Computation of Heritability for Production and Reproduction Traits in Frieswal Cattle under Field Progeny Testing

ABSTRACT

Aims: To study the genetic parameter (heritability) for production and reproduction traits in Frieswal cattle under field progeny testing programme**.**

Place and Duration of Study: G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India, between March, 2023 and March, 2024.

Methodology: The present study was conducted on 1163 Frieswal cattle comprised of five different sets maintained at six field units over a period from 2013-2021. The traits considered were age at sexual maturity (ASM), age at first calving (AFC), gestation period (GP), test day peak yield (TDPY), 305 days milk yield (305D-MY), fat percentage (FP), lactation length (LL), calving interval (CI), service period (SP), number of services per conception (NSPC), dry period (DP). The data were analyzed for the estimation of heritability by the software WOMBAT.

Results: The heritability estimates of the traits namely; ASM, AFC, GP, TDPY, 305D-MY, FP, LL, CI, SP, NSPC and DP were 0.469±0.082, 0.467±0.082, 0.259±0.067, 0.248±0.059, 0.354±0.013, 0.413±0.069, 0.389±0.071, 0.394±0.071, 0.452±0.072, 0.072±0.046 and 0.08±0.06 respectively.

Conclusion: Therefore, the heritability estimates were found to be low to high magnitude for different reproduction and production traits and further it has been concluded that, this study will aid breeders in selecting high-performing animals for future generations, taking into account the genetic factors that influence milk production and reproductive traits during early lactation.

Key words: Frieswal, Heritability, Production traits, Reproduction traits

1. INTRODUCTION

Frieswal is a synthetic strain of cattle developed by crossing Holstein Friesian (62.5%) and Sahiwal (37.5%) at military dairy farms with an objective of milk yield of 4000, 4500 and 5000 kg milk yield in first, second and third lactation, respectively, with 4% fat in a standard lactation length of 305 days [4]. The progeny-testing initiative commenced during the Third Five-Year Plan at the cattle breeding farm in Hissar, focusing initially on Hariana cows. This programme aimed to guarantee the production and recognition of high-quality bulls with known genetic merit. Rather than relying solely on the yield of their dams, the programmeevaluated bulls based on the actual performance of their progeny [12].The genetic makeup of a population can be examined by assessing the comparative significance of hereditary influences and environmental factors on the performance of individuals within that population [19]. To evaluate the performance, variation concerning both genetic and non-genetic influences, it's essential to obtain estimates of phenotypic and genetic parameters. This enables the utilization of genetically determined variations for enhancing traits and exploring potential associations between different characteristics [52].Assessing the extent of additive genetic variability in economically important traits provides insight into the potential for genetic enhancement of those traits through selective breeding [5].The present investigation was conducted to compute the heritability among different production and reproduction traits in Frieswal cattle under field progeny testing.

2. MATERIAL AND METHODS

2.1 Source of data and data collection

Data of 1163 first lactation records of Frieswal cows sired by 69 sires spread over a period of 9 years(2013-2021) maintained at Animal Genetics and Breeding Division, GBPUA&T, Pantnagar, under the pre-existing All India Coordinated Research Project (AICRP) on progeny testing were used for present investigation. The Field Progeny Testing (FPT) programmefor Frieswal cattle in the Udham Singh Nagar district of Uttarakhand was launched by ICAR-CIRC, Meerut (Uttar Pradesh). This district is situated in the Tarai region of the Kumaon division, positioned approximately between 29º 1' N latitude and 79º 31' E longitude, with an average elevation of approximately 521 meters.

2.2 Data editing

Records of animals with known pedigree and normal lactation were taken into account. Any instances of culling, mid-lactation disposal, abortion, stillbirth, or pathological conditions impacting lactation yield were regarded as abnormalities and thus excluded from the analysis. Animals producing less than 1500 kg of milk and having a lactation length shorter than 200 days were also not included in the study.

2.3 Traits studied

A total of eleven traits viz., 305-days milk yield (305D-MY), Test day peak yield (TDPY), Fat percentage (FP), Lactation length (LL), Age at sexual maturity (ASM), Age at first calving (AFC), Gestation period (GP), Calving interval (CI), Service period (SP), Dry period (DP) and Number of services per conception (NSPC) were studied.

