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RESEARCH ARTICLE

FACTORS AFFECTING PRODUCTION PERFORMANCE OF SIROHI GOATS UNDER FIELD CONDITIONS

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ABSTRACT

The present investigation was conducted to study the production performance of Sirohi goats under field conditions. The overall least-squares means for production traits 90 days milk yield (90 DMY), 150 days milk yield (150 DMY), total milk yield (TMY), lactation length (LL) and dry period (DP) were 61.79 ± 2.48 lit., 90.96 ± 2.58 lit., 91.08 ± 2.56 lit., 150.75 ± 0.72 days and 151.63 ± 14.25 days respectively. Sire, cluster and year of birth had highly significant ($P \leq 0.01$) effect on all lactation traits. Season of birth had highly significant ($P \leq 0.01$) effect on all lactation traits except on dry period. Parity had highly significant ($P \leq 0.01$) effect on all lactation traits except on lactation length. Regressions of dam's weight at kidding were positive and highly significant ($P \leq 0.01$) effect on all lactation traits except on lactation length. Heritability estimate of all production traits were medium to high, ranges from 0.391 ± 0.087 for dry period to 0.652 ± 0.101 for 90 days milk yield indicating scope for further improvement through selection and effective management practices.

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INTRODUCTION

India produces largest amount of goat milk (4.85 million kg) followed by Bangladesh (2.60 million kg) and Sudan (1.53 million kg) as per FAOSTAT (2012). India is a rich repository of goat genetic resources in the form of 23 well defined breeds (NBAGR, 2013). The total goat population of country was 135.17 million, which constituted 26.40 % of total livestock population (Livestock census, 2012). Rajasthan ranks first in the country contribute 16.03 % of total goat population. Among various goat genotypes available, the Sirohi is one of the principal and renowned breed of goats in Rajasthan. Animal of this breed is medium to large in size and mainly reared for milk and meat by rural poor people. Production traits are affected by various non-genetic factors like sex, season, year and type of birth, obscuring recognition of genetic potential (Kumar *et al.,* 2007). Milk production of does also affect early growth and survival of their kids. The information available in the literature with regard to effect of genetic and non-genetic factors affecting production traits under field condition (Tyagi *et al.* 2013 in Surti goats and Pathodiya *et al.* 2010 in Sirohi goats), organized farms (Singh and Ramachandran, 2007 in Sirohi goats and Swami *et al.* 2005 in Sirohi and its crosses with Beetal) and also by other authors (Sangare and Pandey, 2000; Greyling *et al*., 2004; Prasad *et al*., 2005; Guney *et al*., 2006; