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Genetic analysis of production and reproduction traits in Karan Fries and Karan Swiss cattle

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The extent of genetic variation existing in herd(s) helps in deciding appropriate selection and mating procedure. The estimates of phenotypic and genetic parameters are required to evaluate the variation in performance with respect to genetic and non-genetic factors, so that genetically determined variation can be utilized for improvement of characteristics and to investigate any association that exists between the characters. Present study therefore was aimed to estimate genetic parameters for important economic traits in closed herd of Karan Fries and Karan Swiss cattle.

The investigation was carried out on 656 Karan Fries (Holstein Friesian bulls × Tharparkar cows) and Karan Swiss (Brown Swiss bulls × Sahiwal cows) developed at the National Dairy Research Institute, Karnal, born during1980 to 1990 and calved during 1982 to 1992. Data with lactation length less than 100 days/ incomplete or abnormal records were excluded from the analysis. Data were classified into 5 periods of 2 years each except the 6 period (3 years due to small number). The year was sub divided into 5 seasons i.e. winter (Dec-Jan), spring (Feb-March), summer (April-June), rainy season (July-September) and autumn (Oct.-Nov) based on relative humidity and ambient temperature. Data were adjusted for non-genetic effects (period and seasons of calving) estimated by least-squares method (Harvey 1975). The sires, which had a minimum of 5 daughters with performance records, were included in the analysis and minimum 2 or more lactation performances were utilized for estimating expected breeding value (EBV) and expected breeding efficiency (EBE) estimated as per Wilcox *et al.* (1957). The heritabilities, genetic and phenotypic correlation s were obtained by the paternal half-sib correlation method (Becker 1986).

The least-squares means and coefficient of variation of economic traits in Karan Fries and Karan Swiss cattle are shown in Table 1. The average age at first calving (AFC) of

Table 1. Least-squares means and coefficient of variation (CV%) of performance traits in Karan Fries and Karan Swiss cattle.

Trait (s)	*Karan Fries*		*Karan Swiss*	
	Mean±SE	CV%	Mean±SE	CV%
AFC (days)	978±10	14	1009±14	14
FLY (kg)	3173±82	26	2616±82	29
TFLY (kg)	3677±135	33	2952±120	38
FLL (days)	346±10	26	328±9	25
FSP (days)	143±11	62	148±12	66
FDP (days)	75±6	64	103±7	72
FCI (days)	423±11	21	436±13	22
MY/FLL (kg)	10.7±0.2	23	8.9±0.2	25
MY/CI (kg)	8.9±0.2	26	7.2±0.3	28
EBV (kg)	3380±26	7	2924±38	9
EBE (%)	88.21±4.00	15.00	86.0±3.96	18.04

Karan Fries heifers was lower, first lactation yield 305 days (FLY), total first lactation yield (TFLY), milk yield per day of first lactation length (MY/FL) and milk yield per day of first calving interval (MY/FCI), were little higher and first lactation length (FLL), first service period (FSP), first dry period (FDP), first calving interval (FCI), were comparable to the estimates reported by Jadhav *et al.* (1991), Raheja (1994) and Singh *et al.* (2000). The coefficient of variation in TFLY was 7 and 8.5% higher than that of FLY in Karan Fries and Karan Swiss, because TFLY is based on actual lactation length which was 8.5% higher than standard lactation length of 305 days. It is because many cows did not settle in pregnancy in time after calving and so the effect of managemental factors are expected to be higher and hence, there was more variation in TFLY. The high coefficient of variation for first lactation milk production traits (23–38%) and very high for FSP and FDP (62 –72%) indicated the presence of large variation in these herds which could be exploited for improvement.

