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Significance of Environmental Influences on Average Daily Milk Traits of Sirohi Goats in Their Native Tract

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ABSTRACT

Data on 3244 Sirohi kidding during 2004 to 2016 in farmer's flocks under All India Co-ordinated Research Project on Goat Improvement (AICRP) project, Vallabhnagar, Udaipur were utilized to estimate the average daily milk (ADM) at different lactation months and subjected to least square analysis to study the effect of various non-genetic factors like cluster, periods of kidding, season of kidding, parity, type of birth and regression of dam's weight. The overall least-squares means for ADM_1, ADM_2, ADM_3, ADM_4, ADM_5 and overall ADM were 564.07±18.34, 671.92±15.17, 633.41±10.75, 508.93±8.01, 329.72±7.93 and 540.79±10.78 ml, respectively. Cluster and period wise variation were highly significant on all stages of average daily milk yields. The parity had statistically highly significant effect on average daily milk yields, in which seemed that milk yields increase as parity increase, thereafter declined slowly. The effect of type of kidding was non-significant on all stages of average daily milk yield under this study. The regression of dam's weight at kidding was positive and highly significant ($P \leq 0.01$) on all average daily milk yield. The heritability estimates for these traits ranged from 0.03±0.01 (ADM_4) to 0.19±0.02 0.06±002 (ADM_1). The high estimates of genetic correlations of average milk yield of different periods with overall average daily milk yield. The phenotypic correlations were positive and low between ADM_1 and ADM_{4-}, ADM_5 and medium between ADM_1 and ADM_4, ADM_5. In order to augment goat milk production, goat keepers need to be focused on nutritional and others environmental conditions as it affect their flock.

Key words: Average daily milk yield, Heritability, Non-genetic factors, Sirohi goat.

INTRODUCTION

Goat milk production is a dynamic and growing industry that is fundamental for both wellbeing and economical incomes for millions and millions people worldwide. Therefore, in the (previous) years, interest concerning the milk from small ruminant has been observed increased in order to find new avenue after exploring the potential of local breeds (Selvaggi and Dario, 2015).

Sirohi breed of goats have economic and social importance in southern Rajasthan because of their ability to use poor vegetation in marginal areas. The importance of Sirohi goat is increasing due to its maximize return with limited input. Sirohi goats are reared by small and marginal farmers who graze them on bare pasture land and with crop residue. They are mainly reared for chevon purpose, but income from sale of milk is also significant as in on an average goat yields 933 g milk per day in first 90 days of lactation Shinde *et al*. (2008). The genetics of milk production in goats seems to be the similar to that of cattle and sheep. But in terms of live weight, the goat is believed to be the efficient as milk producer than those of other two species (Mackenzie, 1967).

Several factors had already been reported in the documentations on record influencing the efficiency of milk production and lactation length as reported by Ibnelbachyr *et al*. (2015) and Prajapati *et al*. (2017). The magnitude of genetic and non-genetic factors on milk production and lactation length differs among different husbandry and management practices. The knowledge of genetic parameters for milk production traits may support animal breeding strategies by selecting animal with superior genetic merits in order to optimize response for selection and improvement of dairy traits (Barillet, 2007; Assan, 2015).

Number of genetic and non-genetic factors affect the milk production traits of animals, which could be estimated by way of genetic parameters and thereby the evolution of more efficient selection programme for future could be ascertained. Therefore, The purpose of study was to investigate the influence of non-genetic factors on stages of average daily milk yield estmate the heriatabily, genetic and phenotypic corrleation of different average daily milk yield traits in Sirohi goat under breeding tracts.

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MATERIALS AND METHODS

Data

Data for the present study was collected from Sirohi farmers' flocks maintained under All India Co-ordinated Research

Project (AICRP) on Sirohi goats at Livestock Research Station, Vallabhnagar, Udaipur. Data on 3244 Sirohi kidding were collected for different lactation months over a period of 12 years (2004 to 2016). The lactation length were evaluated in terms of average daily milk (ADM_1) during 0-30 days, (ADM_2) 31-60 days, (ADM_3) 61-90 days, (ADM_4) 91-120 days, (ADM_5) 121-150 days and (ADM) for initial to 150th days of lactation. The environmental effects studied were cluster, period, season, parity, types of birth and dam's body weight at kidding. The data were classified into six clusters *viz*. Vallabhnagar, Railmagra, Devgarh and Nathdwara (Rajsamand), Bhadsoda and Bojunda (Chittorgarh). The duration of kidding was divided into 4 periods each consisted of 3 years *viz*. P_1 (2004-07), P_2 (2007-10), P_3 (2010-13) and P_4 (2013-16) and year was divided into 3 seasons *viz*. rainy (Jul–Oct), winter (Nov– Feb) and summer (Mar- Jun). The records pertaining to culling in the middle of lactation, abortion, still birth or any other pathological causes affecting the lactation yield of the animals were considered as abnormalities, and thus, such records have not been included in the present study.

