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Estimates of Genetic Parameters and Trends of Lactation Performance Traits of Deoni Cattle

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ABSTRACT

Data on 114 Deoni cows maintained at Cattle Cross Breeding Project, Vasantrao Naik Marathwada Agriculture University, Parbhani over a period of 25 years were used for the present investigation. The data were subjected to assess the effect of period of calving, season of calving, lactation order and age at first calving on persistency and lactation traits. The records corrected for significance and non-genetic factors were used for estimating genetic parameters of the milk production traits. Least squares means for persistency of milk yield in Deoni cattle by Mahadevan method was 2.98±0.20. The significant effect of period of calving was recorded on 305 DMY, LL, PY and DAPY and non-significant effect, was recorded on persistency of milk yield, lactation milk yield .The non-significant effect of season of calving & lactation order was recorded on persistency of milk yield & all milk production traits. The significant ($P<0.05$) effect of age at first calving was observed only on lactation length. It showed increasing trend from A_1 to A_3. Moderate to high estimates of heritability for all lactation traits were observed indicating improvement in these traits, which may probably be brought about by individual selection. Moderately high heritability was observed for persistency of milk yield (0.36 ± 0.23) and LL (0.25 ± 0.23). The repeatability estimates for all the traits under study were high indicating that the first lactation performance of these traits was most reliable estimates to predict future performance and selection of these animals.

Keywords: Deoni, non-genetic factors, production traits, heritability, repeatability

Marathwada region of India has been gifted by two important cattle breeds i.e. Deoni for dual and Red Kandhari for draft quality. The importance of Deoni cattle lies in their draught power capacity, heat tolerance, disease resistance, adaptability to harsh agro-climatic conditions and ability to survive and perform under scarce feed and fodder. All these favourable traits made this breed popular (Kayastha *et al.*2011). Deoni animals kept largely for draft power and milk are the assets of farming community of this region.

Lactation persistency is the ability of the cow to maintain milk production at a high level after the peak yield, i.e. a persistent animal has a flatter milk curve (Cobuci, *et al*. 2003). High persistency is associated with more resistance to disease, better utilization of feed, reduced stress from high peak milk yield, and low reproductive costs (Cole and Null, 2009; Gengler, 1996; Swalve and Gengler, 1999) . Persistent animals generate more return (Dekkers *et al.,* 1998); therefore, enhancing persistency could promote efficient and economical milk production. Scanty reports are available on the persistency estimates and effect of various genetic and non-genetic factors on persistency of milk yield in Deoni cattle. Aggregated lactation milk yield is the criterion traditionally used for management decisions and genetic evaluation. The main objective of this study was to evaluate the persistency of milk of Deoni cattle and to determine the influence of environmental and genetic factors affecting it, and to find out how persistency is correlated with production traits.

Material and Methods

Data, herd and management

The dataset used was a sample of lactation records over a period of 25 years during initiated between 1988 to 2012 maintained at Cattle Cross Breeding Project (CCBP), Vasantrao Naik Marathwada Agriculture University, Parbhani. Deoni cattle were naturally mated and hand milked twice a day. Milk yield was recorded daily. In the present study, monthly milk yields were the sums of 4–week periods. Lactations shorter than 120 days were deleted. Also, records of abnormal cases like abortion, still births, lactation affected by diseases were excluded. Final datasheet was comprised of 438 lactations of 114 Deoni cows descendant of 12 sires.

Calculation of persistency

Persistency of milk yield was calculated by using Mahadevan method (1951) as follows:

$$P = \frac{(A - B)}{B}$$

Where, P = Persistency of milk yield; A = Total lactation milk yield; B = Initial milk yield upto attainment of peak yield

Classifications and analyses

Lactations were grouped according to calving period (5 levels; 1988-1992(P_1); 1993–1997(P_2); 1998–2002 (P_3); 2003–2007 (P_4); 2008-2012(P_5)), calving season (3 levels; Rainy(S_1) = June to September; winter (S_2)= October to January; Summer (S_3) = February to May), parity order (5 levels; 1 through 5), and age at first calving (5 levels; < 45; 46-50;51-55; 56-60; >61 months). Data were analyzed according to the following linear model using the GLM procedure of the Statistical Analysis System software (SAS, 2002). Means were compared using the least squares means (LSM/PDIFF) option of the same procedure.

$Yijklm = \mu + Pi + Sj + Lk + D_l + eijklm$

where Yijklm = m^{th} observation of the dependent variable, μ = the overall mean, Pi= the effect of ith period of calving, Sj = the effect of j^{th} season of calving, Lk = the effect of k^{th} parity, D_l= effect of l^{st} age at first calving, and, eijklm = the random error. The statistical significance of various fixed effects was studied by F-test. Whenever, the effects were significant, the difference between means was tested for significance by t-test.

