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Research Article

PREDICTION OF LIFETIME MILK PRODUCTION BASED ON FIRST LACTATION TRAITS IN SAHIWAL CATTLE AT ORGANIZED DAIRY FARM

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ABSTRACT

Data on milk production records of Sahiwal cows maintained at ICAR-National Dairy Research Institute, Karnal spanned over a period of 25 years (1989-2013) was compiled to predict lifetime milk yield (LTP) up to 3rd, 4th and 5th lactation based on first lactation 305 days milk yield (FL305DMY), first lactation length (FLL) and first service period (FSP). Multiple regression of each of three measures of LTP on all possible combinations of three first lactation traits was fitted. The criterion for judging the suitability of multiple regression models was coefficient of determination (R^2). Accuracies of prediction of LTP up to 3rd lactation (LTP3) based on FL305DMY (one trait), FL305DMY and FLL (two traits), FL305DMY and FSP (two traits), FL305DMY, FLL and FSP (three traits) were 64.46, 64.72, 64.59 and 64.73%, respectively. While R^2 value for prediction of LTP up to 4th lactation (LTP4) based on these traits were 53.00, 53.31, 54.37 and 54.37%, respectively. Similarly, accuracies of prediction of LTP up to 5th lactation (LTP5) based on these traits were 51.48, 53.62, 53.43 and 53.97%, respectively. It is concluded that for prediction of LTP3, LTP4 and LTP5; FL305DMY and FLL could be used as adequate predictors because addition of FSP as predictor did not increase R^2 significantly.

Keywords: Early selection, Lifetime milk production, Sahiwal cattle.

In order to make dairying an economically feasible enterprise, it would be desirable to improve lifetime productivity of animals. Waiting for productive life of animals would not be desirable from the point of view of genetic improvement per unit of time. Therefore, selection of females is generally done on the basis of first lactation traits. Ultimate aim of the dairy producers is to maximize milk production and profitability, therefore lifetime milk production is an important economic trait. Generation interval and expenses involved in maintaining less productive animals could be reduced if the animals are selected for lifetime productivity on the basis of traits expressed in their early lifetime. Several workers Kumar and Hooda, 2013; Singh *et al.,* 2013) have reported that it is important to predict lifetime milk production based on early lactation traits as it is not desirable to wait for an animal to complete its lifespan for selection purposes. Puri and Sharma (1965) studied first lactation yield and age at first calving for prediction of lifetime production and determined their relative importance for selection purposes in Red Sindhi and crossbred cows. In Sahiwal cattle, lifetime milk production was predicted from age at first calving, first lactation 305 days or less milk yield, first lactation length, first service period and first dry period using artificial neural network and multiple regressions (Gandhi *et al.,* 2009). Shinde *et a*l. (2010) predicted lifetime milk yield up to 3rd lactation in Phule Triveni cattle. The purpose of this study was to evaluate the number of first lactation traits that would be sufficient to predict the lifetime productivity of Sahiwal cattle.

MATERIALS AND METHODS

The present study was carried out on data pertaining to Sahiwal cattle maintained at livestock farm of National Dairy Research Institute, Karnal. The farm is located in Indo-Gangetic alluvial plain region of India at an altitude of 250 meters above mean sea level on 29^0 42' N latitude and 77^0 02' E longitudes. The temperature ranges from 0 ^{0}C in winter months to 45 ^{0}C in summer. The rain fall is about 760 to 960 mm out of which most of the rain fall is received during the months of July and August. The relative humidity ranges from 41 to 85%. Thus, it is obvious that the cattle maintained at NDRI farm get exposed to extreme climatic conditions.

Data on milk production records of Sahiwal cows spanned over a period of 25 years (1989-2013) maintained at Animal Genetics and Breeding Division, ICAR-NDRI was compiled to predict lifetime milk yield (LTP) up to 3rd, 4th and 5th lactation along with information on first lactation 305 days milk yield (FL305DMY), first lactation length (FLL) and first service period (FSP). Analysis was carried out on the records of animals with known pedigree and normal lactation. Culling, disposal in middle of lactation, abortion, stillbirth and pathological conditions which affected lactation yield were considered as abnormalities and hence such records were excluded from analysis. Animals having less than 500 kg of milk yields and lactation length less than 100 days were excluded from the present study. Number of observations up to 3rd, 4th and 5th

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lactation was 215, 157 and 108, respectively. To study the effect of different non-genetic factors like season of calving, period of caving and age group at first calving on traits under study data was divided into different groups. Based on prevalent conditions of the area, year was divided in to four season viz. Winter: December-March; Summer: April-June; Rainy: July-September and Autumn: October-November and total duration was classified into six periods of four year each.

