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CONTENTS

Studies on productive herd life, longevity, and selective value and their components in crossbred cattle

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ABSTRACT: Data for the present investigation were collected from a history sheet of crossbred cattle at the Instructional Dairy Farm of G. B. Pant University of Agriculture and Technology, Pantnagar. The data pertained to 1000 crossbred cattle with a total of 3583 calving records from 87 sires distributed over 32 years from 1988 to 2019.The average values for productive herd life, longevity, total calf production, total alive calves born, total female calves born, selective value, and CGR were estimated as 6.58±0.06 years, 9.78±0.06 years, 4.68±0.03, 4.44±0.03, 2.16±0.05, 1.45±0.04, and 0.72±0.02, respectively. The impact of the season was observed significant on productive herd life (PHL), longevity, total calf production, and the number of total alive calves born. However, the effect of season was found to be non-significant on the total number of female calves born, selective value, and calf-growth rate (CGR). The period has been found to have a highly significant effect on all the studied traits. The effect of the First Lactation Milk Yield (FLMY) group was found to have a significant impact on all the traits under study. Longevity had the heritability estimate of 0.32, while other traits such as PHL, total calf production, and total alive calves were also shown from lower to moderate heritability estimates. On the other hand, total female calves born, selective value, and CGR had relatively lower heritability estimates. The genetic and phenotypic correlations among productive herd life, longevity, and selective value and their components ranged from lower to very high. A long productive life of cows increases their life time milk yield and the number of calves born, which has an essential effect on production profitability. Therefore, the optimum lifespan of a cow should be the composite of breeding and economic results. Therefore, the future selection of dairy cattle for productive herd life and longevity breeding will require a fully integrated and balanced breeding model.

Key words: Crossbred cattle, first lactation milk yield, heritability, Life Time Traits, Least Square Means

Since the start of the 21st century, the decreasing average time a cow stays in the herd (as reflected by age at culling) has been of growing concern for dairy industries across the globe. In the absence of human intervention, a dairy cow is biologically capable of a life span of up to 20 years, yet average time in the herd currently ranges between 4.5 and 5.5 years, or 2.5 and 3.5 lactations. Human intervention is often cited as the cause of a reduced length of life due to the seemingly "unnatural" housing and management conditions of some dairy systems and an almost exclusive focus on genetic selection for production-related traits before the 1980s. Extensive research focusing on genetic, environmental, and management factors affecting time in the herd has been conducted in attempts to increase understanding and guide farm profitability. However, the amount of time cows spend in the herd is still much shorter than their biological capability.

More efficient production leads to economic, environmental, and animal welfare benefits and often is associated with a longer productive life, often referred to as longevity. Therefore, the dairy industry has strived to increase longevity. Based on available data, dairy cow longevity, referred to as both herd life (HL; from birth until culling) and length of productive life (LPL; from first calving to culling), has generally decreased, where culling is referred to as a dairy cow leaving the herd regardless of reason, destination, and condition at departure. The aim of this review, therefore, was to explore current understanding regarding longevity, HL or LPL, to identify factors affecting HL and LPL, and to identify knowledge gaps where further understanding is needed.

MATERIALS AND METHODS

Data sets and sources

Data for the present investigation were collected from history sheet of crossbred cattle maintained at Instructional Dairy Farm of G. B. Pant University of Agriculture and Technology, Pantnagar. The data pertained to 976 crossbred cattle from 66 sires were distributed over a period of 32 years from 1988 to 2019. Cows with abnormal and incomplete records were excluded from the study. Only the sires having records on at least 5 daughters were included in the present study. The records of only those animals with known pedigree and normal lactation were considered. The lactation records of less than 150 days were considered as abnormal and were not included in the analysis. The total duration of the present study was divided into 6 periods, out of which first period is of 7 years and rest five periods are of five years each. The first lactation group was divided in 6 groups. Each year was divided into three seasons namely winter (November-February), Summer (March–June), and Rainy (July – October). In order to classify the data for first lactation milk yield group, periods and seasons of calving were considered for all the traits. The traits considered in the present study were productive herd life, longevity, total calf production, total alive calves born, total female calves born, selective value, and CGR.

