The Pharma Innovation Journal 2021; SP-10(11): 563-566

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(11): 563-566

www.thepharmajournal.com
Received: 02-09-2021
Accepted: 16-10-2021

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Estimation of non-genetics parameters of reproduction performance traits in Hardhenu cattle

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Abstract
The present study was conducted to evaluate the effect of non-genetic factors of reproduction performance traits {First service period (SP), First dry period (DP), First calving interval (CI), Number of AI for first Conception (FNI) and Number of AI for second conception (SCI)} in Hardhenu Cattle. The records pertaining to the first lactation of 341 cows, the progeny of 51 sires; calved during the year 1995-2018 and maintained at Cattle Breeding Farm, LUVAS, Hisar were analysed by using a mixed technique of Harvey model. The overall least-squares means of SP, DP, CI, FNI and SCI in Hardhenu cattle for present investigation were 172.57±9.86 days, 135.29±7.07 days, 456.48±9.35 days 2.06±0.13 and 2.87±0.16, respectively in Hardhenu cattle. The effect of calving period on SP, CI and SCI for Hardhenu cattle was obtained significant. The effect of season of calving was significant on all the reproduction performance traits under the present study in Hardhenu cattle except FNI. The results revealed that the effect of the linear regression of age at first calving was significant ($p< 0.05$) on SP and FNI in Hardhenu cattle.

Keywords: Hardhenu cattle, reproduction performance traits and non-genetic factors

Introduction
Hardhenu is one of the synthetic breeds recently developed by Dept. of Animal Genetics and Breeding, LUVAS, Hisar and gaining recognition in the north India due to its high milk-producing capacity along with better adaptability during local environment weather temperature variations; moreover, it is having promising high potential for further genetic improvement. This breed is started to get dispersed out from Hisar to predominantly in all over Haryana and districts of adjoining states (Punjab, Rajasthan, UP and Delhi). India is having 192.49 million heads of cattle as reported in 2019th livestock census. Improvement in productive period in terms of milk and reduction in inter calving period and age at first calving are current demands in Dairy sector. The situation gets more tough when the environment becomes non-supportive and harsh for utilization of animal fullest capability in term of milk production. In order to develop better breeding schemes, and to get improvement of Hardhenu cattle; evaluation of the genetic value of performance traits becomes necessary, which further requires knowledge of several other parameters. The present study was planned to determine the influence of Period of calving, Season of calving and Age at first calving on several reproduction performance traits of Hardhenu cattle maintained at an organised farm at LUVAS, Hisar.

Materials and Methods
The data from history and pedigree sheets on certain production performance traits obtained from 341Hardhenu cattle born to 51 sires at Cattle Breeding Farm, LUVAS, Hisar for 24 years (1995-2018) were obtained. The data was recorded from first lactation on all animals which were milked more than 150 days in the herd. Records on service period (SP), dry period (DP), calving interval (CI), number of services required for first conception (FNI) and number of services required for second conception (SCI) were analysed to estimate the effect of period of calving, season of calving and regression of age at first calving by using a mixed model technique of Harvey (1990) [6]. The duration of twenty-four years was divided into six periods, *viz*. period 1 (1995-1998), period 2 (1999-2002), period 3 (2003-2006), period 4 (2007¬2010), period 5 (2011-2014) and period 6 (2015-2018). The year was divided into four seasons *viz*., summer (April-June); rainy (July-September); autumn (October-November) and winter (December-March).

The mixed statistical model used to explain the biology of the various performance traits in the study was:

$$Y_{ijk} = \mu \pm S_i \pm h_j + c_k + b_1(A_{ijk} - \bar{A}) + b_2(A_{ijk} - \bar{A})^2 + e_{ijk}$$

Where

Y_{ijkl} was record of individual pertaining to i^{th} sire calved in j^{th} period and k^{th} season.

μ was the overall population mean.

S_i was the random effect of i^{th} sire; h_j was the fixed effect of j^{th} period of calving.

c_k was the fixed effect of k^{th} season of calving.

b_1&b_2 were linear and quadratic partial regression coefficients of age at first calving on trait(s), respectively.

A_{ijk} was the age at first calving.

$\bar{A}$ was the mean for age at first calving.

e_{ijk} was the random error associated with each and every observation and assumed to be normally and independently distributed with mean zero and variance σ^2 e

Considering the presence of non-orthogonality in the data, arising due to unequal subclasses frequencies, a computer program of Least-Square Maximum Likelihood "Harvey (1990) [6]" using Henderson's Method III (Henderson, 1973) [7] was utilized to evaluate the effect of various non-genetic factors on reproduction performance traits.

