

PHENOTYPIC, GENETIC AND ENVIRONMENTAL TRENDS IN MILK YIELD AND MILK PRODUCTION EFFICIENCY TRAITS IN KARAN FRIES CATTLE

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ABSTRACT

The first lactation records of 643 Karan Fries cattle sired by 77 bulls maintained at NDRI, Karnal herd during 1992-2009 were used to estimate the phenotypic, genetic and environmental trends of economic traits viz. first lactation total milk yield (FLTMY), first lactation total milk yield per day of first calving interval (FLTMY/FCI), first lactation total milk yield per day of first lactation length (FLTMY/FLL). The phenotypic trends were estimated as 34.04 ± 8.62 kg (0.90 percent of herd average), 0.05 ± 0.04 (0.57 percent of herd average) and 0.06 ± 0.02 kg (0.48 percent of herd average) for FLTMY, FLTMY/FCI and FLTMY/FLL respectively. The genetic trends were compared by six methods as Smith method1 (SM1), Smith method 2(SM2), Powell and Freeman method1 (PM1), Powell and Freeman method2 (PM2), Least Squares method of Burnside and Legate (LSMBL) and BLUP methods. The annual genetic trends for FLTMY were found to be positive by SM1 (1.08 kg), PM1 (0.83 kg) and BLUP (3.44 kg). The annual genetic trends for FLTMY/FCI were positive and significant by SM2 (0.56 ± 0.10 kg) and PM2 (0.43 ± 0.09 kg). The annual genetic trends for FLTMY/FLL were found to be positive by SM1 (0.08 ± 0.11 kg), LSMBL (0.01 ± 0.06 kg) and BLUP (0.01 ± 0.02 kg) methods. However, the estimates obtained by BLUP method had the lowest standard errors and were more reliable compared to other methods.

Key words: Karan Fries Cattle, Phenotypic trends, Genetic trends, Production efficiency traits.

INTRODUCTION

The aim of an animal breeder is to maximize the genetic gain per unit of time for various traits of economic importance in a breed improvement programme. In dairy cattle breeding, this implies maximizing genetic gain mainly for milk yield and production efficiency traits. This calls for evaluation of a breeding programme in terms of assessing change in the genetic constitution as well as environmental (managerial) conditions over time in organized herds of a particular breed. The magnitude and direction of production trends in a herd indicate effectiveness of breeding programme and help in developing or modifying appropriate strategies for bringing further improvement. Therefore, the genetic trends in production traits are important in that they allow for the evaluation of the efficacy of selection and management schemes. Many studies have examined genetic trend by regression of estimated breeding values on time (Powell *et al.*, 1985; Lee *et al.*, 1985) or regression

of production on time for estimation of phenotypic trends (Burnside and Legate, 1967; Powell and Freeman, 1974).

In India, annual genetic in first lactation 305-day milk yield were estimated by Singh (1995); Singh *et al.* (2002); Raja (2004) and Mukherjee (2005) in Karan Fries, Haryana, Sahiwal and in Frieswal. In the present study an attempt has been made to compare the genetic and environmental trends of first lactation milk yield and production efficiency traits viz. first lactation total milk yield per day of first calving interval and, first lactation total milk yield per day of first lactation length by six methods as Smith method1 (SM1), Smith method 2(SM2), Powell and Freeman method1 (PM1), Powell and Freeman method2 (PM2), Least Squares method of Burnside and Legate (LSMBL) and BLUP methods in Karan Fries cattle.

MATERIALS AND METHODS

The records of Karan Fries (KF) cows on production traits were collected from history-cum-

pedigree sheets maintained at National Dairy Research Institute, Karnal during the period of 18 years from 1992 to 2009. The animals with lactation length less than 100 days and with abnormal calving like still birth, abortion were excluded from the study. The data were grouped in four seasons, Winter (December to March), Summer (April to June), Rainy (July to September) and Autumn (October to November), : six periods viz. period-1 (1992-1994), period-2 (1995-1997), period-3 (1998-2000), period-4 (2001-2003), period-5 (2004-2006), period-6 (2007-2009) and six age groups viz. age group-1 ($0-875\text{days}$), group-2 (876- 950days), group-3 (951-1025 days), group-4 (1026-1100 days), group-5 (1101-1175 days) and group-6 (≥ 1176 days).

Estimation of phenotypic trends: The phenotypic trends for each trait were estimated by taking regression of performance of the population on the year as $b_{(PT)}$.