Statistical Analysis

As the data in the present study were non-orthogonal in nature with unequal subclass numbers, they were subjected to least squares analysis of variance without interactions using different models to examine the effect of non-genetic factors on productive herd life, longevity, total calf production, total alive calves born, total female calves born, selective value, and CGR as per standard procedures of Harvey (1990). The model was based on the assumption that different components fitting in the model were linear, independent and additive. The non-genetic factors (first lactation milk yield groups, periods and seasons of calving) were taken as fixed effects in the model. Duncan's Multiple Range Test as modified by Kramer (1957) was used to make pairwise comparisons of least squares means for statistical significance. Prior to estimation of genetic parameters, the data were adjusted for each significant effect of the source of variation. The data after adjustment for different significant effects were utilized for estimation of genetic parameters. Paternal half sib correlation method was used to

Table 1: Least-square mean ± SE and effect of non-genetic factor on longevity, PHL, selective values and its components in crossbred cattle

Source	No. of cows	Longevity (years)	PHL (years)	Total calves produced by each cow	Total alive calves born	Total female calves per cow	Selective value	CGR
Overall	1000	9.78±0.06	6.58±0.06	4.68±0.03	4.44±0.03	2.16±0.05	1.45±0.04	0.72±0.02
SEASON								
Winter	289	9.99±0.09^{a}	6.77±0.09^{a}	4.89±0.05^{a}	4.54±0.06	2.14±0.07	1.49±0.06	0.75±0.03
Summer	301	9.42±0.09^{b}	6.22±0.09^{b}	4.56±0.05^{b}	4.34±0.07	2.11±0.07	1.39±0.06	0.69±0.03
Rainy	410	9.71±0.08^{a}	6.51±0.08^{a}	4.63±0.05^{ab}	4.42±0.05	2.08±0.06	1.38±0.05	0.69±0.03
PERIOD								
1988-1994	228	10.03±0.12^{bc}	6.94±0.12^{b}	4.89±0.07^{ab}	4.68±0.07^{ab}	2.47±0.09^{a}	1.69±0.08^{a}	0.84±0.04^{a}
1995-1999	169	9.81±0.12^{bc}	6.59±0.12^{bc}	4.64±0.07^{c}	4.48±0.07^{bc}	2.10±0.09^{a}	1.49±0.08^{a}	0.74±0.04^{a}
2000-2004	164	9.63±0.12^{c}	6.40±0.12^{c}	4.69±0.07^{bc}	4.38±0.08^{c}	2.25±0.10^{a}	1.51±0.08^{a}	0.76±0.04^{a}
2005-2009	176	10.41±0.12^{a}	7.20±0.12^{a}	4.04±0.07^{a}	4.75±0.07^{a}	2.21±0.09^{a}	1.44±0.08^{a}	0.72±0.04^{a}
2010-2014	161	10.06±0.12^{ab}	6.83±0.12^{ab}	4.95±0.07^{a}	4.73±0.08^{ab}	2.16±0.09^{a}	1.44±0.08^{a}	0.72±0.04^{a}
2015-2019	102	8.32±0.15^{d}	5.08±0.15^{d}	3.82±0.09^{d}	3.56±0.10^{d}	1.48±0.12^{b}	0.95±0.10^{b}	0.48±0.05^{b}
FLMY group								
≤ 2400	217	9.49±0.11^{ab}	6.29±0.11^{b}	4.70±0.06^{ab}	4.41±0.07^{ab}	1.90±0.09^{b}	1.28±0.08^{b}	0.64±0.04^{b}
2401-2900	230	9.57±0.10^{ab}	6.39±0.11^{a}	4.80±0.06^{a}	4.56±0.07^{a}	2.11±0.08^{ab}	1.41±0.07^{ab}	0.71±0.04^{ab}
2901-3400	190	9.32±0.11^{b}	6.12±0.11^{b}	4.54±0.07^{bc}	4.34±0.07^{b}	1.96±0.09^{b}	1.29±0.08^{b}	0.64±0.05^{b}
3401-3900	153	9.68±0.13^{a}	6.46±0.13^{a}	4.17±0.07^{a}	4.51±0.08^{a}	2.34±0.10^{a}	1.64±0.09^{a}	0.82±0.04^{a}
3901-4400	127	10.02±0.14^{a}	6.83±0.14^{a}	4.74±0.08^{ab}	4.53±0.08^{ab}	2.11±0.11^{b}	1.40±0.10^{b}	0.70±0.05^{b}
≥4401	083	10.17±0.17^{a}	6.96±0.17^{a}	4.53±0.10^{c}	4.25±0.11^{d}	2.25±0.14^{b}	1.51±0.12^{b}	0.75±0.06^{b}

