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Genetics and Phenotypic Analysis of First Lactation Production, Reproduction and Part Lactation Traits in Frieswal Cattle

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ABSTRACT

Background: The Frieswal cattle a crossbred cattle breed having 62.50 per cent of exotic (inheritance) having total lactation milk yield of 4000 Kg with average lactation length 300 days (PDC Annual Report, 2015-16). Presently, the Frieswal Animal is mainly maintained at 36 Military Farms located in various agro-climatic regions in the country.

Methods: The present study was undertaken on first Part lactation production, reproduction and part lactation records of 1470 Frieswal cows maintained over a period of 10 years (2003-2012) two military farms *viz* Meerut and Ambala at CIRC, Meerut.

Result: The estimate the heritability of production and reproduction traits were 0.29 ±0 .098,0.142±.081, 0.130±0.079, 0.087 ±.074, 0.631 ± 0.255, 0.345 ± 0.247 and 0.100 ± 0.153 for standard 305 days milk yield, age of first calving (AFC), First lactation total milk yield (FLMY), First lactation 305-day or less milk yield (FL305DMY), First lactation length (FLL), Inter calving interval (ICI), First dry period (FDP), First Service Period (FSP), respectively. All the genetic and phenotypic correlation among different production and reproduction traits were high and positive. The estimates of heritability of first lactation individual part monthly yields in Frieswal cattle were found to be 0.100 ± 0.069, 0.105 ± .070, 0.100 ± 0.069, 0.112 ± 0.071, 0.204 ± 0.086, 0.160±0.079, 0.176 ± 0.081, 0.221 ± 0.088, 0.213 ± 0.087 and 0.192 ± 0.09, respectively.

Key words: Frieswal cow, Genetic and phenotypic correlation, Heritability.

INTRODUCTION

The Frieswal cattle a crossbred cattle breed having 62.50 per cent of exotic (inheritance) having total lactation milk yield of 4000 Kg with average lactation length 300 days (PDC Annual Report, 2015-16). Presently, the Frieswal Animal is mainly maintained at 36 Military Farms located in various agro-climatic regions in the country. Animal Husbandry in India is predominantly rural based and it provides employment opportunity, nutritional security and steady income to majority of the rural agricultural masses. It is also an important subsidiary enterprise to agriculture as it plays a significant role in contributing to the national economy in general and rural economy in particular. The contribution of livestock sector to the national Gross Domestic Product at current prices during the year 2013-14 was 4.1 per cent while the contribution of whole agricultural sector including livestock sector was 13.9 per cent.

The genetic potential of Indian cattle for milk production can be increased either by selective breeding among native stock or by crossing

The success of any breed improvement programme depends on the selection of genetically superior sires, as semen of bulls is disseminated in various herds under progeny testing programme. Earlier studies around the world on the mode of genetic improvement indicated that the selection of genetically superior bulls would bring about more than 75 per cent of the actual genetic improvement.

MATERIALS AND METHODS

The performance records of 1470 Frieswal cows were collected for generating the first lactation production, reproduction and part lactation traits maintained at Military Dairy Farm, Meerut Uttar Pradesh over a period of eight years (2006-2013) were utilized for the present. The heritability, genetic and phenotypic correlations were estimated only from those progeny groups of sires having three or more daughters. The data of Production and Reproduction were analyzed for the heritability, genetic and phenotypic Coefficients by the method of paternal half sib correlation (intra-sire correlation among daughters) by Becker (1975) was used to estimate the heritability of different traits.

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

Where,

Y_{ij} = Adjusted value of j^{th} progeny of i^{th} sire.

μ = Overall population mean.

S_i = Effect of i^{th} sire, N (0, σ_S^2).

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e_{ij} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e.* NID (0, σ_e^2).

The S_i and e_{ij} are assumed to be independent of each other.

For other first and part lactation traits.

$$Y_{ijklm} = \mu + F_i + S_j + P_k + A_l + e_{ijklm}$$

Where,

Y_{ijklm} = Dependent trait of m^{th} cow born at i^{th} farm in j^{th} season, k^{th} period and l^{th} age group.

μ = Overall mean.

S_i = Effect of i^{th} farm.

F_j = Effect of j^{th} season.

P_K = Effect of k^{th} period.

A_e = Effect of l^{th} age group.

e_{ijklm} = Random error, assumed to be normally and independently distributed with mean zero and constant variance *i.e.* NID (0, σ_e^2).