Heritability estimates of Karan Fries and Karan Swiss cattle

The heritability of age at first calving, first lactation yield,

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Table 2. Heritability, phenotypic and genetic correlations of performance traits in Karan Fries and Karan Swiss cattle

Traits	AFC	FLY	TFLY	FLL	FSP	FDP	FCI	MY/ FLL	MY/ FCI	EBV	EBE
					Karan Fries						
AFC	0.82 ±0.21	0.33** ±0.04	0.29** ±0.04	0.20** ±0.04	0.09 ±0.04	0.88** ±0.04	0.20* ±0.04	0.35** ±.04	0.35** ±0.04	0.16** ±0.04	–0.07 ±0.05
FLY	0.68 ±0.12	0.41 ±0.13	0.86** ±0.02	0.45** ±0.03	0.19* ±0.05	–0.13* ±0.04	0.19* ±0.04	0.87** ±0.02	0.86* ±0.02	0.94** ±0.02	–0.25* ±0.05
TFLY	0.68 ±0.13	0.97 ±0.01	0.34 ±0.12	0.74** ±0.27	0.05 ±0.04	–0.08 ±0.04	0.06 ±0.03	0.89** ±0.04	0.92** ±0.02	0.97** ±0.01	–0.41* ±0.03
FLL	0.29 ±0.34	0.29 ±0.33	0.50 ±0.28	0.097 ±0.07	0.80** ±0.03	–0.03 ±0.04	0.85** ±0.02	0.11** ±0.04	0.23** ±0.04	0.43 ±0.28	0.92** ±0.06
FSP	–0.18 ±0.32	–0.17 ±0.33	0.01 ±0.03	0.88 ±0.14	–0.01 ±0.07	0.35** ±0.04	0.87** ±0.02	–0.09* ±0.04	–0.08* ±0.04	0.10* ±0.04	–0.73** ±0.03
FDP	–0.25 ±0.31	–0.58 ±0.24	–0.39 ±0.41	–0.36 ±0.50	0.47 ±0.43	0.01 ±0.08	0.38** ±0.04	–0.07 ±0.04	–0.32** ±0.04	–0.11* ±0.05	–0.30* ±0.04*
FCI	–0.35 ±0.045	–0.29 ±0.43	0.01 ±0.05	0.82 ±0.25	0.98** ±0.36	0.38 ±0.64	0.00 ±0.07	0.09 ±0.04	0.02 ±0.04	0.13* ±0.05	–0.76** ±0.04
MY/ FLL	0.59 ±0.14	0.95 ±0.01	0.70 ±0.02	0.03 ±0.34	–0.44 ±0.29	–0.48 ±0.25	–0.48 ±0.35	0.51 ±0.15	0.84** ±0.02	0.69** ±0.03	–0.05 ±0.03
MY/ FCI	0.72 ±0.12	0.95 ±0.01	0.76 ±0.02	0.05 ±0.41	–0.31 ±0.33	–0.61 ±0.24	–0.31 ±0.44	0.97 ±0.01	0.41** ±0.14	0.62** ±0.03	–0.03 ±0.05
EBV	0.71 ±0.10	0.74 ±0.03	0.64 ±0.03	0.43 ±0.28	0.43 ±0.20	0.68 ±0.19	0.69 ±0.26	0.96 ±0.01	0.94 ±0.02	0.57 ±0.18	–0.18** ±0.04
EBE	–0.22 ±0.28	–0.13 ±0.35	–0.55 ±0.04	–0.91 ±0.06	–0.58 ±0.57	0.12 ±0.71	–0.74 ±0.28	–0.09 ±0.33	–0.22 ±0.35	–0.29 ±0.27	0.02 ±0.12