Table 2: Analysis of variance for longevity, PHL, selective values and its components in crossbred cattle

Source of variation	d.f.	Longevity (year)	PHL (year)	Total calves produced by	Total alive calves each cow	Total female calves born	Selective value per cow	CGR
Season	2	23.56**	21.42**	5.66**	2.90*	0.23	1.17	0.29
Period	5	59.89**	63.74**	22.12**	22.78**	12.06**	6.56**	1.64**
FLMY group	5	12.38**	12.14**	1.75*	2.13*	4.23**	2.86*	0.72*
Error	922	2.34	2.31	0.78	0.90	1.39	1.08	0.27

$P \leq 0.01$ **; $P \leq 0.05$ *

estimate heritability of different traits (Becker, 1985). The standard error of heritability was estimated by the formula given by Swiger *et al.* (1964). The genetic and phenotypic correlations among different traits were estimated from the analysis of variance/covariance using half sib data as suggested by Becker (1985). The standard error of genetic correlation was estimated according to the formula given by Robertson (1959). The standard error of phenotypic correlation was estimated according to the formula given by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The least squares mean of productive herd life, longevity, selective value, and its components are presented in Table 1 and the analysis of variance for genetic and non-genetic factors has been presented in Table 2.

Productive herd life (PHL)

The average productive herd life (PHL) was calculated as 6.58±0.06 years using least square means. These findings are consistent with the results reported by Shahi (2004) in Sahiwal x Jersey cattle. PHL in the range of 4 to 6 years was observed in studies conducted by Kumar (1999) and Jakhar *et al.* (2010) in Hariana cattle, Goshu *et al.* (2007) in HF cattle, and Singh *et al.* (2011) in Sahiwal cattle. However, some studies reported PHL below 4 years, such as Mukherjee (1993) in crossbred cattle, Abbas (2005) in Sahiwal cattle, Atrey *et al.* (2005c), and Kumar *et al.* (2014) in Frieswal cattle.

The impact of season on productive herd life (PHL) was observed to be highly significant in the current study. Similar results regarding the influence of season were reported in previous studies, including those conducted by Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, Goshu (2014) in HF cattle, and Kumar *et al.* (2014) in Frieswal cattle. On the other hand, Gahlot *et al.* (2001) conducted a study on Tharparkar cattle and Singh *et al.* (2002) on HF cattle, both of which reported a non-significant effect of season. Similarly, Goshu *et al.* (2007) in HF cattle, Singh *et al.* (2011) in Sahiwal cattle, and Jadhav *et al.* (2019b) in HF x Gir cattle found no significant effect of season.

The impact of the period on productive herd life (PHL) was observed to be highly significant in the current study. Similar results regarding the influence of period on PHL were reported in previous studies, including those conducted by Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, Goshu (2014) in HF cattle, and Kumar *et al.* (2014) in Frieswal cattle. On the other hand, Gahlot *et al.* (2001) conducted a study on Tharparkar cattle and Singh *et al.* (2002) on HF cattle, both of which reported a non-significant effect of period on the variables under investigation. Similarly, Goshu *et al.* (2007) in HF cattle, and Singh *et al.* (2011) in Sahiwal cattle. Furthermore, Shahi (2004) in Sahiwal x Jersey and Abbas (2005) in Sahiwal also reported non-significant effects of the period in their respective studies.

The impact of the first lactation milk yield (FLMY) group on productive herd life (PHL) was observed to be highly significant in the current study. Similarly, highly significant effects of the FLMY

Table 3: Heritability of longevity, PHL, selective values and its components in crossbred cattle

Traits	Heritability
Longevity	0.32±0.080
Productive Herd Life (PHL)	0.21±0.081
Total calves produced by each cow	0.20±0.080
Total alive calf	0.31±0.093
Total female calves per cow	0.13±0.064
Selective value	0.16±0.073
Coefficient of gene replication (CGR)	0.16±0.073

(first lactation milk yield) group were reported by Shahi (2004) in Sahiwal x Jersey cattle