Heritability, repeatability and genetic correlations among different traits were estimated through paternal half-sib correlations by the mixed–models least squares and maximum likelihood software (Harvey, 1990).

Results and Discussion

Overall means and factors affecting persistency, lactation milk yield, lactation length, peak yield, days to attain peak yield and 305-day milk yield are presented in Table 1.

Table 1. Least squares means (+ SE) for persistency, lactation milk yield, lactation length, peak yield, days to attain peak yield and 305-day milk yield in Deoni cattle

Source of variation	n	Persistency	LMY (kg)	LL (days)	PY (kg)	DAPY (Days)	305 DMY (kg)
over all	438	2.98 ± 0.20	236.43 ± 12.71	211.26 ± 8.59	7.12 ± 0.24	79.38 ± 3.97	376.83 ± 13.09
Period of Calving							
P_1 (1988-1992)	210	2.81 ± 0.31^a	317.93 ± 14.30^a	211.26 ± 8.59^a	8.64 ± 0.27^a	88.78 ± 4.47^a	455.23 ± 14.73^a
P_2 (1993-1997)	128	3.07 ± 0.34^b	140.08 ± 16.48^a	168.44 ± 9.91^b	4.44 ± 0.32^b	74.87 ± 5.15^b	244.52 ± 16.98^{ab}
P_3 (1998-2002)	15	3.03 ± 0.75^a	123.21 ± 45.37^b	138.03 ± 27.27^c	4.65 ± 0.88^b	62.31 ± 14.18^c	294.18 ± 46.73^a
P_4 (2003-2007)	42	3.07 ± 0.43^c	250.18 ± 26.37^{ac}	186.37 ± 15.85^b	8.34 ± 0.51^{bc}	91.16 ± 8.24^b	405.66 ± 27.16^{ab}
P_5 (2008-2012)	43	2.91 ± 0.41^d	350.77 ± 26.06^{ab}	213.13 ± 15.66^b	9.52 ± 0.50^{bd}	79.81 ± 8.14^d	484.54 ± 26.84^c
Sig		NS	NS	**	**	**	*
Season of Calving							
Rainy	145	2.93 ± 0.26	215.91 ± 16.99	174.84 ± 10.21	6.82 ± 0.33^a	77.93 ± 5.31	361.19 ± 17.50^a
Winter	157	2.81 ± 0.26	242.92 ± 16.40	195.07 ± 9.85	6.96 ± 0.31^a	82.11 ± 5.12	368.26 ± 16.89^{ab}
Summer	136	3.20 ± 0.29	250.48 ± 18.52	180.43 ± 11.13	7.58 ± 0.36^b	78.11 ± 5.79	401.02 ± 19.08^b
Sig.		NS	NS	NS	NS	NS	NS
Parity							
1st lactation	114	3.02 ± 0.30	281.91 ± 19.42^a	196.16 ± 11.67	7.94 ± 0.37	85.74 ± 6.07	403.04 ±20.00

2nd lactation	114	3.47 ± 0.29[a]	220.99 ± 18.96[bc]	177.96 ± 11.40	6.90 ± 0.36	74.80 ± 5.93	354.94 ± 19.53
3rd lactation	114	2.75 ± 0.30	211.42 ± 19.65[c]	159.85 ± 11.81	6.96 ± 0.38	70.83 ± 6.14[a]	374.97 ± 20.24
4th lactation	61	2.48 ± 0.37	228.64 ± 24.04	193.40 ± 14.45	6.48 ± 0.46	91.38 ± 7.51[b]	360.57 ± 24.76
5th lactation	35	3.17 ± 0.47[b]	239.22 ± 30.31	189.87± 18.22	7.31 ± 0.59	74.18 ± 9.48	390.57 ± 31.22
Sig		NS	NS	NS	NS	NS	NS
Age at first calving (months)							
Below 45	222	3.12 ± 0.33[a]	275.57 ± 20.60[a]	202.92 ± 12.33[a]	7.85 ± 0.40[a]	89.64 ± 0.40[a]	372.98 ± 21.22[a]
46-50	109	2.94 ± 0.35[a]	274.32 ± 22.31[a]	203.52 ± 13.35[a]	7.58 ±0.43	91.68 ± 6.97[a]	380.46 ± 22.99
51-55	51	3.14 ± 0.40[a]	264.70 ± 25.63[a]	208.87 ± 15.34[a]	8.06 ± 0.49[a]	83.84 ± 8.00[a]	379.33 ± 26.40[a]
56-60	22	2.36 ± 0.57[ab]	206.19 ± 36.93[ab]	155.00 ± 22.10[ab]	6.34 ± 0.71[ab]	75.67 ± 11.53[ab]	430.31 ± 38.05[ab]
Above 61	34	3.34 ± 0.48[b]	164.77 ± 31.48[b]	136.43 ± 18.84[b]	5.94 ± 0.61[b]	54.92 ± 9.83[b]	350.39 ± 32.43[b]
Sig		NS	NS	*	NS	NS	NS

LMY, Lactation milk yield; 305-DMY, Standardized 305-day milk yield; LL, Lactation length; PY, peak yield; DAPY, Days to attain peak yield, Sig., significance levels; NS, not significant ($P>0.05$); * $P<0.05$, ** $P<0.01$;

a,b,c Within a column and an effect, least squares means without a common superscript letter differ significantly, $P<0.05$.