RESULTS AND DISCUSSION

The estimates of heritability of various first lactation traits and part lactation traits had presented in Table 1 and 2. Critical review of these tables concluded that the heritability estimates for production reproduction traits *viz*., AFC, FLMY, FLL, First, FDP, FSP and CI were 0.29 ±0 .098,0.142±.081, 0.130±0.079, 0.087 ±.074, 0.631 ± 0.255, 0.345 ± 0.247 and 0.100 ± 0.153 while the estimates of heritability of first lactation individual part monthly yields were found to be 0.100 ± 0.069, 0.105 ± .070, 0.100 ± 0.069, 0.112 ± 0.071, 0.204 ± 0.086, 0.160±0.079, 0.176 ± 0.081, 0.221 ± 0.088, 0.213 ± 0.087 and 0.192 ± 0.09, respectively. From the many authors were concluded that first lactation production and reproduction and part lactation traits were low to moderate estimates of heritability. So, individual selection and/or progeny testing could be a tool for bringing out desirable changes in these traits. Except few authors, all reproduction traits showed low estimates of heritability which indicated that these traits can be improved by better managemental practices. The estimate obtained in the present study was near to the results reported by Mukherjee. S. (2005) in different HF crossbred cattle. However, Saha (2001) and Rathee (2015) heritability estimates lower than the present study while Nehra (2011) Divya (2012) and Das (2014) reported higher estimates.

Estimates of genetic and phenotypic correlations

The available literature related to the genetic and phenotypic correlations among and within various productions, reproductions and part lactation traits had been reviewed. The genetic correlations of AFC with FL305DMY, FLMY, FLL, FDP, FSP and ICI were low to highly positive and statistically non-significant and were unreliable and unrealistic due to higher estimate of standard errors. The phenotypic correlations of AFC with all other first lactation traits considered in the study were low and significantly indicating that the AFC was phenotypically independent of all other first lactation traits considered in the study in Frieswal cattle. Contrary to the present findings, Goshu (2014) reported negative and not significantly different from zero genetic correlation between AFC and FCI in Holstein Friesian cows. The phenotypic correlation between AFC and FCI was found to be low (-0.024 ± 0.061), negative and not significantly different from zero. Similar to the present findings, Goshu (2014) also reported low and not significantly different from zero phenotypic correlation between these two traits in Holstein Friesian cattle. Whereas, Banik (2004) also reported similar results in various crossbred cattle herds. The genetic correlation of FL305MY between FLMY was considered not estimable as the estimate obtained was higher than unity. The high and significant genetic correlation between FLMY and FL305DMY was reported by Mukherjee (2005) and Rathee (2015) in Frieswal cattle. On other hand, FLMY with FLL, FSP, FDP, were positive correlation and FL305DMY with FCI was negative (-0.775±0.252) and statistically highly significant (P<0.01). The phenotypic correlation of FL305MY with FLMY, FLL, FLL, FSP, FDP and FCI were Positive statistically significant (P<0.05). Similar to this finding, significant phenotypic correlation between these two traits was also reported by Mohanty (2001), Kannan (2002), Kumar, (2003), Banik (2004) and Raja (2010). On the contrary, Kumar (2007) reported non-

Table 1: Heritability, genetic and phenotypic correlation estimates of various first lactation production and reproduction traits in Frieswal cattle.

Traits	AFC	FLMY	FL305DMY	FLL	FCI	FDP	FSP
AFC	**0.29±0 .098***	0.325±0.308^{NS}	0.308±.323 ^{NS}	0.417±.444 ^{NS}	0.015±0.337 ^{NS}	0.376±.458 ^{NS}	0.045±.514 ^{NS}
FLMY	0.110±0.034**	**0.142±.081^{NS}**	NE	0.444±.279^{NS}	0.794±0.280**	0.850±1.503 ^{NS}	0.580±0.552 ^{NS}
FL305DMY	0.111±0.034**	0.991±0.005**	**0 .130±0.079^{NS}**	0.371±.487^{NS}	-0.775±0.252**	0.956±1.593^{NS}	0.584±0.567^{NS}
FLL	0.003±0.034^{NS}	0.279±0.032**	0.180±0.033**	**0.087±.074^{NS}**	NE	-0.194±1.857 ^{NS}	0.279±0.644 ^{NS}
FCI	-0.024±0.061^{NS}	0.073±0.061^{NS}	0.060±0.061^{NS}	0.200±0.056**	**0.631±0.255***	0.872±0.202**	NE
FDP	0.023±0.068^{NS}	0.134±0.061*	0.139±0.067*	0.009±0.068^{NS}	0.771±0.043**	**0.345±0.247 ^{NS}**	NE
FSP	NE	0.250±0.058**	0.240±0.056**	0.452±0.052**	NE	NE	**0.100±0.153 ^{NS}**

AFC = Age at first calving; FLMY = First lactation total milk yield; FL305DMY = First lactation 305-day or less milk yield; FLL = First lactation length; ICI = Inter calving interval; FDP = First dry period; FSP= First Service Period.

Figures along the diagonal in bold scripts are the heritability estimates; Figures above the diagonal are the genetic correlations; Figures below the diagonal are the phenotypic correlations.

** - Significant at 1% level (P< 0.01); *- Significant at 5% level (P< 0.05); NS- Non-significant.

significant phenotypic correlation between FL305DMY and FDP in Sahiwal cattle. The genetic correlation between FLMY and FLL was high but statistically non-significant (0.444±0.279). Similar to the present findings, Rathee (2015) also reported high (0.51±0.374) but not significant genetic correlation of FLMY with FLL in Frieswal. Mukherjee (2005) also reported high genetic correlation between these two traits in Frieswal cattle. The Phenotypic correlation between FLMY and FLL was low and highly significant (0.279±0.032) with low standard error. Similar to the present findings, a high and highly significant phenotypic correlation of FLMY with FLL was observed by Rathee (2015) in Frieswal cattle. The genetic correlation of FLL with FDP, FSP, was low to highly positive and FLL with FCI was not estimated as the estimate was higher than unity. However, Saha (2010) reported a low and non-significant genetic correlation between FLL and FCI in Karan Fries cattle. The phenotypic correlation between these two traits was highly significant. Similar to the present findings, Mohanty (2001), Kannan (2002), Kumar (2003), Banik (2004), Kumar (2007), Chander *et al.* (2008) and Manoj (2009). The genetic correlation between FDP and FSP was non-estimable. Saha (2010) reported a medium and non-significant genetic correlation between these two traits in Karan Fries cattle. On other hand, the Genetic correlation between FDP and ICI was found to be high, positive and highly significant (0.872±0.202) in Frieswal cattle. On the contrary, Saha (2010) reported a high and highly significant but negative genetic correlation between these two traits in Karan Fries cattle. The phenotypic correlation between FDP and FSP was found to be non-estimable. Most of the workers Banik, 2004; Raja, 2010; Kumar, 2007; Chander *et al.,* 2008; Saha, 2010) reported highly significant phenotypic correlation between these two traits. The phenotypic correlation between FDP and ICI was found to be high, positive and highly significantly (0.771±0.043) in Frieswal cattle. The genetic and phenotypic correlations between FSP and FCI were non estimable. On the contrary, Saha (2010) reported a medium and non-significant genetic correlation and high, positive and highly significant phenotypic correlation between these two traits in Karan Fries cattle.

The estimates of heritability of first lactation individual part monthly yields in Frieswal cattle were found to be 0.100±0.069, 0.105±.070, 0.100±0.069, 0.112±0.071, 0.204±0.086, 0.160±0.079, 0.176±0.081, 0.221±0.088, 0.213±0.087 and 0.192±0.09, respectively. The lowest heritability estimate of 0.100 was obtained for the individual first and third month yields while the highest estimate of 0.221 was observed for individual eight month yield. Significant (P<0.05) heritability estimates were observed for individual 5th, 7th, 8th, 9th and 10th month milk yields and for all other months the estimates were statistically non-significant Table. The heritability estimates for early months were low and from 4th months onwards showed an increasing trend up to 8th months and declined thereafter. However, the heritability estimate of 5th month was comparatively higher than 6th and 7th month part yields.

Table 2: Heritability, genetic and phenotypic correlation estimates of various individual monthly milk yields in Frieswal cattle.