Longevity

The present study revealed that the least square means of longevity in the studied population was found to be 9.78±0.06 years. These results are consistent with the findings of Kumar (1999) in Hariana cattle and Shahi (2004) in Sahiwal x Jersey cattle, who also observed similar longevity figures in their respective studies. Furthermore, the longevity observed within the range of 6 to 9 years by Singh (2001) in Karan Fries cattle, Atrey *et al.*, (2005c), Kumar *et al.* (2014) in Frieswal cattle, Goshu *et al.* (2007) in HF cattle, Jakhar *et al.* (2010) in Hariana cattle, and Singh *et al.* (2011) in Sahiwal cattle. However, it is noteworthy that some cows exhibited shorter longevity below 6 years, as reported by Mukherjee (1983) in crossbred cattle.
The effect due to season had a highly significant impact on the longevity of the cattle in the studied population. Furthermore, the study also identified non-significant seasonal effects on longevity, corroborating the findings of Gahlot *et al.* (2001) in Tharparkar cattle, Singh *et al.* (2002), and Goshu *et al.* (2007) in HF cattle, Singh *et al.* (2011) in Sahiwal cattle, and Jadhav *et al.* (2019b) in HF x Gir cattle. Similarly, non-significant effects of the season were reported by Shahi (2004) in Sahiwal x Jersey cattle, Abbas (2005) in Sahiwal cattle, and Dash (2014) in Karan Fries cattle.

The present results showed a highly significant impact of the period on the longevity of the cattle in the studied population. Our findings align with those of previous studies. Mukherjee (1993) observed similar results in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, Atrey *et al.* (2005) in Frieswal cattle, Goshu (2014) in HF cattle, and Kumar *et al.* (2014) in Frieswal cattle. These consistent results reinforce the significance of considering the period in understanding the factors affecting cattle longevity. The present results showed a highly significant impact of the FLMY (first lactation milk yield) group on the longevity of the cattle in the studied population. As the lower-producing cows in their first lactation were culled from the herd, the higher milk-producing animals were associated with higher longevity and productive herd life. Similarly, highly significant effects of the FLMY (first lactation milk yield) group were reported by Shahi (2004) in Sahiwal x Jersey cattle.

Selective value and its components

(i)Total calves produced by each cow

The mean number of total calves produced by each cow in our study was estimated to be 4.68±0.03. While the results reported by Kumar (1999) in Hariana cattle showed a higher value for total calves produced by each cow compared to our findings. On the other hand, several other studies reported

Table 4: Genetic (above diagonal) and phenotypic (below diagonal) correlations among longevity, PHL, selective values and its components in crossbred cattle

Traits	Longevity	PHL	TCB	TNC	NFC	SV
Longevity	-	0.99±00.01	0.67±0.17	0.71±0.14	0.24±0.31	0.24±0.30
PHL	0.99±0.004	-	0.68±0.16	0.73±0.14	0.26±0.32	0.23±0.30
TCB	0.57±0.026	0.58±0.025	-	0.99±0.03	0.54±0.26	0.17±0.30
TNC	0.52±0.027	0.53±0.026	0.88±0.015	-	0.63±0.22	0.39±0.24
NFC	0.14±0.029	0.14±0.028	0.34±0.029	0.38±0.029	-	0.78±0.14
SV	0.12±0.030	0.12±0.029	0.23±0.030	0.25±0.030	0.78±0.019	-

Notation: PHL- Productive herd life, TCB- Total calving birth, TNC- Total normal calf, NFC- normal female calf, SV- selective value lower values for the total number of calves produced by each cow when compared to our present study. Mukherjee (1993), Singh (2001), Shahi (2004), Abbas (2005), Atrey *et al.* (2005), Goshu (2014)F and Joshi *et al.* (2014) also reported lower values for the total number of calves produced by each cow in their respective studies, which involved crossbred cattle, Karan Fries, Sahiwal x Jersey, Sahiwal, Frieswal, Holstein Friesian, and Kankrej cattle.

The impact of season on the total number of calves produced by each cow was studied, and significant effects were observed. On the other hand, the effect of season on the total number of calves produced by each cow was not significant in the study conducted by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej cattle. Similarly, Shahi (2004) in Sahiwal x Jersey cattle reported a non-significant effect of the period on the total number of calves produced by each cow.