2.4 Statistical analysis

Paternal half-sib correlation (intra-sire correlation among daughters) method as described by [8] was used to estimate the heritabilities of different traits. The following statisticalmodel was used:

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where,

Y_{ij} = Adjusted value of j^{th} progeny of i^{th} sire, μ = Overall population mean, S_i = Effect of i^{th} sire, e_{ij} = Random error, assumed to be normally and independently distributed with mean zero and constant variance i.e. NID $(0, \sigma_e^2)$

The standard error of heritability is determined by following the procedure outlined by [56]:

$$SE = \frac{\sqrt[4]{2(n-1)(1-t^2)(1+(k-1)t^2)}}{\sqrt{K^2(N-S)(S-1)}}$$

Where,

t = intra-class correlation, S = number of sire, N = total number of observation

K = average number of progeny per sire

3. RESULT AND DISCUSSION

The table 1 shows the heritability estimates for various production and reproduction traits in Frieswal cattle under field progeny testing programme.

3.1 Age at Sexual Maturity (ASM)

This trait was observed to have moderately high heritability, indicating that a considerable portion of the variation in age at sexual maturity among Frieswal cattle is due to genetic factors.Selective breeding can be employed to target early sexual maturity, which can lead to earlier breeding age and increased lifetime productivity in the herd.There are few or scanty literature available on estimation of this genetic parameter of age at sexual maturity. [58] in Brahman cattle, [54] and [38] in crossbred cattle have reported almost similar estimates. [37]found even high estimate than the ones observed in the present study. However, [1] reported lower estimate in crossbred cattle than found in the present study.

3.2 Age at First Calving (AFC)

Similar to age at sexual maturity, age at first calving also exhibited a moderately high heritability, suggesting that genetic factors significantly influenced the timing of the first calving. Early calving age is desirable for efficient dairy production, as it allows for more lactation cycles over the lifetime of the cow.[6] reported almost similar estimate in Frieswal cattle.[11], [26] and [43] reported lower estimate in crossbred cattle, and [62]in Holstein Friesian cattle. [10] and [31] reported low estimate in Frieswal cattle. [7] reported very low estimate in Sahiwal cattle than the present study.

3.3 Gestation Period (GP)

Heritability estimate for gestation period was found to be relatively low compared to production traits, indicating that genetic factors play a smaller role in determining the length of pregnancy.Management practices such as nutrition and health care may have a more substantial impact on gestation period compared to genetic selection.The heritability estimate of gestation period in the present study was in agreement with the reports of [2], [13] and [27] in Holstein Friesian and crossbred cattle, respectively. [47] also reported similar estimate in Sahiwal cattle. [50], [36] and [48] reported lower estimate in Sahiwal cattle than the present study. [42] and [18] reported higher estimate in Holstein Friesian cattle.

3.4 Test Day Peak Yield (TDPY)

Test day peak yield also exhibited moderate heritability, suggesting that genetic factors contribute to a significant extent to the maximum milk yield recorded on a single test day during lactation.Selective breeding for higher peak yields can lead to increased overall milk production in the herd. [49] and [21] in crossbred cattle and [41] inHolstein Friesian cattle reported similar estimate. [21] in Sahiwal cattle and [15]in Frieswal cattle reported higher heritability estimate than found in the present study. [45] and [48] reported lower estimate in Holstein Freisian and Sahiwal cattle, respectively. [34] and [32] reported lower estimate in Frieswal.

3.5 305 Days Milk Yield (305D-MY)

Relatively higher heritability of 305 days milk yield indicated that genetic factors played a substantial role in determining the total milk production over a standardized lactation period. Selective breeding for higher milk yield can result in improved productivity in Frieswal cattle.[3], [21] and [26] reported similar estimate in Phule Triveni and crossbred cattle, respectively. [53] reported similar estimate in Karan Fries cattle. [16], [44], [48] and [14] reported lower estimate in Karan Fries and Sahiwal cattle, respectively. [18]reported similar estimate in Holstein Friesian cattle. [33] and [52], however, reported high estimate in crossbred and Karan Fries cattle, respectively.