Traits	1st Month MY	2nd Month MY	3rd Month MY	4th Month MY	5th Month MY	6th Month MY	7th Month MY	8th Month MY	9th Month MY	10th Month MY
1st Month MY	**0.100±0.069^{NS}**	0.634±0.256*	0.460±0.362^{NS}	0.403±0.376^{NS}	0.201±0.371^{NS}	-0.020±0.456^{NS}	-0.203±0.388^{NS}	-0.288±0.339^{NS}	-0.210±0.363^{NS}	-0.851±0.58^{NS}
2nd Month MY	0.865±0.022**	**0.105±0.070^{NS}**	0.983±0.044**	0.945±0.095**	0.754±0.165**	0.588±0.252*	0.481±0.290^{NS}	0.390±0.302^{NS}	0.551±0.278^{NS}	0.284±0.50^{NS}
3rd Month MY	0.775±0.025**	0.924±0.013**	**0.100±0.069^{NS}**	NE	0.978±0.084**	0.847±0.141**	0.765±0.185**	0.625± 0.233*	0.756±0.243*	0.579±0.37^{NS}
4th Month MY	0.697±0.027**	0.837±0.019**	0.920±0.014**	**0.112±0.071^{NS}**	0.971±0.046**	0.823± 0.125**	0.971±0.046**	0.611±0.218*	0.709±0.232*	0.393±0.39^{NS}
5th Month MY	0.641±0.035**	0.776±0.022**	0.844±0.019**	0.926±0.013**	**0.204±0.086***	0.978±0.027**	0.905±0.066**	0.814±0.105**	0.836±0.141**	0.251±0.47^{NS}
6th Month MY	0.611±0.027**	0.726±0.024**	0.783±0.022**	0.857±0.018**	0.933±0.012**	**0.160±0.079^{NS}**	NE	0.968±0.048**	NE	0.228±0.50^{NS}
7th Month MY	0.566±0.028**	0.671±0.026**	0.719±0.024**	0.790±0.021**	0.869±0.017**	0.941±0.012**	**0.176±0.081***	NE	NE	0.180±0.53^{NS}
8th Month MY	0.528±0.029**	0.624±0.027**	0.652±0.026**	0.711±0.024**	0.795±0.021**	0.866±0.017**	0.927±0.013**	**0.221±0.088***	0.969±0.057**	0.136±0.69^{NS}
9th Month MY	0.429±0.031**	0.488±0.030**	0.481±0.030**	0.504±0.030**	0.567±0.028**	0.635±0.027**	0.683±0.025**	0.791±0.021**	**0.213±0.087***	0.915±0.17^{NS}
10th Month MY	0.307±0.035**	0.372±0.12**	0.392± 0.03**	0.405±0.030**	0.473±0.030**	0.509±0.04**	0.535±0.020**	0.619±0.030**	0.687±0.090**	**0.192±0.09***

Figures along the diagonal in bold scripts are the heritability estimates.
Figures above the diagonal are the genetic correlations.
Figures below the diagonal are the phenotypic correlations.
** - Significant at 1% level (P< 0.01); * - Significant at 5% level (P< 0.05).

In general, the heritability estimates obtained in the present study were low for the early monthly yields, while for the mid and later monthly yields the estimates were moderately high. These results suggested that differences between cows other than additive genetic effects appear to affect milk production less in later stage of lactation than in early lactation. Similar to the present findings, Singh *et al.* (1990) reported highest heritability for 7th month yield in Sahiwal cattle. Raja (2010) reported higher estimate of heritability for individual 2nd month part yield in Sahiwal cattle.

Genetic and phenotypic correlations individual monthly yields

The genetic and phenotypic correlations among various individual monthly milk yields are presented in (Table 2). In general, the genetic correlations between various individual monthly yields were positive and apparently high and majority of the estimates were close to unity and some were higher than one. However, negative genetic correlations between few individual monthly milk yields were also observed. It was observed that there were relatively higher genetic correlations among the adjacent individual monthly milk yields compared to distant ones. Most of the genetic correlations between the individual monthly milk yields in showed statistically highly significant (P<0.01) estimates. However, the individual 1st and 10th month milk yields had low and non-significant genetic correlation with other individual monthly yields.

The results of the study revealed positive and statistically highly significant (P<0.01) phenotypic correlations among various individual monthly milk yields in Frieswal cattle. Generally, the phenotypic correlation among various individual monthly milk yields followed a definite trend as the estimates were higher for the adjacent monthly yields and decreased with increase in the gap between months. Banik and Raja (2010) reported high and positive genetic and phenotypic correlations between different individual monthly milk yields in various breeds of cattle.

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