Results and Discussion

The overall least-squares mean of first service period (SP), first dry period (DP), first calving interval (CI), Number of AI for first Conception (FNI) and number of AI for second conception (SCI) in Hardhenu cattle for present investigation was 172.57±9.86 days, 135.29±7.07 days, 456.48±9.35 days 2.06±0.13 and 2.87±0.16, respectively in Hardhenu cattle (Table 2).

Similar results for the least-squares means of SP in Hardhenu were also reported by Manjeet *et al.* (2017) [11]. Shorter service period then present values were reported in Karanfries cattle (Saha *et al.*, 2010, Divya *et al.*, 2014, Japheth *et al.*, 2015 and Dash *et al.*, 2016) [14, 5, 8, 3] and Vrindavani cattle (Singh *et al.*, 2011) [11]. A more extended service period was reported for HF x Jersey x Sahiwal crossbred cattle (Dandapat *et al.*, 2010) [2]. However, shorter dry period in different crossbred cattle like Hardhenu cattle (Verma *et al.*, 2017) [17], Karan fries (Saha *et al.*, 2010 and Japheth *et al.*, 2015) [14, 8] and Frieswal cattle (Rathee *et al.*, 2017) [13] were reported. Results of more extended dry period in indigenous Sahiwal cattle was reported by (Dhawan *et al.*, 2015, Raja and Gandhi, 2015 and Kumar *et al.*, 2017) [4, 12]. Further, similar findings of CI for present investigation in Hardhenu cattle were reported by Manjeet *et al.* (2017) [11]. Moreover, HF x Jersey x Sahiwal (Dandapat *et al.*, 2010) [2] had reports of longer calving interval. While, literature also carries reports of shorter calving interval for Karanfries (Saha *et al.*, 2010 and Dash *et al.*, 2016) [14, 3], Frieswal (Kakati *et al.*, 2017 and Rathee *et al.*, 2017) [9, 13] and Vrindavani (Singh *et al.*, 2011) [11] crossbred cattle. Similar findings to number of service per conception was also obtained by Verma *et al.* (2017) [17] in Hardhenu cattle.

Effect of period of calving

The effect of calving period on SP, CI and SCI for Hardhenu cattle was significant (Table 1). While, non-significant effect of calving period on DP and FNI in Hardhenu cattle were obatined in the present study (Table1).

Similarly, significant effects of calving period on SP were also obtained for Hardhenu cattle by Manjeet *et al.* (2017) [11]. Similar non-significant effect of calving period on SP in Hardhenu cattle was reported by Verma *et al.* (2017) [17]. Saha *et al.* (2010) [14] also reported non-significant effect of calving period on DP in Karanfries cattle. Likewise, significant effect of period of calving-on-calving interval in crossbred cattle was reported in Karan-Fries (Dash *et al.*, 2016) [3] and Frieswal (Kakati *et al.*, 2017) [9]. Likewise, non-significant effect of period of calving on number of services per conception was reported in Hardhenu (Verma *et al.*, 2017) [17] and crossbred cattle (Kumar *et al.*, 2017) [10]. While Verma *et al.* (2017) [17] reported a non-significant effect of calving period on service period in Hardhenu cattle. However, non-significant effect was also obtained in Hardhenu cattle by Manjeet *et al.* (2017) [11].

