



Estimation of Least Squares Means and Non-genetic Factors for Reproduction Traits in Frieswal Cattle under Field Progeny Testing

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ABSTRACT

Background: The reproduction traits are quantitative traits governed by polygenic inheritance and influenced by non-genetic managerial factors to a greater extent as their heritability values are low. This investigation was undertaken to study the effect of period and season of calving in Frieswal cattle under field progeny testing programme.

Methods: The data on Frieswal cattle, pertaining to a period of nine years (2013-2021), from field progeny testing were used for this study and the six reproductive traits studied were age at sexual maturity (ASM), age at first calving (AFC), gestation period (GP), first calving interval (FCI), first service period (FSP), first dry period (FDP) and number of services per conception (NSPC). The data analysis was performed using the mixed model least squares and maximum likelihood PC-2. The impact of non-genetic factors on the traits and statistical significance of various fixed effects in the least squares model was determined using the 'F' test in SPSS software. Significant effects were further analyzed by using Duncan's multiple range test (DMRT).

Result: The overall least squares means of 810.59 ± 6.57 , 1088.65 ± 6.57 , 278.06 ± 0.16 , 373.14 ± 0.41 , 95.08 ± 0.45 , 1.47 ± 0.02 and 62.59 ± 0.14 for ASM, AFC, GP, FCI, FSP, FDP and NSPC, respectively, were observed in the present study. The highest and lowest coefficient of variation for NSPC and GP, respectively, showing the extent of variability in population. The effect of period was significant ($P < 0.01$) on ASM, AFC, GP, FCI and FSP whereas effect of season was significant ($P < 0.01$) on GP only. It is concluded that the prevailing location specific climatic conditions of Tarai region of Uttarakhand, with respect to feed and fodder availability influence reproduction performance and also this cattle is well adapted to the seasonal environmental fluctuation of area.

Key words: FPT, Frieswal cattle, Non-genetic factors, Reproduction traits.

INTRODUCTION

The sustained success of a dairy herd relies on the optimal productive and reproductive performance of animals. Key reproductive traits, including age at sexual maturity, age at first calving, gestation period, calving interval, service period, dry period and conception rate, significantly impact the productive lifespan of dairy animals. Reducing age at first calving is crucial for minimizing heifer rearing costs and optimizing milk production expenses. Milk production in dairy cows is a complex trait influenced by genetic factors, environmental interactions and reproductive performance. Enhancing dairy productivity requires a deep understanding of the factors affecting production, composition characteristics (Shah *et al.*, 2021; 2022) and reproduction performance of animals. Research has shown that reproductive performance varies across locations, breeds, production systems and geographic areas (Ahamad *et al.*, 2021), with non-genetic factors like birth year, parity and calving season impacting dairy cattle reproduction (Olawumi and Salako, 2010).

Efficient reproduction is vital for maintaining a viable dairy herd, directly impacting productive lifespan and overall profitability. Understanding the factors influencing reproductive traits is essential for optimizing dairy cattle management and selection strategies. Non-genetic factors, including birth year, parity and calving season, significantly impact reproductive performance, while genetic factors,

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such as breed and genetic makeup, contribute to variations in reproductive efficiency.

Improving reproductive traits can lead to substantial economic benefits, including reduced rearing costs, enhanced milk production and extended productive lifespan. In the context of Frieswal cattle, a popular dairy breed in tropical regions, investigating the effects of non-genetic factors on reproductive traits is critical for informing management decisions and selecting for improved productivity and reproductive efficiency.

This study aims to investigate the influences of non-genetic factors on reproductive traits in Frieswal cattle under a field progeny testing program, providing valuable insights for dairy farmers and breeders, seeking to enhance the productivity and sustainability of dairy operations.

MATERIALS AND METHODS

The data spanning over a period of nine years (2013-2021), pertaining to Frieswal cattle maintained at Pantnagar centre under field progeny testing were utilized for the present study. The classification of data was done into three periods and three seasons *viz.* winter, summer and rainy. US Nagar district of Uttarakhand where Field Progeny Testing (FPT) programme on Frieswal cattle is in progress lies in the Tarai region of the Kumaon division, situated between a latitude of 29°1'N and a longitude of 79°31'E having an elevation around 521 meters. The present study was carried out at G.B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand from 2023-2024. The traits studied were Age at sexual maturity (ASM), Age at first calving (AFC), Gestation period (GP), First calving interval (FCI), First service period (FSP), First dry period (FDP) and Number of services per conception (NSPC).