Estimation of genetic trends: Genetic trends were estimated as the pooled intrasire regression of progeny performance on time as per method I and method II of Smith (1962) using the following formulae.

$$\hat{g} = 2(b_{P.T} - b_{P.T/S}) \text{ Method I}$$

$$\hat{g} = -2(b_{(P-\bar{P}).T/S}) \text{ Method II}$$

where,

g = Genetic trends, t = Environmental trends

b_{PT} = is regression of population performance on time

$b_{PT/S}$ = is within sire regression of progeny performance on time

$b_{(P-\bar{P}).T/S}$ = is within sire regression of progeny performance on time record being deviated from population mean.

Least Squares method of Burnside and Legate (LSMBL): Burnside and Legate method (1967) utilizes the principle of least squares method. In this method estimated $b_{(\bar{A}G/2 + \bar{A}E)}$ was obtained from the weighted regression of year constants on years and these year constants were obtained from least squares analysis making adjustment for sire, farm, year and season. Differences in these year constants, which was adjusted for sires, reflected the differences

in the dam effects and the environmental effects associated with different years, i.e. one half of genetic trend plus the environmental trend, $b_{(\bar{A}G/2 + \bar{A}E)}$.

Powell and Freeman's Methods: This procedure was given by Powell and Freeman in 1974. It is a modification over Smith method (1962) procedure for estimation of genetic trend because this method removes the bias due to non-random allotment of dams to sires with respect to age. Considering this, the estimators of genetic trends would improve as follows:

$$\hat{g} = 2(b_{P.T} - b_{P.T/S}) / (1 + b_{DAT/S} - b_{DAT})$$

$$\hat{g} = -2(b_{(P-\bar{P}).\bar{T}/S}) / (1 + b_{DAT/S} - b_{DAT})$$

where,

b_{DAT} = is regression of dam's age on period

$b_{DAT/S}$ = is within sire regression of dam's age on period

BLUP method : The genetic trends were estimated by calculating the transmitting ability (ETA) of sires. The transmitting ability of sire is half of additive genetic value and therefore genetic trends was obtained as 2 times regression of weighted average of sire's transmitting abilities (WAETA) for each year on year as: (Hintz *et al.*, 1978)

$$WAETA = \sum n_{ik} \sqrt{n.k}$$

where,

n_{ik} = Number of daughter of sire i ($i = 1, 2, \dots, m$) in k^{th} year

S_i = Estimated Transmitting ability (ETA) of sire i^{th}

$n.k$ = Number of daughters of m sires in the k^{th} year

Transmitting ability is half of the additive genetic value and additive genetic value calculated by BLUP (best linear unbiased prediction) method (Henderson, 1975) as:

$$Y = Xb + Zu + e$$

where,

Y is the vector of observations for i^{th} trait ($I = 1, 2, 3$).

b is the vector of observations of unknown i^{th} fixed effects (Season, period and age group)

u is a vector of observations of unknown i^{th} random effect (Sire)

X and Z are the incidence matrices pertaining for fixed and random animal effect respectively

e is the vector of random error

G^{-1} is inverse of sire relationship matrix

The mixed model equation is:

$$\begin{bmatrix} X^0 R^{-1} X^0 & X^0 R^{-1} Z \\ Z R^{-1} X^0 & Z R^{-1} Z + G^{-1} \end{bmatrix} \begin{bmatrix} b \\ u \end{bmatrix} = \begin{bmatrix} X^0 R^{-1} Y \\ Z R^{-1} Y \end{bmatrix}$$

By solving the mixed model equations the BLUP of breeding values of the sires were obtained.

Environmental trends: Environmental trend (ΔE) was obtained by subtracting the genetic trend (ΔG) from the overall phenotype trend (ΔP).

$$\Delta E = \Delta P - \Delta G$$

The standard error of environmental trend S.E. (ΔE) was estimated as:

$$SE(\Delta E) = \sqrt{SE(\Delta P)^2 + SE(\Delta G)^2}$$

$$SE(\Delta P) = \sqrt{\frac{\sum P^2 - b_{P,T}(\sum Pt)}{(\sum t^2)(N-2)}}$$

where,

$b_{P,T}$ is linear regression of population performance (P) on time(T)

N is number of observations

Standard errors of different regression and genetic trends were calculated using the following general formulae assuming covariance between regressions to be zero.

$$\frac{V(b_{Y.X}) = V(Y) / V(X) - b^2_{Y.X}}{N - S - 1}$$

where,

(Van Vleck *et al.*, 1961)

S is number of subclasses

RESULTS AND DISCUSSION

Phenotypic, Genetic and Environmental trends in first lactation total milk yield (FLTMY): The phenotypic trend of first lactation total milk yield (FLTMY) was 34.04 ± 8.62 kg per year (0.90% of herd average) and was statistically significant ($P \leq 0.05$). The overall average FLTMY of Karan Fries cows was 3762.63 ± 67 kg. There was a fluctuating trend (Fig.1) in yearly averages during the period from 1992 to 2009.