The impact of the period on the total number of calves produced by each cow was found highly significant influence. Similar findings for the period effect were reported in previous studies. Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, Atrey *et al.* (2005) in Frieswal cattle, and Goshu (2014) in HF cattle all found significant effects of the period on the total number of calves produced by each cow. The FLMY group, it was found to have a highly significant effect on the total number of calves produced by each cow in the studies conducted by Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, Shahi (2004) in Sahiwal x Jersey cattle, Atrey *et al.* (2005) in Frieswal cattle, Goshu (2014) in HF cattle, and Joshi *et al.* (2014) in Kankrej cattle. The higher milk-producer cows produced more number of total normal calves than the lower-producer cows.

(ii)Total alive calves born

The average number of total alive calves born was found to be 4.44±0.03 in the present study, and these results closely matched with those reported by Kumar (1999) in Hariana cattle. However, when compared to other studies involving different cattle breeds, the total number of alive calves born in this study was higher than the reported values by Mukherjee (1993), Singh (2001), Shahi (2004), Abbas (2005), Atrey *et al.,* (2005), Goshu (2014), and Joshi *et al.,* (2014) in crossbred cattle, Karan Fries, Sahiwal x Jersey, Sahiwal, Frieswal, Holstein Friesian, and Kankrej cattle, respectively.

The effect of season on total alive calves born was found to be non-significant in the present study. Similar results were reported by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej, where season showed non-significant effects. However, Mukherjee (1993), Kumar (1999), Singh (2001), Atrey *et al.* (2005), and Kumar *et al.* (2014) in crossbred cattle, Hariana cattle, Karan Fries, Frieswal, and Frieswal cattle, respectively.

The period showed a highly significant impact on total alive calves born. Similar results were reported by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej, where season showed non-significant effects. However, Mukherjee (1993), Kumar (1999), Singh (2001), Shahi (2004), Atrey *et al.* (2005), and Kumar *et al.* (2014) in crossbred cattle, Hariana cattle, Karan Fries, Frieswal, and Frieswal cattle, respectively, reported highly significant effects of period on the total alive calves born.

The FLMY group had a significant effect on the total live calves born. Similar results were reported by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej, where season showed non-significant effects. However, Mukherjee (1993), Kumar (1999), Singh (2001), Shahi (2004), Atrey *et al.* (2005), and Kumar *et al.* (2014) in crossbred cattle, Hariana cattle, Karan Fries, Frieswal, and Frieswal cattle, respectively, reported highly significant effects of FLMY group on the total alive calves born.

(iii)Total Female calves per cow

The average number of total female calves born was found to be 2.16±0.05 in the present study. This finding is consistent with the results reported by Kumar (1999) in Hariana cattle and Shahi (2004) in Sahiwal x Jersey cattle. However, lower values of total female calves born, compared to our study, were reported by Mukherjee (1993), Singh (2001), Abbas (2005), Atrey *et al.* (2005), Jakhar *et al.* (2010), Goshu (2014), and Joshi *et al.* (2014) in crossbred cattle, Karan Fries, Sahiwal, Frieswal, Hariana, Holstein Friesian, and Kankrej cattle, respectively. In the present study, the effect of season was found to be non-significant on total female calves born. Similar results were reported by Goshu (2014) in HF cattle for the season and by Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, and Atrey *et al.* (2005) in Frieswal cattle.

The period showed a highly significant impact on the total number of female calves born. Similar results were reported by Goshu (2014) in HF cattle for the season and by Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, and Atrey *et al.,* (2005) in Frieswal cattle for the period. However, Shahi (2004) in Sahiwal x Jersey and Abbas *et al.* (2005) in Sahiwal cattle reported a non-significant effect of the period on the total female calves born.

The FLMY group showed a highly significant impact on the total number of female calves born. Similar results were reported by Goshu (2014) in HF cattle for the season and by Mukherjee (1993) in crossbred cattle, Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, and Atrey *et al.* (2005) in Frieswal cattle for the period.

(iv)Selective value (female calves reached to milking herd)

The least-square means of selective value was estimated as 1.45±0.04 in the present study. The result showed that more than one replacement heifer was available to replace the existing cows in the herd. These findings were consistent with the results obtained by Shahi (2004) in Sahiwal x Jersey cattle and Abbas (2005) in Sahiwal cattle, supporting the validity of our study. However, it is important to note that some previous studies, including those conducted by Mukherjee (1993), Kumar (1999), Singh (2001), Atrey *et al.,* (2005), Jakhar *et al.* (2010), Goshu (2014), and Joshi *et al.* (2014) in Crossbred, Hariana, Karan Fries, Frieswal, Hariana, Holstein Friesian, and Kankrej cattle, respectively, reported lower values for the selective value parameter compared to our present study.