Feeding and management

The Sirohi goats are maintained under semi-intensive system in project area. Goats remained on pasture six to eight hours a day for grazing. Various types of tree, shrubs and grasses remain available in pasture land of project area during different seasons of the year. Vaccination and treatment facilities were provided to registered goat keepers by project staff and animal husbandry department of Rajasthan in the project area. Goats were generally housed during night in Kacha floor coated with cow dung, at farmer's house.

Statistical analysis

Data were analyzed using Mixed Model Least-squares Maximum Likelihood programme (Harvey, 1990). Heritability and genetic correlation were estimated by paternal half-sib correlation method. Effect of sire was estimated using mixed model incorporating sire as random effect. Whereas, cluster, period and season of birth, type of kidding and parity were estimated as fixed effect. Dam's weight at kidding was estimated by considering it as co-variable. Following statistical model was used to analyze the data.

$$Y_{ijklmnp} = \mu + A_i + B_j + C_k + D_l + E_m + F_n + b(DW_{ijklmno} - \overline{DW}) + e_{ijklmnp}$$

Where,

$Y_{ijklmnp}$ = Performance record of the pth progeny of ith sire belonging to jth cluster, kth season of birth, lth period of birth, mth parity and nth type of birth.

μ = Population mean

A_i = Random effect of sire

B_j = Fixed effect of jth cluster (j = 1, 2, 3, 4, 5, 6)

C_k = Fixed effect of kth season of birth (k = 1, 2, 3)

D_l = Fixed effect of lth period of birth (l = 1, 2, 3, 4)

E_m = Fixed effect of mth parity (m= 1,2,3,4, ≥ 5),

F_n = Fixed effect of nth type of birth (n = 1, 2),

$e_{ijklmnp}$ = Residual random error associated with $Y_{ijklmnp}$ and assumed to be identically and independently distributed with mean zero and constant variance.

$b(DW_{ijklmn} - \overline{DW})$ = The regression of the trait on dam's weight at kidding Duncan's Multiple Range Test as modified by Kramer, (1957) was used for testing differences among least squares means.

RESULTS AND DISCUSSION

General performance

The estimates of overall least-squares means and standard errors for ADM_1, ADM_2, ADM_3, ADM_4, ADM_5 and overall ADM were 564.07±18.34, 671.92±15.17, 633.41±10.75, 508.93±8.01, 329.72±7.93 and 540.79±10.78 ml, respectively (Table 1). The overall least-square means for average daily milk yield showed that highest average daily milk was recorded during 31st to 60th day (ADM_2) of lactation and thereafter it started declining with the advancement of lactation length. Hassan *et al*. (2010) also reported that highest milk yield was in second month and lowest in the fifth month after kidding in Jamunapari goats. Similar finding for average daily milk (ADM) in Marwari was reported by Rai *et al*. (2001) as 560±0.02 ml and 524.3±138.3 ml in Jamunapari by Hassan *et al*. (2010). Contrary to this, lower means were reported as 362.40±15.91 ml by Pathodiya *et al*. (2010) as well as by Swami *et al*. (2005) as 0.380±0.034 ml in Sirohi and in Black Bengal as 354.76 ml by Mia *et al*. (2014). However, higher means were reported by Singh and Ramchandran, (2007) as 627.70±46.2 ml in Sirohi goats.

Effect of non-genetic factors

The effect of various non-genetic factors affecting average daily milk yield at different stages of lactation have been presented in Table 2.

Random effect of sire was highly significant (P≤0.01) on all traits under the study. Similar finding were in close agreement with reports of Pathodiya *et al*. (2010) and Yadav *et al*. (2004) that indicated existence of variation in transmitting ability of sire for milk performance traits.

The least squares analysis of variance revealed that the cluster-wise variation was highly significant (P≤0.01) on all stages of average daily milk. These results were in accordance with that of Pathodiya *et al*. (2010) in Sirohi goat. Average daily milk was lowest in Bojunda cluster and highest in Devgarh cluster, which was maintained throughout lactation length as compared to other clusters. Difference among average milk yield performances of clusters may be due to variation in management practices followed for goat rearing by the farmers in that area.

