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Studies on factors affecting age at first calving in Gir halfbreds

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Abstract

Data on the reproductive performance of Gir halfbreds maintained at the Research-cum-Development Project on Cattle (RCDP), Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahilyanagar district, Maharashtra, were used for the present study. This dataset provided comprehensive insights into the reproductive traits of Gir halfbred cattle under the project's management conditions. Age at first calving least squares means were analyzed considering the influence of sire and non-genetic factors such as calving period and season. Analysis revealed that the period of calving had a strong and highly significant influence ($P < 0.01$) on AFC indicating that the year when a Gir halfbreds gives birth has an important impact on how old the cow was when she gave birth for the first time while season of calving did not have a statistically significant influence on AFC indicating that the season in which cow gives birth does not have an important noticeable impact on how old the cow was when she gave birth for the first time. The genetic factor, sire, had a significant effect ($P < 0.05$) on AFC indicating that the sire that fathered the calf has an important influence on how old the daughter cow was when she gave birth for the first time.

Keywords: Gir halfbreds, AFC

Introduction

Age at first calving is a key economic trait in dairy cattle. Genetic improvement aimed at reducing this age is considered beneficial, as it shortens the non-productive phase, enables early culling of uneconomical animals, and enhances the total lifetime milk yield of cows. Such an improvement could only be brought about, firstly by knowing accurate magnitude of the AFC, its heritable fraction or variance and planning an appropriate selection system which can be adopted for achieving the desired goal.

Earlier calving (typically between 22–24 months) allows a heifer to start producing milk or calves sooner. This reduces the non-productive period, lowering the cost of rearing.

Delayed calving increases feed, housing, and labour costs without income return. Optimal AFC maximizes the number of lactations and calves produced over the animal's life. Heifers calving too late or too early may have shorter productive lives. Proper timing helps achieve peak lifetime milk yield. A lower average AFC allows faster turnover of generations, accelerating genetic improvement in herds. More frequent replacement cycles help in selecting better-performing animals.

Materials and Methods

The dataset for the present study was compiled from reproductive performance records of Gir halfbreds maintained at the Research Cum-Development Project on Cattle, Mahatma Phule Krishi Vidyapeeth (M.P.K.V.), Rahuri, covering a 20-year period from 2000 to 2020.

For the assessment of reproductive traits, the research data were categorized into three distinct periods of calving: P_1 (2000–2006), P_2 (2007–2013), and P_3 (2014–2020). Similarly, calving seasons were grouped into three categories: S_1 (Rainy, June–September), S_2 (Winter, October–January), and S_3 (Summer, February–May).

The influence of genetic (sire) and non-genetic factors, including period of calving and season

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of calving, was evaluated using least-squares analysis as outlined by Harvey (1990) [5]. The least-squares means for age at first calving (AFC) were estimated through a model that accounted for the effects of both genetic (sire) and non-genetic (period and season of calving) factors. The model was as follows:

$$Y_{ijkl} = \mu + P_i + S_j + M_k + e_{ijkl}$$

Where, $Y_{ijkl,}$ Observations of AFC of l^{th} animal belonging to i^{th} period of calving, j^{th} season of calving and k^{th} sire, μ, overall mean, $P_{i,}$ fixed effect of i^{th} period of calving (i = 1,2 and3), $S_{j,}$ fixed effect of j^{th} season of calving (j = 1,2 and 3), $M_{k,}$ fixed effect of k^{th} sire (k = 1.n), e_{ijkl}, random error associated with NID ~ (0, σ^2e).

Duncan's Multiple Range Test (DMRT)

Duncan's Multiple Range Test (DMRT), as refined by Kramer (1957) [8], was used to carry out pairwise comparisons of the least-squares means, employing inverse elements and the root mean square error as the basis for evaluation.

If the values:

$$(Yi - Yj) \times \sqrt{\frac{2}{Cii + Cjj + 2\,Cij}} > \sigma^2 e,\ Z\ (P,\ ne)$$

Where,

Yi – Yj: Difference between two least squares means

Cii: Corresponding i^{th} diagonal elements of C matrix

Cjj: Corresponding j^{th} diagonal elements of C matrix

Z (P, ne): Standardized range value in Duncan's table at the chosen level of

probability for the error degrees of freedom

P: Number of means involved in the comparison

σ^2e: Root mean squares for error

Results and Discussion

Effect of non-genetic factors on Age at First Calving

The overall least-squares mean age at first calving (AFC) in Gir halfbreds was 1091.18±21.45 days. Comparable AFC estimates have been reported by Jadhav and Khan (1996) [7], Sahana (1996), Panja (1997) [9], Mukherjee (2005), and Rathi (2015) in HF crossbred cattle. The present values were higher than those reported by Bhoite (1996) [3] in JG halfbreds, but lower than the AFC observed by Thombare *et al.* (2002) [13] in HF × D halfbreds and by Dubey and Singh (2005) [4] in Sahiwal crossbreds.