The period-wise least-squares means for SP indicated that it was the longest (336.70 days) for first-period calvers (1995-1998) and shortest (74.10 days) for Hardhenu cattle calved during the sixth period (2015-2018) (Table 2). A significant difference was obtained in first and other periods. While, the second, third and fourth periods did not differ significantly among themselves. Further, the third, fifth and sixth periods did not differ significantly among themselves. Further, a declining trend for means of SP was obtained over different periods from first to sixth period except fourth period. The period wise least-squares mean for DP indicated that it was the longest (270.49 days) for Hardhenu cattle calved during the first period (1995-1998) and the shortest (74.19 days) for animals calved during the sixth-period (2015-2018). A definite trend of reduction in dry period from fourth to sixth period was obtained in Hardhenu cattle. The period-wise least-squares mean for CI indicated that it was the longest (610.07 days) for Hardhenu cattle calved during first-period (1995-1998) and the minimum (388.45 days) for cows calved during fifth-period (2011-2014). A trend of reduction in calving period was obtained over different periods. Value of first-period calvers differed significantly with all other periods. Estimate obtained for third and fourth period calvers did not differ significantly from other periods except first-period. Second-period calvers differed significantly from fifth and sixth period. A trend of improvement shows that the selection is in the right direction for this trait in Hardhenu cattle. The period wise least squares mean for FNI indicated that it was maximum (2.49) for Hardhenu cattle calved during fourth period (2007-2010) and minimum (1.65) for cattle calved during second period (1999-2002) (Table 2). Increase in FNI over periods may be due to reduction in age at first service and possible early service attempting. The period wise least-squares means for SCI indicated that it was maximum (6.43) for Hardhenu cattle calved during first period (1995-1998) and minimum (1.31) for cattle calved during sixth period (2015-2018). A pattern of decline in number of AI required for second conception was obtained over different periods showing that the selection for this trait is in desired direction in Hardhenu cattle.

Effect of season of calving

The effect of season of calving was significant on all the reproduction traits under the present study in Hardhenu cattle except FNI (Table 1).

Similarly, in Hardhenu cattle similar significant effect of calving season was found on SP (Verma *et al.* 2017 and

Manjeet *et al.*, 2017) [17, 11] and DP (Verma *et al.*, 2016) [16]. Further, significant (Saha *et al.*, 2010 and Dash *et al.*, 2014) [14] effects of calving period on SP were reported in Karanfries crossbred cattle. Moreover, in Frieswal cattle Rathee *et al.* (2017) [13] obtained significant effect of calving season on DP. Furthermore, Dash *et al.* (2016) [3] found a significant effect of calving season on CI in Karan-Fries crossbred cattle. Similarly, Verma *et al.* (2017) [17] in Hardhenu cattle reported similar non-significant effect of calving season on FNI. Non-significant (Divya *et al.*, 2014 and Japheth *et al.*, 2015) [5, 8] effects of calving period on SP were reported in Karanfries crossbred cattle. However, non-significant effect of season of calving on FCI was reported by Manjeet *et al.* (2017) [11] in Hardhenu cattle.

The season-wise means for SP indicated that it was the longest (197.85 days) during summer season calvers (Apr-June) and the shortest (149.22 days) in autumn (Oct-Nov) in Hardhenu cattle. The season-wise averages for means of DP indicated that it was the maximum (157.69 days) for Hardhenu cattle calved during summer season (Apr-June) and the minimum (107.80 days) for autumn season calvers (Oct-Nov). Least square means of DP in Hardhenu cattle calved during winter season (Dec-March) did not differ significantly with other season calvers; whereas monsoon and autumn (July to Nov.) calvers differed significantly with summer season calvers (Apr. to June). The season-wise averages for CI indicated that it was the maximum (482.57 days) in Hardhenu cattle calved during summer season (Apr-June) and the lowest for autumn season (Oct-Nov.) calvers. Moreover, the averages for summer calvers differed significantly with monsoon and autumn calvers. However, winter calvers did not differ significantly from other seasons. The season-wise averages for FNI indicated that it was the maximum (2.24) for Hardhenu cattle calved during monsoon season and the minimum (1.97) for autumn season calvers. The season wise averages for SCI indicated that it was the maximum (3.60) for Hardhenu cattle calved during summer season (Apr.-June) and minimum (2.38) for autumn season calvers (Table 2). The better performance of monsoon and autumn season calvers (July to Nov.) might be due to ample availability of palatable lush green fodders to these animals during an advanced stage of pregnancy and early lactation leading to availability of required minerals for early heat and conception

Effect of age at first calving

The results revealed that the effect of the linear regression of age at first calving was significant ($p< 0.05$) on SP and FNI in Hardhenu cattle (Table 1). The results further revealed that the effect of the linear regression of age at first calving was not significant ($p< 0.05$) on DP, CI and SCI in Hardhenu under study. Moreover, results further revealed that the effect of the quadratic regression of age at first calving was not significant ($p< 0.05$) on all the traits under study in Hardhenu cattle.

The results further revealed that there would be increase in 0.06±0.03 day of service period by increasing one day in age of first calving in Hardhenu cattle (Table 2).