The results revealed that the effect of season was not significant, indicating that seasonal variations did not have a substantial impact on the studied parameters.

However, the period was found to be highly significant, suggesting that the time period under consideration had a significant influence on the Selective value. These findings were consistent with previous research by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej cattle, who also reported non-significant effects of season on the studied parameters. Similarly, Mukherjee (1993), Kumar (1999), Singh (2001), Shahi (2004) and Atrey *et al.* (2005) in Crossbred, Hariana, Karan Fries, and Frieswal cattle, respectively, found that the period had a highly significant effect on the Selective value. The FLMY group also exhibited a significant effect on the Selective value, indicating that the number of first lactation milk yield groups played a significant role in determining these parameters. Moreover, previous studies by Mukherjee (1993), Kumar (1999), Singh (2001), Shahi (2004), Atrey *et al.* (2005), Jakhar *et al.* (2010), Goshu (2014), Joshi *et al.* (2014) in Crossbred, Hariana, Karan Fries, Frieswal, Hariana, Holstein Friesian, and Kankrej cattle, respectively, also supported the highly significant effect of the FLMY group on the studied parameters. These findings were consistent with previous research by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej cattle, who also reported non-significant effects of season on the studied parameters. Similarly, Mukherjee (1993), Kumar (1999), Singh (2001), Shahi (2004) and Atrey *et al.* (2005) in Crossbred, Hariana, Karan Fries, and Frieswal cattle, respectively, found that the period had a highly significant effect on the Selective value.

Coefficient of gene replication (CGR)

The least-square means of coefficient of gene replication (CGR) was estimated as 0.72±0.02, in the present study. The result indicated that each cow was more than replacing herself in a herd or it was more than one gene replication that could contribute to future generations. These findings were consistent with the results obtained by Shahi (2004) in Sahiwal x Jersey cattle and Abbas (2005) in Sahiwal cattle, supporting the validity of our study.

However, it is important to note that some previous studies, including those conducted by Mukherjee (1993), Kumar (1999), Singh (2001), Atrey *et al.* (2005), Jakhar *et al.* (2010), Goshu (2014), and Joshi *et al.* (2014) in Crossbred, Hariana, Karan Fries, Frieswal, Hariana, Holstein Friesian, and Kankrej cattle, respectively, reported lower values for the coefficient of gene replication (CGR) compared to our present study.

In the present study, the influence of different factors on the Coefficient of gene replication (CGR) was examined. The results revealed that the effect of season was not significant, indicating that seasonal variations did not have a substantial impact on the studied parameters. These findings were consistent with previous research by Goshu (2014) in HF cattle and Joshi *et al.,* (2014) in Kankrej cattle, who also reported non-significant effects of season on the studied parameters. Similarly, Mukherjee (1993), Kumar (1999), Singh (2001), and Atrey *et al.,* (2005) in Crossbred, Hariana, Karan Fries, and Frieswal cattle, respectively, found that the season had a highly significant effect on the CGR.

The period was found to be highly significant, suggesting that the time period under consideration had a significant influence on CGR. These findings were consistent with previous research by Goshu (2014) in HF cattle and Joshi *et al.* (2014) in Kankrej cattle, who also reported non-significant effects of period on the studied parameters. Similarly, Mukherjee (1993), Kumar (1999), Singh (2001), and Atrey *et al.* (2005) in Crossbred, Hariana, Karan Fries, and Frieswal cattle, respectively, found that the period had a highly significant effect on the CGR. Furthermore, the FLMY group also exhibited a significant effect on the CGR, indicating that the number of first lactation milk yield groups played a significant role in determining these parameters. Moreover, previous studies by Mukherjee (1993), Kumar (1999), Singh (2001), Atrey *et al.* (2005), Jakhar *et al.* (2010), Goshu (2014) and Joshi *et al.* (2014) in Crossbred, Hariana, Karan Fries, Frieswal, Hariana, Holstein Friesian, and Kankrej cattle, respectively, also supported the highly significant effect of the FLMY group on the studied parameters.

Heritability of Productive herd life, longevity, and selective value and their components

Heritability estimates of productive herd life (PHL), longevity, and lifetime calf production traits have been presented in Table 3.