The effect of period of calving had non-significant effect on persistency of milk yield (estimated by Mahadevan method) and lactation milk yield in Deoni cows, whereas significant ($P<0.05$) effect on 305-DMY, lactation length, peak yield and days to attain peak yield was observed in the present investigation The availability of feeds, fodder and management conditions are usually varied from period to period which might have reflected on persistency of milk yield. Similar results of significant period effects on production traits but not on persistency were observed by Tekerli et al.(2001).However, previous researchers have shown significant year/period effects on production and persistency traits in buffaloes and cattle (Kaya and Kaya, 2003; Prasad, 2007). The present study revealed that period P_2 and P_3 had lower peak yield as compared to P_1, P_4 and P_5. The peak yield exhibited decreasing trend from P_1 to P_3. This type of results is expected from any such study, which may be reflecting the variation of feeding and management over periods. The cows calved during P_2 period required less days (42.53±6.09 days) to reach peak yield than those calved during all other periods. The more days were required to attain peak yield for those cows calved during P_4 period (74.17 ±7.58 days). The t-test showed that cows calved in P_5 period significantly differed from cows calved in all other periods for LMY. The period P_3 also significantly differed from P_1, P_2, P_4 and P_5 lactations.

Season did not significantly affect persistency and lactation traits. In general, lactations initiated in summer followed by spring were associated with the highest lactation yield, lactation length and persistency. On an average, cows calved in summer season had the higher persistency (3.20 $\pm$ 0.29) and peak yield (7.58 ± 0.36 kg) than rainy (2.93 $\pm$ 0.26, 6.82 $\pm$ 0.33) and winter (2.81 $\pm$ 0.26, 6.96 $\pm$ 0.31) calvers. Rainy calvers were observed to be early reaching to peak yield (54.07 ± 4.66 days) while winter and summer calvers required more days to reach peak record than other seasons. Persistency of milk yield was highest in summer season (S_1) followed by rainy (S_2) and winter (S_3). The similar non-significant effects were observed by Jagtap *et al* (1994), Habib *et al* (2010) Shelke *et al*. (1992) and Tekreli *et al.* (2001) in Red Sindhi, Red Chittagong, Red Kandhari cattle and Anatolian buffaloes, respectively.

Variance analysis revealed that parity of lactation had non- significant effect on persistency of milk yield.

Parity had non-significant effect on persistency and all lactation traits in this study. The least square means for LMY in 1st lactation was highest (281.91 ± 19.42), while lowest for 3rd lactation (211.42 ± 19.65). LMY showed decreasing trend from 1st to 3rd lactation and increasing trend from 4th to 5th lactation in Deoni cattle.

During the early lactation, the animals were not only in productive stage, but also in growing stage and both the processes lead to drain off energy reserve of the animal. The average days to attain peak yield in Deoni cattle was higher (63.18 ± 6.59 days) in 4th lactation than all remaining lactations. It showed decreasing trend from L_1 to L_3. Similar results were recorded by Tekreli et al. (2001) and Yüksel and Yanar, 2009 in Brown Swiss cattle.

The persistency of milk yield, LMY, 305-DMY, peak yield and days to attain peak yield didn't differ significantly from each other due to the effect of age at first calving in Deoni cattle, whereas significant effect of age at first calving on lactation length was observed in the present investigation (Table 1). Decreasing trend from A_1 to A_5 indicated that as age at first calving of cows increased, their milk production decreased gradually. The study revealed that cows calved at A_4 group showed higher 305-DMY (430.31 ± 38.05kg) than those calved for all other age groups and observed increasing trend from A_1 to A_4 group. The peak yield exhibited increasing trend from A_1 to A_3.

