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Assessment of Non-Genetic Factors Affecting Production and Reproduction Traits in Badri Cattle

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ABSTRACT

The present study was aimed to assess the effect of non-genetic factors on production and reproduction traits in Badri cattle. The study assessed the production and reproduction traits of 147 calving records of Badri cattle , spread over a period of 7 years from 2014-2020, at Instructional Dairy Farm, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India. Least-square maximum likelihood programme was used to analyse the effect of non-genetic factors (NGF) *viz.* parity number of animal, season of calving and period of calving on production and reproduction traits viz. total milk yield (TMY), peak yield (PY) and daily milk yield (DMY), service period (SP), dry period (DP) and calving interval (CI) respectively. Effect of animal's parity number was significant ($P < 0.05$) on TMY, PY, DMY and SP. Season of calving was found to be significant on PY ($P < 0.05$). Effect of period of calving was significant ($P < 0.05$) on DMY and ($P < 0.01$) on TMY. Thus, it can be asserted that non-genetic factors have significant effect on the production and reproduction traits in Badri cattle. It is pertinent to pre-adjust the data of environmental factors for evaluating genetic parameters of production and reproduction traits in dairy cattle.

HIGHLIGHTS

- Non-genetic factors significantly affect production traits in Badri cattle.
- Production traits viz.TMY, DMY and PY significantly increase with increasing parity number.
- Badri cattle performs better in reproduction traits and lesser in production traits.

Keywords: Badri cattle, non-genetic factors, production traits, reproduction traits

Livestock sector constitutes 28.4% of total agricultural gross domestic production (GDP) and 4.9% of total GDP in India (20th Livestock Census All India Report, 2019). India possesses a huge number of livestock germplasm and forms 10.71% of world's livestock population despite sharing a low percentage (2.4%) of earth's land area. The country has a cattle population of a whopping 193.90 million, consisting of about 142.11 million indigenous and 51.36 million crossbred cattle (20th Livestock Census All India Report, 2019). Currently, there are 50 indigenous cattle breeds registered in India. Badri cattle earliest known as Pahadi or Hill cattle, is one of the 50 registered cattle breeds of India, noted in the hilly districts of the state of Uttarakhand. Badri cattle is the only registered and characterised (Dar *et al.,* 2020) cattle breed of

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Uttarakhand which is the source of A2 milk (Dar *et al.,* 2018). Indigenous or zebu cattle breeds have evolved overtime to overcome hostile climatic conditions with traits for heat tolerance, survival on minimal nutrition and resistance to some tick-borne diseases, Larcombe *et al.* (2019). Due to low cost of rearing and disease-resistant attributes, Badri cattle forms backbone of hill farmers' economy. Besides ensuring nutritional security to farmers of hills of Uttarakhand, it is a subsistent source of income and adds to the livelihoods of the poor and marginal farmers of the hilly state through the milk production and manure. Majority (94.2%) of farmers are keeping Badri cattle for fulfilment of need for milk and milk products followed by manure utilization (68.3%) and draught power (10%), Joshi *et al.* (2019). Though the breed is reared by people of hilly regions as source of their livelihood, but its production performance is abysmal, Joshi *et al.* (2019). Kumar *et al.* (2016), reported conception rate of 1.77 ± 0.09, indicating good reproductive potential of Badri cattle. Therefore, it is imperative to focus on improving the production performance of Badri cattle and simultaneously maintaining its reproductive performance. Besides genetic factors, variation in production and reproduction traits in dairy animals is attributed to several non-genetic factors. As a result, adjusting the effect of significant non-genetic factors is critical for accurate and unbiased estimates of genetic parameters. This study zeroes in on to study the effect of non-genetic factors on production and reproduction traits so that the Badri cattle will be efficiently managed for higher production and sustainable reproductive potential.

MATERIAL AND METHODS

Source of Data

The data on various production and reproduction traits was collected from the pedigree sheets of Badri cattle from Instructional Dairy farm Nagla of GB Pant University of Agriculture & Technology- Pantnagar, Uttarakhand India. Located in Himalayan foot hills, the Tarai region has a latitude of 290 N, longitude 79.30 E and an altitude of 243.84 m. It has a humid subtropical climate and experiences cold winter and blistering summer. The temperature during winters dips to a 2ºC and the summers may see a maximum rise of 43ºC with relative humidity ranging between 15 to 95%. The study was conducted on the production and reproduction data recorded from 2014 to 2020. Production traits recorded were TMY (kg), PY (kg) and DMY (kg). Reproduction traits recorded were SP (days), DP (days) and CI (days). The data for each trait was normalised by mean ± 3 standard deviations.