In this study, the heritability estimates varied across the different traits. Longevity had the highest heritability estimate of 0.32, indicating that additive genetic variance played a significant role in determining the variation in longevity among the cattle. Other traits such as PHL, total calf production, and total alive calves born also showed moderate heritability estimates, suggesting a substantial additive genetic variance influence on these traits. On the other hand, total female calves born, selective value, and CGR had relatively lower heritability estimates, implying that environmental factors might play a more significant role in determining the variability in these traits. Similar heritability estimates were reported by Rawal (1991) in Tharparkar cattle, suggesting that the genetic component plays a comparable role in determining CGR in both studies. On the other hand, higher heritability estimates compared to the present study were reported by Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, and Atrey (2003) in Frieswal cattle. while, lower heritability estimates than the present study were reported by Mukherjee *et al.* (1999) in Karan Swiss cattle, Shahi (2004) in Sahiwal x Jersey cattle, Abbas (2005) in Sahiwal cattle, and Goshu (2014) in Holstein Friesian cattle. This indicates that the genetic contribution to selective values and CGR might be less significant in these particular cattle breeds compared to the findings of the current study.

Genetic (above diagonal) and phenotypic (below diagonal) correlations among longevity, PHL, selective values and its components in crossbred cattle have been presented in Table 4.

The genetic and phenotypic correlations of longevity with productive herd life (PHL), total calving birth (TCB), and total normal calf (TNC) were found to be highly positive. Conversely, the genetic correlations of longevity with normal female calf (NFC) and selective value (SV) were positive and moderate, while the phenotypic correlations were positive and low. The genetic and phenotypic correlations of productive herd life (PHL) with total calving birth (TCB) and total normal calf (TNC) were found to be highly positive. On the other hand, the genetic correlation of PHL with normal female calf (NFC) and selective value (SV) was positive and moderate, while the phenotypic correlation was low and positive.

The genetic and phenotypic correlations of total calving birth (TCB) with total normal calf (TNC) and normal female calf (NFC) were found to be highly positive. Conversely, the genetic correlation of TCB with selective value (SV) was low and positive, while the phenotypic correlation was positive and moderate.

The genetic correlation of total normal calf (TNC) with normal female calf (NFC) was found to be highly positive. Similarly, the genetic correlation of TNC with selective value (SV) was positive and moderate. Furthermore, the phenotypic correlations of total normal calf (TNC) with normal female calf (NFC) and selective value (SV) were reported to be positive and moderate as well. The genetic and phenotypic correlations of normal female calf (NFC) with selective value (SV) were found to be highly positive. This indicates a significant and consistent relationship between NFC and SV, both at genetically and phenotypically level, with a high level of correlation. This suggests a stronger relationship between longevity and these traits at the phenotypic level, indicating that cows with longer life spans tend to have higher values for PHL, TCB, and TNC. In contrast, the phenotypic correlation of longevity with normal female calf (NFC) and selective value (SV) was reported as positive but relatively low. This implies that there is a weaker phenotypic association between longevity and NFC and SV, suggesting that the relationship between longevity and these traits is not as strong as with the other traits. These findings provide valuable insights into the genetic and the phenotypic relationships between longevity and various reproductive and productive traits in cattle. Similar results were reported by Kumar (1999) in Hariana cattle, Singh (2001) in Karan Fries cattle, and Atrey (2003) in Frieswal cattle. Conversely, lower values estimates than the present study were reported by Mukherjee *et al.* (1999) in Karan Swiss cattle, Shahi (2004) in Sahiwal x Jersey cattle, Abbas (2005) in Sahiwal cattle, and Goshu (2014) in Holstein Friesian cattle.

REFERENCES

Abbas, M. (2005). Studies on replacement rate in Sahiwal cattle. M.V.Sc. Thesis. NDRI, Karnal, Haryana, India.

Atrey, R. K, Singh, H. P, Kumar, D and Sharma, R. K. (2005c). Factors affecting the productive herd life, Longevity and life time calf production traits in Frieswal cattle. *Indian J. Anim Sci*., 75: 1172–75.

Atrey, R. K, Singh, H, Kumar, D and Sharma, R. K. (2005). Factors affecting the replacement rate and its components in Frieswal cattle. *Indian J. Anim. Sci*., 75(3): 324-326.

Becker, W.A. (1985). Manual of Quantitative Genetics. 4th Edn., Washington State University, Pullman. Washington. USA, 73p.