SPSS Software (version 24) employing the method proposed by Snedecor and Cochran, (1967) was used for estimation of descriptive statistics of the Frieswal cattle dataset. Due to non-orthogonal data caused by unequal and disproportionate subclass frequencies, an analysis was performed using the mixed model least squares and maximum likelihood computer programme PC-2 (Harvey, 1990). The mathematical model aimed to assess the impact of non-genetic factors on the traits under investigation. The statistical significance of various fixed effects in the least squares model was done using the 'F' test in SPSS software. To compare significant differences between pairs of fixed effects, Duncan's multiple range test (DMRT) as modified by (Kramer, 1957) was used.

RESULTS AND DISCUSSION

Descriptive statistics

The descriptive statistics of reproduction traits in Frieswal cattle are reflected in Table 1. The coefficient of variations (CV; %) of all traits ranged from low (1.97) for GP to high (52.86) for NSPC. High variable traits, therefore, have scope for further improvement.

Table 1: Descriptive statistics production and reproduction traits.

Traits	Mean±S.E.	Standard deviation (S.D.)	Coefficient of variation (CV; %)
ASM	810.80±6.34	216.19	26.66
AFC	1089.19±6.34	216.26	19.85
GP	278.39±0.16	5.48	1.97
FCI	373.26±0.42	14.18	3.80
FSP	94.87±0.45	15.31	16.13
NSPC	1.48±0.02	0.78	52.86
FDP	62.54±0.14	4.62	7.39

Least squares means and effect of non-genetic factors in reproduction traits

Age at sexual maturity (ASM)

The least squares means for ASM along with effect of non-genetic factors is reflected in Table 2. An overall estimate of 810.59±6.57 days was observed in the present study. ASM is influenced by body mass and age of animal and is directly associated with lifetime productivity as the heifers which attain puberty at an early age are expected to produce more number of calves and lactation yield. More or less, similar estimates for ASM were reported by Talib *et al.* (2002) in Bali cattle. On the contrary, Uddin *et al.* (2008) in indigenous, Friesian, Sahiwal and Sindhi crossbred cattle and Islam *et al.* (2017) in Sahiwal and Friesian crossbred dairy cows reported lower estimates whereas Islam *et al.* (2017) reported higher estimates in local and crossbred jersey dairy cows. The effect of period was highly significant whereas season was observed to be non-significant on ASM in the present investigation. The lowest and highest estimate of 773.31±11.19 days and 836.33±9.78 days was observed in first and second periods, respectively. From second to third period, the trait presented a slight decrease by 14.2 days. A non-significant effect of season was observed on ASM (Table 2) indicating that Frieswal cattle are adapted to the seasonal fluctuation of Uttarakhand with respect to ASM.

Age at first calving (AFC)

An overall mean of 1088.65±6.57 days with coefficient of variation of 19.85% was estimated in the present study (Table 2). Comparatively higher estimate for AFC was reported by Thombre *et al.* (2002) in HF crossbred cattle. The lower AFC is associated with increased number of lactations and calves in dairy cattle thus overall profitability. The effect of period was highly significant whereas effect of season was non-significant on AFC in the present study. The trait presented an increase followed by decrease from first to second and second to third periods, respectively. The results are in conformity with those of Parveen *et al.* (2018) and Gupta *et al.* (2019). The non-significant effect of season might be due to the fact that the animals were adequately managed across the seasons.

Gestation period (GP)

Mammals possess a characteristic and fixed gestation period with expected species, breed and individual variation (Rather *et al.*, 2022). The least squares means for GP along

Table 2: Effect of genetic and non-genetic factors on reproduction traits.

Effect	N	ASM (Days)	AFC (Days)	GP (Days)	FCI (Days)	FSP(Days)	NSPC(Nos.)	FDP (Days)
Overall	1163	810.59±6.57	1088.65±6.57	278.06±0.16	373.14±0.41	95.08±0.45	1.47±0.02	62.59±0.14
Period	p-value	0.0001**	0.0001**	0.0001**	0.0002**	0.0002**	0.2784NS	0.1131NS
Period 1(2013 to 2015)	370	773.31±11.19 ^a	1052.22±11.19	278.91±0.28 ^b	379.49±0.70	100.58±0.77	1.50±0.04	62.79±0.24
Period 2 (2016 to 2018)	490	836.33±9.78 ^b	1115.45±9.79	279.13±0.24 ^b	371.39±0.61	92.27±0.67	1.51±0.04	62.10±0.21
Period 3 (2019 to 2021)	303	822.13±12.54 ^b	1098.28±12.54	276.15±0.31 ^a	368.55±0.79	92.39±0.86	1.41±0.05	62.89±0.27
Season	p-value	0.5711NS	0.6198NS	0.0061NS	0.1082NS	0.0631NS	0.2784NS	0.4537NS
Winter (November-February)	416	808.29±10.55	1086.74±10.55	278.44±0.26	372.18±0.66	93.73±0.73	1.43±0.04	62.67±0.23
Summer (March-June)	462	800.60±10.09	1079.10±10.10	278.51±0.25	374.09±0.63	95.58±0.70	1.50±0.04	62.62±0.22
Rainy (July-October)	285	822.87±12.88	1100.11±12.89	277.24±0.32	373.16±0.81	95.92±0.89	1.49±0.05	62.48±0.28