Effect of period of calving on age at first calving in Gir halfbreds

The period of calving had a highly significant effect ($P< 0.01$) on the age at first calving in Gir halfbreds (Table 1). Comparable findings were also reported by Singh *et al.* (2014) [12] and Rathi (2015) in Frieswal cattle.

The difference in age at first calving of cows born during period P_1 and P_3 were at par with each other similarly period P_2 and P_1 were at par with each other. A significantly lower age at first calving was during period P_2 (Table 2).

The observed differences in age at first calving across periods may be attributed to variations in feeding and management practices of young stock, as animals raised under better nutritional conditions tended to grow faster than those in other years, leading to earlier calving compared to those reared under less optimal nutritional conditions.

Effect of season of calving on age at first calving in Gir halfbreds

The impact of season of calving on age at first calving (AFC) in Gir halfbreds was non-significant. Nevertheless, the highest numerical AFC was observed in heifers born during the rainy season (1115.59±40.50 days), followed by summer (1092.08±33.26 days) and winter (1065.87±33.68 days). These findings are consistent with Bhoite (1996) [3], Shinde (2010) [11], Mukherjee (2005), and Singh *et al.* (2014) [12] in HF crossbred cattle. In contrast, Akhtar *et al.* (2003) [1], PDC AR (2003–04), and Dubey and Singh (2005) [4] reported differing results in various crossbred cattle.

Effect of genetic factor sire on age at first calving in Gir halfbreds

The overall least squares mean for age at first calving was 1068.67±17.65 days (Table 4).

The effect of sire on age at first calving was significant ($P< 0.05$). Similar significant effects have been reported by Jadhav (1990) in HF × SW cattle, Akhtar *et al.* (2003) [1] in 5/8 HF × 3/8 SW cattle, Singh *et al.* (2014) [12] in Frieswal, and Ambhore *et al.* (2017) [2] in Phule Triveni cattle, indicating that certain sires contributed to notably higher or lower values of age at first calving. This highlights the importance of sire selection in genetic improvement programs targeting reproductive traits.

Table 1: Analysis of variance of AFC as affected by non-genetic factors

Source of Variation	d.f.	MSS	F value
POC	2	356881.57917	6.882**
SOC	2	24522.39833	0.473
Error	126	51857.63502	

(**p<0.01)

Table 2: Least squares means for AFC as affected by non-genetic factors

Effect	N	Least square means of AFC	
		Mean	SE
μ	131	1091.18	21.45
Period of Calving			
P_1	54	1116.63^{ab}	31.57
P_2	52	987.11^{b}	31.89
P_3	25	1169.79^{a}	45.63
Season of Calving			
S_1	32	1115.59	40.50
S_2	50	1065.87	33.68
S_3	49	1092.08	33.26

Means within the same column bearing different superscripts differ significantly

Table 3: Analysis of variance of AFC as affected by sire

Source of Variation	d.f.	MSS	F value
SIRE	38	71433.52387	1.7205*
Error	92	41517.25807	

(*p<0.05)

Table 4: Least squares means for AFC as affected by sire

Effect	N	Least square means of AFC	
		Mean	SE
µ	131	1068.67	17.65
SIRE			
1	11	1011.29	42.75
2	2	1047.65	100.25
3	2	1085.75	100.25
4	15	1117.58	36.60
6	5	1134.97	63.40
8	4	1232.89	70.89
10	10	1093.71	44.83
11	8	1093.32	50.12
12	3	955.55	81.86
15	4	1123.32	70.89
16	4	1290.44	70.89
21	13	1104.91	39.32
22	4	1154.90	70.89
25	6	948.15	57.88
28	3	1106.43	81.86
29	2	858.43	100.25
30	4	1440.66	70.89
31	4	1140.89	70.89
32	3	1312.81	81.86
33	4	854.16	70.89
35	2	1017.97	100.25

Conflict of Interest
Not available

Financial Support
Not available

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