Periods of birth had significant (P≤ 0.01) on average daily milk at different stages of lactation months. Similar finding was reported Swami *et al*. (2005); Singh and Ramchandran, (2007) and Yadav *et al*. (2004). However, Pathodiya *et al*. (2010) reported non-significant effect of period on overall average daily milk in goats. Average daily

Table 1: Least-squares means and S.E. for average daily milk production (ml) of Sirohi goat.

Traits Factors	N	ADM_1	ADM_2	ADM_3	ADM_4	ADM_5	ADM
Overall	3244	564.07±18.34	671.92±15.17	633.41±10.75	508.93±8.01	329.72±7.93	540.79±10.78
Sire		**	**	**	**	**	**
Cluster		**	**	**	**	**	**
Vallabhnagar	89	479.77^{C}±30.91	702.88^{D}±27.98	666.30^{D}±23.09	537.12^{D}±22.79	367.27^{C}±15.73	557.02^{D}±29.93
Railmagra	439	406.09^{B}±23.06	631.43^{B}±20.11	689.41^{D}±15.72	507.95^{BC}±14.41	221.24^{A}±11.00	478.38^{B}±19.02
Devgarh	2031	882.47^{D}±20.18	988.85^{F}±17.13	805.54^{F}±12.78	637.35^{F}±10.78	460.02^{E}±9.16	756.12^{E}±14.33
Nathdawara	180	523.28^{E}±31.03	677.45^{C}±28.10	617.97^{C}±23.20	485.65^{B}±22.91	321.58^{B}±15.80	519.87^{C}±30.08
Bhadsora	419	767.88^{F}±26.52	665.33^{C}±23.62	590.52^{B}±19.05	519.15^{CD}±18.27	390.76^{D}±13.13	586.48^{D}±24.04
Bojunda	86	324.95^{A}±41.43	365.61^{A}±38.24	430.72^{A}±32.35	366.37^{A}±32.84	217.43^{A}±31.78	346.86^{A}±43.06
Season		*	**	NS	*	**	NS
Jul - Oct	1311	561.32^{B}±18.55	667.48^{AB}±15.40	627.82±10.99	507.09^{AB}±8.36	342.18^{C}±8.07	541.79±11.22
Nov - Feb	1509	577.09^{B}±18.76	685.35^{B}±15.62	639.43±11.22	499.19^{A}±8.68	327.91^{AB}±8.21	546.53±11.64
Mar - Jun	424	553.80^{A}±19.77	662.94^{A}±16.70	632.98±12.34	520.51^{C}±10.20	319.06^{A}±8.89	534.04±13.59
Period		**	**	**	**	**	**
2004-2007	854	485.77^{A}±20.25	494.57^{A}±17.21	538.34^{A}±12.86	473.82^{A}±10.88	331.83^{B}±9.21	463.48^{A}±14.46
2007-2010	571	650.54^{D}±20.40	696.68^{B}±17.36	664.88^{B}±13.01	517.27^{B}±11.08^{B}	324.97^{B}±9.31	565.99^{B}±14.72
2010-2013	892	580.67^{C}±19.86	733.59^{C}±16.79	664.27^{B}±12.43	530.63^{B}±10.33^{B}	349.20^{C}±8.95	573.27^{B}±13.74
2013-2016	927	539.32^{B}±21.60	762.87^{D}±18.61	666.16^{B}±14.26	514.00^{B}±12.64^{B}	312.86^{A}±10.08	560.40^{B}±16.73
Parity		**	**	**	**	**	**
1	950	408.86^{A}±19.10	507.79^{A}±15.98	518.38^{A}±11.60	426.91^{A}±9.21	276.99^{A}±8.44	427.17^{A}±12.31
2	680	546.16^{B}±19.24	658.45^{B}±16.13	626.55^{B}±11.76	512.21^{B}±9.43	324.67^{B}±8.54	539.84^{B}±12.59
3	549	603.81^{C}±19.50	720.57^{C}±16.41	667.33^{C}±12.04	536.87^{C}±9.82	341.70^{C}±8.71	570.14^{C}±13.09
4	376	625.52^{CD}±20.12	733.41^{C}±17.07	674.68^{C}±12.72	534.42^{C}±10.70	351.53^{C}±9.13	579.61^{C}±14.23
>5	689	636.02^{DE}±19.57	739.40^{C}±16.48	680.11^{C}±12.11	534.25^{C}±9.91	353.70^{C}±8.76	587.17^{C}±13.21
Type of Kidding		NS	NS	NS	NS	NS	NS
Single	2600	557.60±18.28	668.30±15.10	634.42±10.67	508.30±7.90	327.97±7.89	535.41±10.64
Multiple	644	570.54±19.25	675.55±16.15	632.40±11.77	509.56±9.45	331.46±8.55	546.16±12.62
Dam's weight regression b (kg/kg)		10.39±1.47**	7.26±1.39**	1.76±1.21**	0.19±1.26^{NS}	- 0.69±0.80^{NS}	3.59±1.65*