Dash, S. (2014). Genetic evaluation of Karan Fries cattle for fertility and production traits. Ph.D Thesis. NDRI, Karnal, (Haryana), India, 102 p.

Gahlot, G .C, Pant, K. P and Bharahat, N. K. (2001). Longevity and lifetime performance of Tharparkar cows. *Indian J. Anim Sci.,* 71 (4): 391-393.

Goshu, G. (2014). Genetic studies on replacement rate and first lactation traits in Holstein Friesian cattle at Holeta bull dam station, Ethiopia. Ph.D dissertation, Addis Ababa University, Ethiopia.

Goshu, G., Kelay, B. and Berihun, A. (2007). Effect of parity, season and year on reproductive performance and herd life of Friesian cows at Stella private dairy farm, Ethiopia. *Livestock Research for Rural Development*, 19(7): 9.

Harvey, W. R. (1990). User's guide for LSMLMW PC-2 Version. Mixed Model. Least-squares and Maximum Likelihood Computer Program. Ohio State University, Columbus, USA.

Jadhav, S .S, Deokar, D. K, Fulpagare, Y. G, Bhoite, U.Y, Mandkmale, S.D and Nimbalker, C.V. (2019b). Lifetime Performance of HF x GIR Half breed Cows in Intensive Management Conditions. *Int. J. Curr. Microbiol. App. Sci.,* 8(2): 3275-3281.

Jakhar, G. S, Singh, R, Malik, C.P and Kumar, R. (2010). Factors affecting productive herd life, longevity, and lifetime calf production traits in Hariana cattle. *Indian J Anim Sci*., 80 (12): 1251–53.

Joshi A., Patel, V. K, Kalma, R.P, Srivastava, A. K and Patel, J. B. (2014). Effect of season of first calving on productive herd life, longevity, and life time calf production in Kankrej cow at organised farm. *Vet. Pract*., 18 (1): 141-43.

Kramer, C.Y. (1957). Extension of multiple range tests to group correlated adjusted means. *Biometrics,* 13(1): 13-18.

Kumar, A. (1999). Genetic evaluation of Hariana cattle for selective value. Ph.D. Thesis. CCSHAU, Hisar, India.

Kumar A., Kumar S., Singh U. and Beniwal, B. K. (2014). Factors affecting herd life and total calf production in Frieswal cows. *Indian J Anim Sci*., 48(2): 159-161.

Mukherjee, K. (1993). Genetic evaluation of crossbred cattle for selective value. Ph.D. Thesis, NDRI, Deemed University.

Mukherjee, K., Tomar, S. S and Sadana D. K. (1999). Genetic study on productive herd life and longevity in a herd of brown Swiss crosses. *Indian Journal of Animal Research*, 33 (2): 95-98

Panse, V. G and Sukhatme, P.V. (1967). Statistical methods for agricultural workers, lCAR, Krishi Bhawan, New Delhi.

Rawal, S.C. (1991). Coefficient of gene replication in Zebu cattle. M.Sc. Thesis, NDRl, Karnal, Haryana, India.

Robertson, A. (1959). The sampling variance of the genetic correlation coefficient. *Biometrics*, 15 (3): 469-485.

Schuster, C., Herman, W, Barkema, Albert De Vries, David, F and Kelton, Karin Orsel. (1959). Invited review: Academic and applied approach to evaluating longevity in dairy cows Jesse. *J. Dairy Sci*., 103:11008–11024

Shahi, B. N. (2004). Genetic studies on components of replacement rate and selective value in Sahiwal and jersey-Sahiwal cattle. Thesis, Doctor of Philosophy, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India.

Singh, L. (2001). Genetics of replacement rate in Karan Fries cattle. PhD Thesis. NDRI, Karnal, Haryana, India.

Singh S., Khanna A. S. and Singh, R. P. (2002). Replacement and lifetime production traits: Effect of non-genetic factors and sire Evaluation. *Asian Australas J. Anim. Sci.,* 15(1): 11-15.

Singh U., Kumar A., Kumar S. and Beniwal B. K. (2011). Evaluation of Sahiwal cattle for lifetime traits in an organized herd. *Indian J. Anim Sci*., 81: 708-710.

Swiger, L.A, Harvey, W.R, Eversson, D.U. and Gregory K. E. (1964). The variance of intraclass correlation involving group with one observation. *Biometrics*, 20: 818-826

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