Classification of NGF viz. parity number of animal, season of calving and period of calving

The NGF such as parity number of animal, season of calving and period of calving was classified into different fixed sub-class effects in order to evaluate the effect of NGF on the traits taken into consideration in the present study. The classification of NGF *viz.* season of calving, period and parity number is given in Table 1.

Table 1: Classification of non-genetic factors *viz*. season, period of calving and parity

Season of calving		Parity of animal	Period of calving	Code
Month	**Season**			
December to March	Winter	Ist	2010-11	1
April - June	Summer	2nd	2012-13	2
July to August	Rainy	3rd	2014-15	3
—	—	4th	—	4
—	—	5th	—	5
—	—	6th	—	6

Assessing the effect of non-genetic factors on production and reproduction traits

To subdue the non-orthogonality of effects due to unequal and disproportionate sub-class frequencies least-squares analysis was applied to determine the significance of NGF as suggested by (Harvey, 1990). For this study, the model, $Y_{ijkl} = \mu + P_i + S_j + Pr_k + e_{ijkl}$, were, Y_{ijkl} is observation on l^{th} animal of i^{th} period, calved in j^{th} season having k^{th} parity, P_i is effect of i^{th} period, S_j is effect of j^{th} season of calving, Pr_k is effect of k^{th} parity of an animal, and e_{ijkl} is random error associated with each observation assumed to be normal in distribution with error zero and variance σ_e^2, was considered with the assumptions that the different components being fitted into the model are linear and independent.

Estimation of heritability of production and reproduction traits

Heritability estimates for various production and reproduction traits were obtained from sire component of variances using paternal half-sib correlation method (Becker, 1975). The model, $Y_{ij} = m + s_i + e_{ij}$, was used to estimate the heritability, where, Y_{ij} is observation of the j^{th} progeny of the i^{th} sire, m is effect of the i^{th} sire, normal in distribution with error zero and variance σ_e^2, e_{ij} is random error with error zero and variance σ_e^2. The s_i and e_{ij} were assumed to be independent of each other.

Statistical analysis

Analysis by Least-square maximum likelihood programme was performed using Harvey Software, Harvey (1990). The statistical significance of various non-genetic factors was set on by F-test.

RESULTS AND DISCUSSIONS

The least squares means (LSM) of production traits viz. TMY, PY, and DMY were 497.85 ± 22.69 kg, 4.57 ± 0.09 kg and 2.15 ± .06 kg respectively. The LSM of reproduction traits viz., SP, DP and CI were 75.08 ± 11.28 days, 161.66 ± 21.57 days and 354.78 ± 11.63 days respectively. The LSM and standard errors of production and reproduction in different classes of calving seasons, parities and periods is presented in Table 2.

Effect of non-genetic factors on production and reproduction traits

Effect of parity and period was significant (P <0.01) on TMY while as, effect of season of calving was non-significant on TMY. TMY was significantly increasing with parity number of animal till fifth parity (Fig. 1). TMY was found highest in fifth parity (659.78 ± 55.29kg) and lowest in first parity (293.12 ± 49.11 kg). TMY showed significantly declining trend with period. In semblance to our findings, Bhutkar *et al. (*2014), Ratwan *et al.* (2016), Ratwan *et al.* (2019a) reported significant effect of parity number of animal, period of calving and non significant effect of season of calving on TMY. On the contrary, Verma *et al.* (2016) reported non significant effect of period of calving on TMY. Dongre *et al.* (2017) reported

Table 2: Least squares means with standard errors and effects of non-genetic factors on production and reproduction traits in Badri cattle

