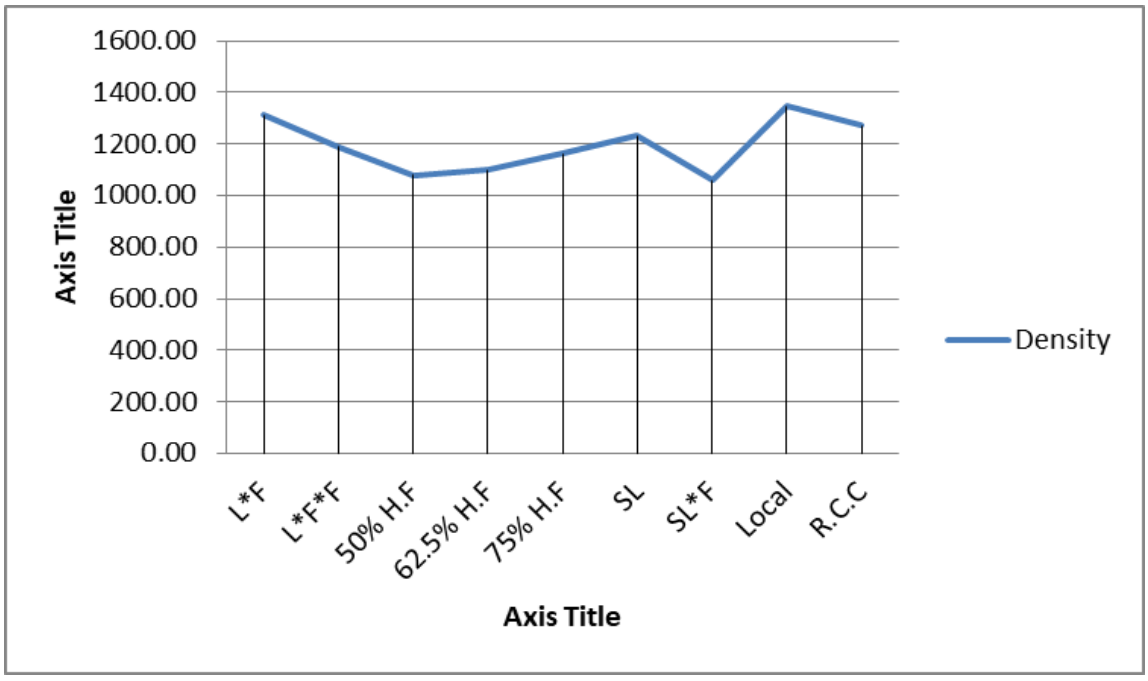

Figure 3: Concentration of semen of different cross breeds

From the above discussion it is prominent that the Holstein Friesian crossbreed (LxF) provides the best quality semen based upon volume, concentration, and motility in a semi-intensive system, while the SL×F crossbreed indicated comparatively less quality semen depending on three parameters. Hasan et al. (2014) noted that L×F and 50% H.F. crosses are feasible for the breed development of Bangladesh because of higher conception rates and adaptation capacity.

CONCLUSION

Semen production of bull depends on physical condition of bull, scrotum circumference and body condition score. Physical and chemical properties of bull semen influence the quality of semen. Semen analysis and fertility of a bull are both highly important for selecting a breeding bull, and motility of sperm is a critical parameter that indicates the progressive movement of sperm towards the oocyte in the reproductive tract of a female. Three parameters of 57 diverse types of breeding bulls at the Central Cattle Breeding and Dairy Farm, Savar, Dhaka, have discussed. It was evident that depending on breed, the volume of semen, concentration of semen and motility of semen are varied. Holstein Friesian cross L×F produces high-quality semen based on volume, concentration, and motility, followed by 75% H.F., L×F×F, 50% H.F., Local, R.C.C., Sahiwal, and 62.5% H.F., respectively. It suggested that local breed upgradation is considerable for milk production, but introducing 100% HF will make calving difficulties.

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