Traits	AFC	FLY	TFLY	FLL	FSP	FDP	FCI	MY/ FLL	MY/ FCI	EBV	EBE
					Karan Swiss						
AFC	0.63 ±0.18	0.16** ±0.05	0.12** ±0.05	0.07 ±0.05	–0.03 ±0.05	0.04 ±0.05	0.07 ±0.05	0.17** ±0.05	0.18** ±0.05	0.20** ±0.05	0.14** ±0.05
FLY	0.19 ±0.05	0.49 ±0.17	0.89** ±0.02	0.53* ±0.04	0.17* ±0.05	–0.28* ±0.05	0.18** ±0.05	0.83** ±0.02	0.88** ±0.01	0.80** ±0.03	–0.15* ±0.05
TFLY	0.31 ±0.20	0.97 ±0.02	0.42 ±0.18	0.71** ±0.03	0.39** ±0.04	–0.21** ±0.05	0.41** ±0.04	0.75** ±0.03	0.78** ±0.03	0.66** ±0.02	–0.38** ±0.05
FLL	0.69 ±0.13	0.67 ±0.15	0.83 ±0.08	0.19 ±0.12	0.67** ±0.05	–0.71* ±0.05	0.75** ±0.03	0.22** ±0.05	0.30** ±0.05	0.36** ±0.05	–0.45** ±0.05
FSP	0.43 ±0.23	–0.25 ±0.35	–0.48 ±0.36	–0.94 ±0.13	–0.10 ±0.08	0.43** ±0.05	0.91** ±0.02	0.01 ±0.05	–0.04 ±0.05	0.03 ±0.05	–0.56** ±0.05
FDP	–0.52 ±0.34	–0.26 ±0.48	–0.63 ±0.38	–0.76 ±0.30	–0.45 ±0.56	0.01 ±0.02	0.57** ±0.04	–0.24** ±0.05	–0.47** ±0.05	–0.34** ±0.06	–0.30** ±0.05
FCI	0.31 ±0.24	–0.32 ±0.28	–0.59 ±0.02	–0.99 ±0.13	0.91 ±0.13	–0.27 ±0.49	0.05 ±0.06	0.02 ±0.05	–0.49** ±0.05	0.01 ±0.01	–0.51** ±0.05
MY/ FLL	0.00 ±0.02	0.98 ±0.02	0.95 ±0.01	0.68 ±0.17	–0.05 ±0.05	0.17 ±0.52	–0.16 ±0.28	0.42 ±0.16	0.91** ±0.02	0.72** ±0.03	0.03 ±0.05
MY/ FCI	0.01 ±0.02	0.98 ±0.01	0.99 ±0.06	–0.10 ±0.39	–0.09 ±0.38	–0.46 ±0.43	–0.21 ±0.31	0.99 ±0.00	0.44 ±0.19	0.70** ±0.04	0.15* ±0.05
EBV	0.15 ±0.26	0.99 ±0.00	0.99 ±0.01	0.61 ±0.25	–0.41 ±0.39	–0.91 ±0.10	–0.64 ±0.26	0.99 ±0.02	0.96 ±0.04	0.32 ±0.15	0.04 ±0.05
EBE	–0.64 ±0.18	–0.11 ±0.36	–0.41 ±0.41	0.19 ±0.63	0.41 ±0.36	–0.20 ±0.56	0.13 ±0.04	0.06 ±0.35	0.06 ±0.37	0.19 ±0.42	0.13 ±0.07

*Significant (P<0.05); ** significant (P<0.01). The estimates above the diagonal are the phenotypic correlations and those below the diagonal are the genetic correlations. The values on diagonal are the estimates of heritability.

total first lactation yield, milk yield per day of first lactation length and per day of first calving interval and expected breeding value were moderate to high (Table 2), which indicated that these traits were more influenced by additive genetic variability and could be improved by selection. The high magnitudes of h^2 of EBV in Karan Fries herd indicated that selection based on EBV would result in higher genetic gain than for FLY/ TFLY. The MY/FL and MY/FCI are also a good choice for making selection index as both traits incorporate 2 important traits and both have higher h^2 than FLY. However, in Karan Swiss cattle highest additive genetic variability was shown by FLY (Table 2). The h^2 estimates of FSP, FDP, FCI and EBE in both herds were low and associated with high standard error, indicating that performance of these traits could be enhanced by improving management and other environmental factors. Moderate h^2 of FLL in Karan Swiss (0.19±0.12) indicated that both management and selection are important. Present results are in agreement with the findings reported by Taneja *et al.* (1978), Sachdeva and Gurnani (1989), Rao and Nagarcenkar (1992), Singh *et al.* (1995, 2000).