Effects/ Levels	N	Total Milk Yield (kg)	Peak Yield (kg)	Daily Milk Yield (kg)	Service Period	Dry Period (days)	Calving Interval
Overall	147	497.85±22.69	4.57±0.09	2.15±0.06	75.08±11.28	161.66±21.57	354.78±11.63
Season		NS	*	NS	NS	NS	NS
Summer	39	542.72 ±41.40	4.70 ±0.17	2.25± 0.12	71.91±14.84	115.29 ±26.17	354.55 ±20.43
Rainy	53	511.67 ±33.54	4.52 ±0.14	2.22± 0.09	85.03±11.51	180.21 ±27.80	357.32± 16.70
Winter	55	439.17 ±35.16	4.51 ±0.15	1.97± 0.10	68.31±13.88	189.48± 32.80	352.48 ±18.73
Period		**	NS	*	NS	NS	NS
2014-15	28	635.03 ±51.69	5.40 ±0.22	2.62± 0.15	86.69±23.24	147.01 ±33.38	351.14 ±23.82
2016-17	53	461.68 ±35.52	4.53 ±0.15	2.09± 0.10	60.78±12.62	140.18 ±24.62	378.63 ±15.98
2018-20	66	396.85 ±30.74	3.79 ±0.13	1.74± 0.09	77.78 ±9.98	176.31 ±25.68	334.58±20.79
Parity		*	*	*	*	NS	NS
First	24	293.12 ±49.11	3.64 ±0.21	1.48± 0.14	113.03±11.78	189.48 ±22.80	406.49 ±26.94
Second	30	355.89 ±44.12	3.96 ±0.18	1.79±0.13	114.03±12.38	187.03 ±19.10	338.73 ±20.72
Third	29	527.52 ±45.77	4.46 ±0.19	2.16± 0.13	77.01±12.86	105.62 ±26.64	354.58 ±21.13
Fourth	24	497.71 ±52.28	4.63 ±0.22	2.24± 0.15	57.06±12.57	168.24 ±24.64	338.22 ±23.52
Fifth	22	659.78± 55.20	5.27 ±0.23	2.68± 0.16	71.42±13.57	108.26 ±18.50	344.11 ±30.45
Sixth	18	653.11 ±64.10	5.48 ±0.27	2.55± 0.18	55.63±15.46	-	-

*Significant at 0.05; ** Significant at 0.01; NS= Non significant; N= Number of observations.

non significantly effect of parity number of animal on TMY.

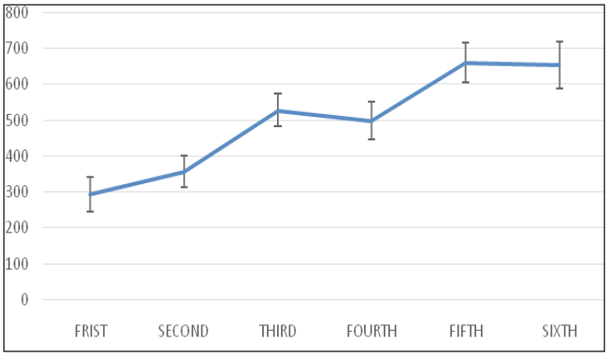

Fig. 1: Effect of parity number of animal on Total Milk Yield (kg)

Effect of parity and season of calving was found significant on PY (P <0.05) while period had non-significant effect on PY. PY was significantly increasing with parity number of animal (Fig. 2). The PY was observed highest in sixth parity (5.48 ± 0.27 kg) and lowest in first parity (3.64 ± 0.21 kg). The PY was observed significantly higher in summer (4.70 ± 0.17 kg) followed by rainy (4.52 ± 0.14 kg) and winter season (4.51 ± 0.15 kg). In agreement to our results, Tekerli *et al*. (2000) reported significant effect of season of calving on PY. Contrarily, Bhutkar *et al.* (2014) found significant effect of period of calving on PY.

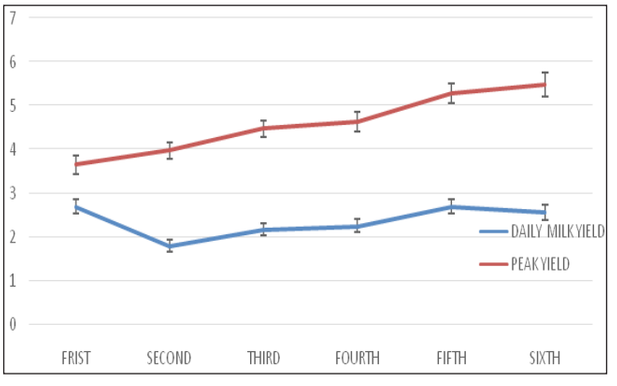

Fig. 2: Effect of parity number of animal on Peak Yield and Daily Milk Yield (kg)

Effect of parity number of animal and period of calving was found to be significant (P<0.05) while season of calving was non-significant on DMY. DMY was significantly increasing with increase in parity number of animal till fifth parity (Fig. 2). DMY was observed highest in fifth parity (2.68 ± 0.16 kg) and lowest in first parity (1.48 ± 0.14 kg). The DMY estimated was significantly declining with period. DMY was highest in 2014-15 (2.62 ± 0.15 kg) and lowest in 2018-2020 period (1.74 ± 0.09 kg). Findings of, Bayou *et al.* (2015) shows similar outcome of significant effect of parity number of animal and season of calving with non-significant effect on DMY as were formulated during this study. The increasing trend of production traits with advancement of parity number of animal is due to better development of mammary glands.