Table 1. Heritability for Production and Reproduction Traits in Frieswal Cattle (N=1163)

S.N.	Traits	h^2±S.E.	Abbreviation
1	Age at Sexual Maturity	0.469±0.082	ASM
2	Age at First calving	0.467±0.082	AFC
3	Gestation Period	0.259±0.067	GP
4	Test Day Peak Yield	0.248±0.059	TDPY
5	305 Days Milk Yield	0.354±0.013	305D-MY
6	Fat Percentage	0.413±0.069	FP
7	Lactation Length	0.389±0.071	LL
8	Calving Interval	0.394±0.071	CI
9	Service Period	0.452±0.072	SP
10	Number of Services Per Conception	0.072±0.046	NSPC
11	Dry Period	0.08±0.06	DP

3.6 Fat Percentage (FP)

Fat percentage in milk was observed to have moderately high heritability, suggesting that genetic factors influence the proportion of fat content in the milk produced by Frieswal cattle. Selective breeding can be employed to enhance milk composition, targeting higher fat content if desired by the market.[55] reported similar estimate in Holstein Friesian cattle. [24] in Holstein Friesian cattleand [23] in crossbred cattle reported higher estimates of heritability than found in the present study.[61] and [57] have reported lower heritability estimate in crossbred cattle.

3.7 Lactation Length (LL)

Lactation length had moderately high heritability estimate (Table 1), which indicated that genetic factors significantly influenced the duration of milk production during a lactation cycle.Selective breeding for longer lactation lengths can lead to increased milk production efficiency in the herd. [11], [59], [30] and [26] reported lower estimate in crossbred cattle. [18] reported higher estimate in Holstein Friesian cattle. [46] and [28] reported higher estimate in Sahiwal cattle.

3.8 Calving Interval (CI)

Calving interval exhibited a moderately high heritability (0.394±0.071). Similar findings have also been reported by [11] in crossbred cattle. Moderately high heritability for calving interval suggested that genetic factors play a significant role in determining the time between consecutive calvings.Selective breeding for shorter calving intervals can improve reproductive efficiency and overall herd productivity.[29] and [40] reported low estimates in Frieswal cattle. [18] and [26]also reported lower estimates in Holstein Friesian and crossbred cattle. [17] and [39] reported high heritability estimate of calving interval in crossbred cattle.

3.9 Service Period (SP)

The heritability value of service period was observed to be as0.452±0.072 which was moderately high.[20] and [35] also found similar estimates in Frieswal and crossbred cattle, respectively. Service period is a reproductive trait which is lowly heritable, however, the high estimate in the present study indicated greater influence of genetic factors on this trait inFrieswal cattle.[40] in Frieswal cattle [26] in crossbred cattle, [18]in Holstein Friesian and [48] and [14] in Sahiwal cattle reported low estimates.

3.10 Number of Services per Conception (NSPC)

This trait being reproductive in nature, was found to have low heritability(0.072±0.046), which suggested that genetic factors had minor role in determining the successful conception. [22], [9] and [62] have reported similar heritability estimates in Holstein Friesian cattle. [47] reported higher estimate in Sahiwal and [36] reported slightly high estimate in Sahiwal cattle than the present study. [62] reported low estimate in Holstein Friesian cattle than the presentstudy. [60] reported low estimate and [32] reported high estimate in crossbred cattle. Now-a-days, artificial insemination technique is adopted for inseminating cattle, therefore, number of services depends upon the skill of AI worker in recognition of appropriate heat and deposition of semen at an appropriate site in female reproductive tract. In addition to this, other managemental practices such as reproductive health may also have a more significant impact on this trait compared to genetic selection.

3.11 Dry Period (DP)

Dry period had an extremely low heritability (Table 1). [25] in Sahiwal cattle and [48] in Sahiwal cattle reported similar estimates of heritability. [26] reported higher estimate in crossbred and [46] reported high estimates in Sahiwal cattle. The heritability estimate in the present study suggested that genetic factors had negligible influence on the length of the dry period.Management practices such as nutrition and udder health management are crucial for determining the optimal dry period length in dairy cows.

4. CONCLUSION

In summary, understanding the heritability of production and reproduction traits is essential for designing effective breeding programmes aimed at improving overall productivity, reproductive efficiency. By focusing on traits with higher heritability, such as milk yield, fat percentage, and reproductive performance, breeders can make more informed decisions to genetically enhance the traits of interest in the population.

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