Sadana and Tripathi (1986) in HF crosses cattle at Hisar; Gupta (1992) in Red Sindhi cattle at

Hosur and Puddukkottai farms; Singh (1995) in Karan Fries cattle at NDRI, Karnal and Singh and Nagarcenkar (2000) in Sahiwal cattle at Durg farm also reported positive phenotypic trends for FLTMY. The genetic trends for FLTMY estimated using SM1, SM2, PF1, PF2, LSMBL and BLUP methods are shown in Table-1. The genetic trends were statistically non-significant ($P \leq 0.05$) by all the methods but standard error was relatively low in BLUP method.

Negative genetic trend for FLTMY were reported by Gupta (1992) in Red Sindhi cattle at Chiplima Farm and by Tripude *et al.* (1995) in Sahiwal cattle at Nagpur Farm. Singh (1995) in Karan Fries cattle at NDRI farm and Mukherjee (2005) in Frieswal cattle at various military dairy farms also reported negative genetic trends.

The estimated environmental trends were estimated using SM1, SM2, PF1, PF2, LSMBL and BLUP methods (Table1). Environmental trends were also statistically non-significant but in positive direction.

Desirable environmental trend was also reported by Desraj (1987) in Kankrej cattle at Mandavi Farm; Murdia and Tripathi (1991) in Jersey cattle and by Tripude *et al.* (1995) in Sahiwal cattle; Herbert and Bhatnagar (1988) at NDRI in KS cattle; Singh (1995) at NDRI in Karan Fries & Karan Swiss cattle.

Phenotypic, Genetic and Environmental Trends in First Lactation Milk Yield per Day of First calving Interval (FLMY/FCI): The mean FLMY/FCI in Karan Fries cows was 8.71 ± 0.15 kg. There was no definite trend (Fig.2) for yearly averages FLMY/FCI up to 2009. The changes in yearly means were quantified by the phenotypic trend which was 0.05 ± 0.04 kg (0.57% of HA) and was statistically non-significant.

The genetic trends estimated by SM1, SM2, PF1, PF2, LSMBL and BLUP methods are shown in Table1. The genetic trends for the FLMY/FCI estimated by SM2 and PF2 were found to be statistically significant ($P \leq 0.05$). While genetic trends were found to be negative and statistically significant ($P \leq 0.05$) by SM2 and PF2 methods.

The environmental trends were estimated shown in Table1 by SM1, SM2, PF1, PF2, LSMBL

TABLE 1: Phenotypic, genetic and environmental trends in total milk yield and milk production efficiency traits in First Lactation Records estimated using different methods.

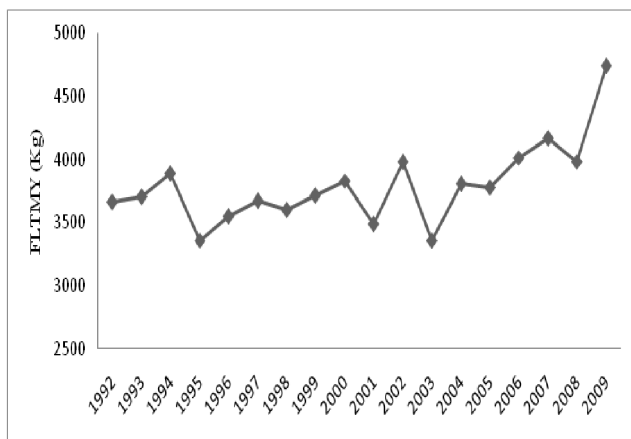
Traits	Trends	Smith methods		Powell and Freeman Methods		LSMBL	BLUP	
		SM1	SM2	PM1	PM2			
FLTMY (Kg)	ΔP	ΔG	1.08 ±	- 8.20 ±	0.83 ±	- 6.30 ±	- 5.61±	3.44 ±
			52.98	51.08	49.98	47.07	24.18	2.60
		ΔG % of	0.03	- 0.22	0.02	- 0.17	- 0.15	0.09
	34.04 ± 8.62	HA						
		ΔE	32.95 ±	42.24 ±	33.20 ±	40.34 ±	39.65 ±	30.60 ±
FLMY/FCI (Kg)	ΔP	ΔG	0.09 ±	0.56 ±	0.08 ±	0.43 ±	0.07 ±	- 0.01 ±
			0.11	0.10	0.07	0.09	0.04	0.02
		ΔG % of	1.03	6.43	0.92	4.94	0.80	- 0.11
	0.05 ± 0.04	HA						
		ΔE	- 0.04 ±	- 0.50 ±	-0.02 ±	- 0.38 ±	- 0.02 ±	0.06 ±
FLMY/FLL (Kg)	ΔP	ΔG	0.08 ±	- 0.37 ±	0.07 ±	- 0.28 ±	0.01 ±	- 0.01 ±
			0.11	0.10	0.06	0.06	0.06	0.02
		ΔG % of	0.76	- 3.52	0.67	- 2.66	0.01	- 0.10
	0.06 ± 0.02	HA						
		ΔE	-0.03±	0.43 ±	-0.01±	0.34 ±	0.06 ±	0.07 ±
		0.11	0.10	0.08	0.06	0.08	0.03	