NOTE: LS Means with different superscripts differ significantly. ** = Highly significant (P≤0.01), * = Significant (P≤0.05), NS = Non-significant.

Table 2: Least squares analysis of variance for various factors affecting production traits in Sirohi goats.

Traits	D.F.	ADM_1 M.S.	AMD_2 M.S.	ADM_3 M.S.	AMD_4 M.S.	ADM_5 M.S.	ADM M.S.
Sire	139	124716.89**	88337.83**	47618.87**	31659.94**	24929.08**	56281.34**
Cluster	5	7481264.03**	5473305.84**	1438285.58**	853952.02**	1545961.51**	2782434.65**
Season	2	106387.16*	116571.64**	37073.64^{NS}	66444.49*	99469.44**	22906.27^{NS}
Year	3	2344639.73**	4088838.37**	1431073.31**	210329.63**	87193.59**	974963.56**
Parity	4	3803844.69**	4213174.81**	2061877.07**	1054240.91**	435668.84**	1996822.61**
Type of birth	1	69500.70^{NS}	21842.76^{NS}	1699.51^{NS}	653.67^{NS}	5074.07^{NS}	47998.1.4^{NS}
Reg. on DWK	1	1321401.51**	645560.18**	277412.63**	485.38^{NS}	5953.76^{NS}	157881.12*
Error	3088	26628.32	23766.35	17960.89	19573.24	7941.12	33523.92

Note ADM_1= Average daily milk yield (1st - 30 days), ADM_2= Average daily milk yield (31-60 Days), ADM_3= Average daily milk yield (61-90 Days), ADM_4= Average daily milk yield (91-120 Days), ADM_5 = Average daily milk yield (121-150 Days), ADM = Overall average daily milk yield, D.F. =Degree of freedom, M.S. = Mean squares, Reg. on DWK =Regression on weight of dam at kidding. ** = Highly significant (P≤0.01), *= Significant (P≤0.05).

milk of different lactation stages was not observed at definite pattern in different periods. However, highest average daily milk was recorded during period 2010-13 as compared to others periods, which might be due to the differences in plane of nutrition, availability of top feeds, cropping pattern and climatic conditions during different periods.

The season of birth had highly significant (P≤0.01) effect on ADM_2 and ADM_5, while significantly (P≤0.05) affected on ADM_1 and ADM_3 (Table 1). However, effect of season of birth was non-significant on overall average daily milk of lactation. Also non-significant effect of season on overall average daily milk yield in Sirohi goat was reported by Pathodiya *et al*. (2010). On the other hand, significant effect was observed on average daily milk yield by Singh and Ramchandran, (2007) and Swami *et al*. (2005). Highest average daily milk yield was recorded during second month (ADM_2) of lactation in winter season kidding doe as compared to other kidding season, which might be due to combined effect of weather and feeding conditions in a particular season. This was confirmed by Crepaldi *et al*. (2000) who observed that kidding season significantly affected the milk yield with goats kidding in winter season have higher milk production compared with those which kidded in the rainy and summer. Lower milk yield in rainy season may be linked to the greater occurrence of disease such as parasitical infestation and bacterial infection due to higher humidity and temperature.

The parity had statistically highly significant (P≤0.01) effect on average daily milk yield traits of all lactation stages. Milk yield increased gradually with the advancement of parity in the present study. In the same way, several researchers reported significant (P≤0.01) effect of parity on overall average milk yield of lactation (Yadav *et al*. 2004; Singh and Ramchandran, 2007; Pathodiya *et al*. 2010 and Mia *et al*. 2014. However, Swami *et al*. (2005) observed non-significant effect of parity on average daily milk yield in goat. The highest overall average milk yield was obtained in the fifth and above lactation, probably due to the increased animal size (greater digestive capacity) and udder combined with advancing age, which led to the development of the mammary glands (an increase in the number of alveoli and muscle fibres in a limb). Similarly Alkass and Merkhan, (2011) observed that milk yield of does increase gradually with increase of age in Alpine goat.