Correlation estimates in Karan Fries and Karan Swiss cattle

The age at first calving had significant and high magnitude of genetic and phenotypic correlations with FLY, TFLY, FLL, MY/FLL, MY/FCI and EBV indicating that late first calvers tended to have longer lactation length and higher milk production in Karan Fries herd (Table 2). However, positive and significant phenotypic correlation of AFC with FDP, FCI and negative with EBE suggested that higher AFC might reduce the reproductive performance of the animals in the herd by increasing mean FSP, FDP and FCI. Dalal *et al.* (2002) also reported positive association of AFC with FDP and FCI in Hariana cattle. Contrary to phenotypic correlation its genetic association with FSP, FDP and FCI was negative indicating that lowering of age at first calving leads to undesirable increase in these reproductive traits. The result suggested that the optimization of first calving with respect to production and reproduction traits is necessary. The correlation trend of first calving with other traits in Karan Swiss herd was almost similar to Karan Fries cattle, however, in Karan Swiss higher AFC would resulted in increase of service period, calving interval and decreased breeding efficiency at genetic scale (Table 2).

The FLY in both the herds showed high positive and significant genetic and phenotypic correlation with TFLY, FLL, MY/FL, MY/FCI and EBV, which is obvious as FLY is component of these traits and selection for FLY would lead to correlated positive response for above mentioned traits (Table 2). Positively significant r_p of FLY with FSP, FCI and negative with EBE indicated that increase of lactation yield also tended to increase service period and calving interval. However, at genetic scale its association with FSP, FDP and FCI was negative and desirable indicating that cows producing more milk tended to have shorter service period, dry period and calving interval. These findings also indicated that positive association of FLY with reproductive traits was mainly due to environmental factors and they could be improved by better management factors. Results were in conformity to the findings of Taneja *et al.* (1978) and Raheja (1994).

The genetic and phenotypic correlation of FLL was of high magnitude and positive with FSP, FCI and moderate with MY/FL, MY/FCI and EBV, and negative with FDP and EBE in Karan Fries (Table 2). The results suggested that cows with longer lactation length are desirable to improve the production efficiency traits. However, longer lactation period largely decreases the breeding efficiency both at genetic and phenotypic level, since heifers with longer service period tended to have longer lactation length and calving interval. High magnitude of correlations among FLL, FSP and FCI is expected because they are one of the components of calving interval. The result thus suggested the optimization of FLL in selection programmes with respect to production and breeding efficiency traits. However, lactation length in Karan Swiss cattle showed little different trend to Karan Fries (Table 2) as its association at genetic scale with FSP, FCI was negative, indicating that longer lactation length is likely to lead to improve the reproductive performance (Table 2). Results were in agreement with the findings of Deshmukh *et al.* (1995). The association among FSP, FDP and FCI were highly positive and these traits had negative correlations with MY/FL, MY/FCI and EBE, which indicated that cows with shorter service period not only lower the FDP and FCI with EBV was low in magnitude indicating that reaction of these traits may not affect the breeding value (Table 2). The MY/FL/FCI and EBV had significant correlation among each other. However, these traits have significant and relative association with breeding efficiency. The high magnitude of genetic and phenotypic correlation among milk production traits and poor r_p between production and reproduction traits obtained in the present study were in agreement with the reports of Batra *et al.* (1986), Dhangar and Patel (1991), Singh *et al.* (1995) and Dalal *et al.* (2002). These results support the hypothesis that production and reproduction traits are governed by different set of genes e.g. selection for higher lactation yield might lengthen the service period, dry period and calving interval.

SUMMARY

The genetic parameters for important economic traits were estimated in closerd herd of Karan Fries and Karan Swiss Cattle. The result inferred that additive genetic variability of age at first calving and milk production traits were moderate to high indicating a large variation in transmitting ability of sires for AFC and production traits. Selection for MY/FCI might hare resulted in higher gain than selection on the basis FLY for improvement of both production and reproduction

traits. The results also suggested that production and reproduction traits have either negative or low correlation between each other, which to a extent could be moderated by management interventions. Further reduction of AFC may not led desirable change in overall performance of both the herds.

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