Heritability (h^2), repeatability and correlation estimates are presented in Table 2. Heritability, particularly of persistency (0.36), indicated to a possibility for effective genetic selection through sire evaluation. They were within the range (0.03 – 0.40) of heritabilities estimated by various methodologies for several measures of persistency in buffaloes and cattle (Cobuci *et al.* 2006; Cole and Null, 2009; Gajbhiye and Tripathi, 1992; Elmaghraby, 2013).Heritability estimates of lactation traits of this study are higher than those (0.055 and 0.132) reported by Deb *et al* (2008) in BCB-1 cattle (Bangladesh Livestock Research Institute Cattle Breed-1) cattle for LMY, Singh *et al* (1995) in Karan Swiss cattle for 305 DMY, Pundir and Singh (2007) in Hariana and Red Sindhi cattle for LL; Nanavati and Qureshi (1996) in Gir cattle for DAPY.

Except for the negative phenotypic correlation (r^P) of persistency with DAPY, other estimable coefficients among the persistency and lactation traits measures were moderate to high (r^P, 0.23 to 1.03; $P<0.05$ to $P<0.01$). Consequently, a correlated response in one measure would occur as a result of a change in another. In connection, persistency has been shown to increase with the increase of LMY and LL (r^P, 0.51 to 0.60) and highest PY (r^P, 1.03).

LMY showed high positive r^G and r^P with persistency and LL respectively than other lactation traits, whereas high negative r^P with DAPY. It signifies that more persistency in milk yield and longer lactation length increase lactation milk yield and delay in days to attain peak yield.

Table 2: Estimates of heritability, repeatability and correlation coefficients among different lactation traits in Deoni cattle

Traits → ↓	Persistency of milk yield	LMY	305 DMY	LL	PY	DAPY
Persistency of milk yield	0.36 ± 0.23	0.46 ± 0.033 **	0.44 ± 0.035 **	0.41 ± 0.037**	0.23 ± 0.041**	-0.21 ± 0.040**
LMY	0.60 ± 0.47**	0.45 ± 0.25	0.81 ± 0.021**	0.78 ± 0.03**	0.71 ± 0.031**	-0.38 ± 0.040**
305 DMY	0.25 ± 0.45**	0.83 ± 0.20**	0.62 ± 0.26	0.67 ± 0.04**	0.54 ± 0.02**	0.34 ± 0.030**
LL	0.51 ± 0.34**	0.87 ± 0.13**	0.63 ± 0.25**	0.25 ± 0.23	0.36 ± 0.043**	0.42 ± 0.030**
PY	1.03 ± 0.26**	0.78 ± 0.18**	0.39 ± 0.43**	0.16 ± 0.23**	0.58 ± 0.29	0.12 ± 0.041*
DAPY	-0.36 ± 0.45**	-0.80 ± 0.17**	-0.63 ± 0.31**	0.94 ± 0.06 **	0.60 ± 0.26**	0.83 ± 0.31
Repeatability	0.56 ± 0.074	0.46 ± 0.049	0.86 ± 0.041	0.55 ± 0.076	0.61 ± 0.073	0.89 ± 0.049

LMY, Lactation Milk Yield; 305-DMY, standardized 305-day milk yield; LL, Lactation Length; PY, peak yield; DAPY, Days to Attain Peak Yield

a Heritabilities and correlations were estimated from a subset of data, n = 128; otherwise, n = 438

Diagonal values are the heritabilities and their standard errors

Values above the diagonal are the genetic correlations and their standard errors

Values below the diagonal are the phenotypic correlations

Significance level * P<0.05, ** P<0.01.

305-DMY showed negative r^P with DAPY and highest r^G with LMY. More LMY indicate higher 305-DMY and longer period to attain peak yield. Data also indicate longer lactation length for higher 305-DMY. Similar pattern was indicated by higher r^G of LL with LMY and higher r^P with DAPY.

Higher r^G of PY with LMY indicated that higher peak yield was directly related with higher LMY and longer days to attain PY (r^P 0.60). It signifies that persistent cows reach maximum production later in their lactations than less persistent ones (Cobuci *et al.,* 2003).

The high repeatability estimates observed in present study indicated that the first lactation performance of these traits was most reliable estimates to predict future performance and selection of these animals. The substantial improvement in these traits during subsequent lactations was possible by adopting selection programme in first lactation.

Conclusion

The results indicated that the performance of Deoni cows for LMY, PY and LL was comparatively low which needs an improvement in overall management of dairy cows. Moreover, for all lactation traits concerned seasonal changes had no significant effect. Therefore, additional production strategies in term of management needed to improve the production performance. The studied lactation traits in this herd were less inheritable; however, they were repeatable during the life of the animal. Heritability for LMY (0.45 ± 0.25), PY (0.58 ± 0.29), 305 DMY (0.62 ±0.26) and DAPY (0.83 ± 0.31), indicated that the improvement in these lactation traits may probably be brought about by individual selection. Moderately high heritability was observed for persistency (0.36 ± 0.23) and LL (0.25 ± 0.23). So it can be concluded Deoni cows prove to be promising dairy animals.

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