*Significant at P≤0.05; NS- Non-significant at P>0.05; **Significant at P≤0.01

with non-genetic effects are reflected in Table 2. An overall estimate of 278.06±0.16 days with very small variation was obtained in the present investigation. The estimates in the present study conformed to those reported for different cattle genetic resources. Bhutkar *et al.* (2014) and Varaprasad *et al.* (2013) in crossbred cattle and Singh *et al.* (2014) in Frieswal reported similar estimates for gestation period. However, Basiel *et al.* (2024) and Prasanna *et al.* (2023) reported comparatively lower estimates for GP in crossbred cattle. The small CV (%) indicated little space for improvement through selection and might be due to the fact that mammals possess typical fixed gestation period with negligible to very low individual variations caused by genetic, nutritional and environmental factors (Rather *et al.*, 2022). The effect of period on the GP was highly significant (P<0.01) while that of season was non-significant (Table 2). The significant effect of period was in conformation with the findings of Bhutkar *et al.* (2014) in crossbred cattle.

First calving interval (FCI)

The overall average calving interval of 373.14±0.41 days with CV of 3.8% (Table 1) was observed in the present study. Lower estimates than the present ones for FCI were observed by Banerjee *et al.* (1996) and Shalaby *et al.* (2013) in Frieswal cattle. However, higher estimates were reported by Singh *et al.* (2014) in Frieswal cattle in crossbred cattle. The effect of period was highly significant (P<0.0002) whereas effect of season was non-significant on the trait. Minimum and maximum FCI was observed in third and first periods, respectively, indicating improvement of the trait over the years. Non-Significant influence of season on the trait was observed in the present study, however, Dash *et al.* (2023) reported significant effect of season on this trait.

First service period (FSP)

The least squares mean for FSP has been shown in Table 2. However, higher estimates were observed by Minj *et al.* (2016), Shalaby *et al.* (2013) in Frieswal cattle and Singh *et al.* (2022) also reported higher estimates for FSP in Sahiwal. The effect of period was highly significant (P<0.0002) whereas effect of season was non-significant on FSP. Similar results were observed by Kumar *et al.* (2003) and Dhaware *et al.* (2008) in indigenous cattle, respectively.

Number of services per conception (NSPC)

Overall least squares mean for NSPC as 1.47±0.02 was observed in the present investigation. Ratwan *et al.* (2019) in Sahiwal cattle and Islam *et al.* (2017) in Friesian (LOxFN) crossbred cattle reported higher estimates for NSPC. Minj *et al.* (2016) in Frieswal cattle reported higher estimates. However, Islam *et al.* (2017) in Sahiwal and Friesian (LOxSLxFN) crossbred cattle reported lower estimates for NSPC. The effect of season and period was found to be non-significant on NSPC. The result with respect to non-significant effect of season on NSPC was in concurrence with Hammoud *et al.* (2010) in Friesian cows. The non-

significant variation in NSPC may be due to the fact that the trait mostly depends upon the expertise of the inseminator in terms of identification of stage of estrus and deposition of semen at the right place.

First dry period (FDP)

Period and season were observed to have non-significant effect on FDP. The similar findings in indigenous cattle were also reported by Rajoriya *et al.* (2014) and Dangi *et al.* (2013) which showed. Higher estimates for FDP in crossbred cattle have also been reported by Baranwal *et al.* (2018) and by Shalaby *et al.* (2013) and Singh *et al.* (2014) in Frieswal.

CONCLUSION

In conclusion, it is observed that the prevailing micro-climatic conditions of Uttarakhand, with respect to feed and fodder availability influence the reproductive performance of cattle and also these cattle are well adapted to the seasonal environmental fluctuation of the area.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

Informed consent has been obtained from all individuals included in the present study.

Conflict of interest

Authors have declared that no competing interests exist.

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