and BLUP method which were negative except BLUP method. The environmental trend in FLMY/FCI by BLUP method was found to be positive whereas negative trends were observed by other methods as shown in Table-1.

Murdia and Tripathi (1991) reported significantly negative genetic trend for FLMY/FCI in Jersey cattle at Bhiwani, Bidaj and Anand Farms. The environmental trend was in desirable direction at Bhiwani and Bidaj Farms.

Phenotypic, Genetic and Environmental Trends in First Lactation Milk Yield per Day of First Lactation Length (FLMY/FLL) :The average

FIG.1: Phenotypic trend of FLTMY (Kg).

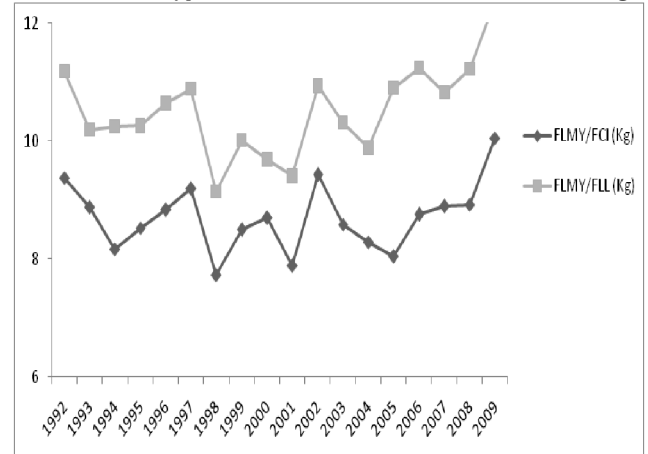


FLMY/FLL in Karan Fries cows was 10.52 ±0.15 kg. The fluctuating trends (Fig.2) were observed over the period of 1992-2009. The changes in yearly differences are quantified by the phenotypic trend which was 0.06 ± 0.02 kg per year (0.48% of HA) and was statistically significant.

The genetic trends for FLMY/FLL were estimated using SM1, SM2, PF1, PF2, LSMBL and BLUP methods (Table1). The genetic trends by SM1, PF1 and BLUP methods were observed to be positive.

Narain and Garg (1972) reported positive and non-significant phenotypic and genetic trends for FLMY/

FIG.2: Phenotypic trends of FLMY/FCI and FLMY/FLL (Kg).



FLL in Red Sindhi cattle at Bangalore and Hosur Farms. However, Murdia and Tripathi (1991) observed negative and significant genetic trend for this trait in Jersey cattle at Bhiwani Farm.

The environmental trends for FLMY/FLL were estimated using SM1, SM2, PF1, PF2, LSMBL and BLUP methods and were observed positive and statistically significant ($P \leq 0.05$) by SM2, PF2 and BLUP methods (Table-1).

CONCLUSIONS

Based on the present investigation, it was found that the Smith method-2 and Powell and Freeman method-2 were superior to Smith method-1 and

Powell and Freeman method-1 but inferior to BLUP and LSMBL methods because of low sampling variance in the BLUP and LSMBL method. The positive phenotypic trends in milk production trait FLMY could be due to desirable environmental trends during the period under study, though the standard errors of these environmental trends were quite high. Therefore, it is suggested that the BLUP method should be used for estimation of genetic trends of economic traits because it gave relatively lower sampling error compared to other methods and corrected for environmental factors more efficiently than other methods.

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