Statistical analyses

Prediction of lifetime production (LTP) was judged by estimating regression of LTP on three independent traits and by fitting multiple linear regression of LTP on all possible combinations of three independent traits taken two at a time and all three. As the nature of relationship among considered traits and lifetime productivity were apparently linear, therefore, more complex non-linear models were not studied in the present study.

RESULTS AND DISCUSSION

Average of FL305DMY, FLL, FSP and LTP along with coefficients of variation is presented in Table 1. Season of calving, period of calving and age group at first calving factors had non-significant effect on the FL305DMY trait but period of calving had significant effect on FLL and FSP traits in the present study. Similar findings were reported by Dongre *et al*. (2013) and Verma *et al*. (2016). However, Manoj *et al.* (2012), Kumar et al. (2016) and Chitra et al. (2016) reported highly significant ($p<0.01$) effect of period of calving and Kumar *et al.* (2015) observed non-significant effect of season of calving on FL305DMY in dairy animals. Significant effect of period and season of calving on different lactation traits was observed by Ratwan *et al*. (2016, 2017) in Jersey crossbred cattle.

Prediction of LTP3 (up to 3rd lactation) on the basis of FL305DMY, FLL and FSP

The regression of LTP3 (up to third lactation) on the three traits viz., FL305DMY, FLL and FSP taken one at a time, two at a time in all possible combinations and three at a time along with correlation coefficient are presented in Table 2. Correlation of LTP3 with FL305DMY was 0.803 which was higher than the values reported by Gopal and Bhatnagar (1972) in Sahiwal cows and Gupta and Bhatnagar (1979) in Tharparkar. Multiple regression equation based on FL305DMY and FLL explained 64.72% of the variation in LTP3. Multiple regression equation based on FL305DMY, FLL and FSP explained 64.73% of the variation in LTP3 (Table 2). It may be concluded that marginal contribution of first service period to accuracy of prediction of LTP3 was negligible therefore FL305DMY and FLL could be used as adequate predictors of LTP3.

Prediction of LTP4 (up to 4th lactation) on the basis of FL305DMY, FLL and FSP

Regression and correlation of LTP4 with all these three traits in all possible combinations are presented in Table 3. Correlation of LTP4 with FL305DMY and FLL were 0.728 and 0.543. Multiple regression equation based on FL305DMY and FLL explained 54.37% of the variation in LTP4 (Table 3). From the present study, it may be concluded that marginal contribution of FSP to accuracy of prediction of LTP4 was negligible hence FL305DMY and FLL could be used as adequate predictors of LTP4. However, the accuracy of prediction of LTP4 on the basis of FL305DMY, FLL and FSP is less than the accuracy of prediction of LTP3 based on these traits.

Prediction of LTP5 (up to 5th lactation) on the basis of FL305DMY, FLL and FSP Regression and correlation of LTP5 with all these three traits in all possible combinations are presented in Table 4. Correlation of LTP5 with FL305DMY and FLL were 0.718 and 0.498. Similar finding was also reported by Singh *et al.* (1964) in Hariana cows, Gopal and Bhatnagar (1972) in Sahiwal, Gupta and Bhatnagar (1979) in Tharparkar. Multiple regression equation based on FL305DMY and FLL explained 53.62% of the variation in LTP5. This estimate was larger than the value reported by Gopal and Bhatnagar (1972), while less than that reported by Singh *et al*., (1964). It may be concluded that the accuracy of prediction of LTP5 on the basis of FL305DMY, FLL and FSP is less than the accuracy of prediction of LTP3 on these traits.

It is concluded that for prediction of LTP3, LTP4 and LTP5 two first lactation traits i.e. FL305DMY and FLL could be used as highly predictors because addition of FSP as predictor did not increase R^2 significantly. Also, accuracy of prediction of LTP4 and LTP5 on the basis of FL305DMY, FLL and FSP is less than the accuracy of prediction of LTP3 based on these traits in Sahiwal cattle.