Effect of parity was significant (P<0.05) while period and season was non-significant on service period. SP showed significant declining trend with increase in parity number of animal except in fifth parity where it increased than previous parity number (Fig. 3).

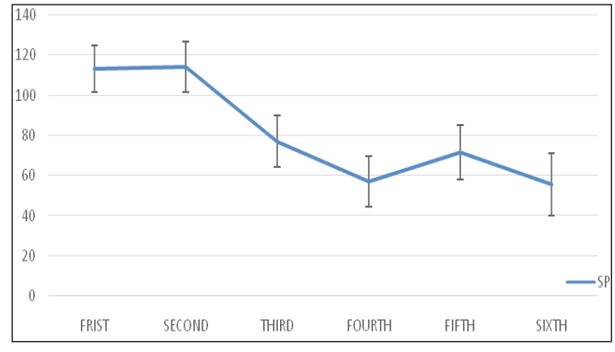

Fig. 3: Effect of parity on Service Period (Days)

SP was lowest in sixth parity (55.63±15.46 days) and highest in first parity (113.03±11.78 days). Bayou *et al.* (2015) delineated season of calving had a significant (p<0.01) effect on SP. Similar to our findings, Bayou *et al.* (2015), described receding trend in service period with advance in parity number of cattle. The present study is also supported by findings by other workers, who reported the longest SP (Giday, 2001) in young cows which may be rendered by lower energy back up as they are not able to divert most of the supplemental food for growth, production, reproduction and maintenance, thus energy backdrop defers the onset of postpartum heat. The results demonstrated in our study for the effect of season of calving on SP, supports the study of various workers, (Aynalem, 2006; Getinet *et al.,* 2009). Effect of season,

parity number of animal and period of calving was non-significant on dry period and calving interval.

Estimation of heritability

The heritability estimated for production traits were low to medium in magnitude varying from 0.02 to 0.26 while as magnitude of heritability estimated for various reproduction traits was low, varying from 0.03 to 0.14 . Similar to our findings, Ratwan *et al.* (2018), reported low to medium range of heritability for production traits in Sahiwal cattle. Magnitude of heritability estimates of reproduction traits were in semblance as reported by Ratwan *et al.* (2019b). The heritability of TMY was found to be medium (0.26) in Badri cattle. The results were comparable with the findings of Hussain *et al.* (2014) and Ratwan *et al.* (2018) in Sahiwal cattle. Heritability estimate of peak yield was 0.15 which was comparatively lower than reported by Ratwan *et al.* (2018), in Sahiwal cattle. Magnitude of heritability estimate for DMY in Badri cattle was found low (0.02). Patond *et al.* (2013) reported higher heritability estimate (0.30) of DMY in Jersey cattle, as compared to this study. In the present study, the heritability of dry period (0.14) was similar to findings of Mohanty (2001) and Ratwan *et al.* (2018) in Sahiwal cattle. Findings of Rehman *et al.* (2008) and Banik and Gandhi (2010), revealed 0.05 and 0.02 heritability estimates of dry period which are comparatively lower than present result. Heritability of service period was found to be low (0.03) in Badri cattle which was comparable with findings of, Rehman *et al.* (2008) in Sahiwal cattle. Choudhary *et al.* (2003) and Ratwan *et al.* (2019b) reported higher estimates. Heritability estimate of calving interval was also found low (0.03). This was very lower compared with heritability estimates reported by Singh *et al.* (1999) and Ratwan *et al.* (2019b) in Sahiwal cattle.

CONCLUSION

The findings of present study confirmed the hypothesis that non-genetic factors are affecting the production and reproduction traits. This study is first of its kind in Badri (Hill) cattle adopted to Himalayan hills of Uttarakhand, India. The analysis made reveal the low production performance and high reproductive performance of Badri cattle. Hence, breeding goals should focus on milk production traits while maintaining sustainability in its reproduction traits performance. Beside this, effect of NGF should be considered in breed improvement programmes. The detailed analysis of these traits can inspire more research and be used for genetic improvement in breeding programmes.

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