The effect of prolificacy was non-significant on average milk yield of all lactation stages under the study. However, doe's which have multiple births produced more milk in comparison to does having single kids, which may be due to the stimulus provided by the sucking kids that increases production. The present finding was in agreement with the reports of Swami *et al*. (2005) and Pathodiya *et al*. (2010) in Sirohi goats.

The regression of dam's weight at kidding was positive and highly significant (P≤0.01) on average daily milk yield on ADM_1, ADM_2, ADM_3 and significant (p≤0.05) to overall average daily milk yield of lactation. It indicated that body weight influenced the average daily milk yield of lactation. Gall, (1981) reported that body weight was the main source of variation in milk yield, he reported regression coefficient of milk yield on body weight to be 4.76 units in goat and Singh and Ramchandran (2004) and Hermiz *et al*. (2004) also reported that significant effect of dam's weight at kidding on average daily milk in goat.

Genetic and phenotypic parameters

The heritability estimates of all the average daily milk parameters in the present study were found ranging from 0.03±0.01 to 0.19±0.02 (Table 3). There are no literature references regarding estimated heritability for average daily milk yield at different lactation period in Sirohi goat so far. However, the estimated heritability for overall average daily milk yield in Sirohi goat was comparable with other breeds of goat.

The heritability estimates ranged from low to moderate indicated that non-additive genetic variance had greater influence. Similar heritability estimates was reported as 0.15±0.04 in Black Bengal goat by Mia *et al*. (2014). However, higher heritability estimates were reported for overall average daily milk yield (Pathodiya *et al*. 2010; Rai *et al*. 2001) in Sirohi goat.

The heritability estimate obtained from average daily milk yield was low, indicating that selection for ADM will take long time. The low heritability estimate and the fact that the trait can only be measured in female suggest that progeny testing is the best sire selection method for this particular trait. The low heritability of ADM indicated that higher ADM could be better achieved through a better control of the environmental conditions associated with the trait.

Table 3: Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlations (below diagonal) among productive traits in Sirohi goats.

Traits	ADM_1	ADM_2	ADM_3	ADM_4	ADM_5	ADM
ADM_1	0.19±0.02	0.81±0.04	0.72±0.07	0.69±0.12	0.53±0.09	1.26±0.08
ADM_2	0.57	0.14±0.02	0.95±0.03	0.79±0.11	0.53±0.09	1.26±0.08
ADM_3	0.38	0.58	0.09±0.01	1.01±0.09	0.59±0.09	1.17±0.06
ADM_4	0.16	0.27	0.39	0.03±0.01	1.04±0.08	1.24±0.12
ADM_5	0.12	0.24	0.33	0.44	0.12±0.09	0.97±0.09
ADM	0.41	0.43	0.57	0.36	0.30	0.04±0.01

Note: ADM_1 (average of 1st to 30th day milk yield), ADM_2 (average of 31st to 60th day milk yield), ADM_3 (average of 61st to 90th day milk yield), ADM_4 (average of 91st to 120th day milk yield), ADM_5 (average of 121st to 150th day milk yield), ADM (Overall average daily milk yield).

Phenotypic and genetic correlations

The genetic correlations obtained were positive and high between average daily milk of different lactation periods. The high estimates of genetic correlations of average milk yield of different periods with overall average daily milk yield indicated pleiotropic effects of genes. Yadav *et al*. (2004) observed high genetic correlation between 150 days milk yield with peak milk yield in Kutchi goat. The phenotypic correlations were positive and low between ADM_1 and ADM_4, ADM_5 and medium between ADM_1 and ADM_4, ADM_5. This may be due to decline milk yield after peak during lactation process. Medium phenotypic correlations were observed between peak milk yields with overall average daily milk yield by Pathodiya *et al*. (2010) in Sirohi goat.

CONCLUSION

The study has shown the importance of non-genetic factors including clusters, year of kidding, season of kidding and parity for average daily milk traits in Sirohi goat in breeding tract. However, the influences of these factors on milk performance traits are not independent. Season and parity influence seems unavoidable in goat milk production; it is actual and relatively important amid the other source of variation. Estimates of heritability for all traits of average daily milk considered for this study were low, therefore there is ample scope of improvement of these traits through selection. However, the non-genetic effects were very important to milk performance of Sirohi, Therefore, it needs to be controlled or adjusted for comparing animal's efficiency and accurate genetic evaluation in Sirohi goat.

Conflict of Interest

The authors declare that there are no conflict of interest among authors and other people and organization.

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