Contrarily, reports of non-significant effect of age at first calving on SP in crossbred cattle, i.e. Karanfries (Divya *et al.*, 2014, Dash *et al.*, 2016) [5, 3] and Frieswal (Rathee *et al.*, 2017) [13]. Similar findings of non-significant effect of age at first calving on DP was obtained in Frieswal (Rathee *et al.*, 2017) [13] and Sahiwal (Raja and Gandhi, 2015) [12]. Dash *et al.* (2016) [3] also reported non-significant effect of age at first calving on calving interval in Karanfries crossbred cattle. However, Verma *et al.* (2017) [17] obtained significant effect of age at first calving on FNI in Crossbred cattle.

Table 1: Analysis of variance for various reproduction performance traits (Cattle)

Source of Variance	D.F.	Mean Squares				
		SP	DP	CI	FNI	SCI
Sire	50	12765.15	7472.95	11885.88	2.22	3.62
Period	5	18274.22*	9333.67	16484.93*	1.00	6.36*
Season	3	30626.45**	23156.40**	28482.42**	0.77	17.81**
Regressions						
AFC (Linear)	1	26830.62*	1140.15	16965.57	61.05**	7.63
AFC (Quad)	1	831.18	7905.93	1211.29	9.69**	0.17
Remainder	280	6558.91	5890.49	7013.39	1.06	2.12

*$P< 0.05$; **$P< 0.01$

Table 2: Least Squares Means with standard errors for various reproduction performance traits (Cattle)

Effects		Obs	Least Sq. Means ± S.E.				
			SP (days)	DP (days)	CI (days)	FNI	SCI
Over All Means		341	172.57 ±9.86	135.29 ±7.07	456.48 ±9.35	2.06 ±0.13	2.87 ±0.16
Period of calving	1995-1998	33	336.70^{a} ±66.06	270.49^{a} ±62.31	610.07^{a} ±68.19	1.83 ±0.84	6.43^{a} ±1.19
	1999-2002	28	196.73^{b} ±32.45	157.75^{b} ±30.14	483.92^{b} ±33.31	1.65 ±0.41	2.68^{b} ±0.58
	2003-2006	67	156.88^{bc} ±23.13	98.34^{b} ±21.05	441.14^{bc} ±23.57	1.82 ±0.30	2.52^{b} ±0.41
	2007-2010	51	172.17^{b} ±25.89	120.58^{b} ±23.76	455.96^{bc} ±26.46	2.49 ±0.33	2.71^{b} ±0.46
	2011-2014	71	98.82^{c} ±26.88	90.39^{b} ±24.73	388.45^{c} ±27.50	2.26 ±0.34	1.60^{c} ±0.48
	2015-2018	91	74.10^{c} ±32.96	74.19^{b} ±30.63	389.37^{c} ±33.84	2.34 ±0.42	1.31^{c} ±0.59
Season of calving	Summer	97	197.85^{a}	157.69^{a}	482.57^{a}	2.04	3.60^{a}

	(Apr-June)		±12.41	±10.05	±12.17	±0.16	±0.21
	Monsoon (July- Sept)	69	157.55^{b} ±13.83	131.43^{b} ±11.60	441.06^{b} ±13.72	2.24 ±0.18	2.58^{b} ±0.24
	Autumn (Oct-Nov)	50	149.22^{b} ±15.26	107.80^{b} ±13.10	436.09^{b} ±15.24	1.97 ±0.20	2.38^{b} ±0.27
	Winter (Dec-March)	125	185.65^{ab} ±11.98	144.23^{ab} ±9.56	466.21^{ab} ±11.70	2.02 ±0.16	2.94^{b} ±0.20
AFC B (Linear)			0.060 ±0.029	-0.012 ±0.028	0.047 ±0.030	0.0028 ±0.00038	0.0010 ±0.00053
AFC B (Quad)			0.000017 ±0.000047	0.000051 ±0.000044	0.000020 ±0.000048	-0.0000018 ±0.00000059	-0.00000024 ±0.00000084

Conclusion

In present study of reproduction performance traits for Hardhenu cattle, the effect of calving period on SP, CI and SCI was obtained significant. The effect of season of calving was significant on all the reproduction traits under the present study except FNI. The results further revealed that the effect of the linear regression of age at first calving was obtained significant ($p< 0.05$) on SP and FNI. Further, improvement in herd noticed as decline in values for recent periods was obtained in SP, DP, CI. In order to get precise values while calculating Genetic parameters of reproductive traits, measures should be taken to avoid error originating from the respective above-mentioned non-genetics parameters.

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