Table1
Average first lactation milk yield, first lactation length, first service period and lifetime production in Sahiwal cattle

Cows records on LTP up to	N	FL305DMY (kg)		FLL (days)		FSP (days)		LTP (kg)	
		Mean	CV (%)	Mean	CV (%)	Mean	CV (%)	Mean	CV (%)
3 lactations	215	2087 ± 61.9	43.47	311 ± 5.9	27.85	150 ± 9.3	90.69	6615 ± 156.9	34.79
4 lactations	157	2150 ± 72.9	42.48	318 ± 6.9	27.18	146 ± 10.6	91.15	9225 ± 219.3	29.78
5 lactations	108	2222 ± 84.7	39.63	319 ± 7.9	25.75	134 ± 11.4	87.79	11696 ± 310.7	27.61

Where, FL305DMY = First lactation 305 days milk yield; FLL = first lactation length; FSP = First service period; LTP = Lifetime production and CV = Coefficient of variation.

Table2
Prediction of LTP3 (up to 3rd lactation) on the basis of FL305DMY, FLL and FSP in Sahiwal cattle

Traits	b0	Regression coefficients			Multiple correlation coefficient	R2 (%)
		b1	b2	b3		
FL305DMY	2364.51	2.04 ± 0.11			0.803	64.46
FLL	1579.48		16.18 ± 1.44		0.609	37.12
FSP	6032.22			3.88 ± 1.13	0.229	5.29
FL305DMY and FLL	2703.56	2.21 ± 0.17	-2.23 ± 1.79		0.805	64.72
FL305DMY and FSP	2395.24	2.07 ± 0.11		-0.634 ± 0.73	0.804	64.59
FLL and FSP	1311.15		18.2 ± 1.69	-2.36 ± 1.08	0.621	38.5
FL305DMY, FLL and FSP	2665.85	2.19 ± 0.18	-1.89 ± 2.05	-0.28 ± 0.84	0.805	64.73

Where, FL305DMY = First lactation 305 days milk yield; FLL = first lactation length; FSP = First service period; LTP = Lifetime production and R2 = Coefficient of determination.

Table 3
Prediction of LTP4 (up to 4th lactation) on the basis of FL305DMY, FLL and FSP in Sahiwal cattle

Traits	b_0	Regression coefficients			Multiple correlation coefficient	R^2 (%)
		b_1	b_2	b_3		
FL305DMY	4517.08	2.19 ± 0.17			0.728	53.00
FLL	3735.12		17.26 ± 2.14		0.543	29.50
FSP	8712.80			3.50 ± 1.63	0.170	2.90
FL305DMY and FLL	4972.81	2.41 ± 0.27	-2.91 ± 2.87		0.730	53.31
FL305DMY and FSP	4585.71	2.33 ± 0.18		-2.60 ± 1.21	0.737	54.37
FLL and FSP	3056.86		21.57 ± 2.59	-4.73 ± 1.68	0.574	32.95
L305DMY, FLL and FSP	4546.02	2.32 ± 0.27	0.26 ± 3.30	-2.65 ± 1.41	0.737	54.37

Where, FL305DMY = First lactation 305 days milk yield; FLL = first lactation length; FSP = First service period; LTP = Lifetime production and R^2= Coefficient of determination.

Table 4
Prediction of LTP5 (up to 5th lactation) on the basis of FL305DMY, FLL and FSP in Sahiwal cattle

Traits	b_0	Regression coefficients			Multiple correlation coefficient	R^2 (%)
		b_1	b_2	b_3		
FL305DMY	5850.55	2.63 ± 0.25			0.718	51.48
FLL	5454.69		19.53 ± 3.30		0.498	24.78
FSP	10918.11			5.79 ± 2.59	0.212	4.48
FL305DMY and FLL	7334.67	3.38 ± 0.42	-9.84 ± 4.47		0.732	53.62
FL305DMY and FSP	5830.16	2.90 ± 0.28		-4.32 ± 2.06	0.731	53.43
FLL and FSP	3940.32		27.59 ± 4.49	-7.90 ± 3.20	0.538	28.90
FL305DMY, FLL and FSP	6813.81	3.27 ± 0.43	-6.46 ± 5.85	-2.41 ± 2.69	0.734	53.97

Where, FL305DMY = First lactation 305 days milk yield; FLL = first lactation length; FSP = First service period; LTP = Lifetime production and R^2= Coefficient of determination.

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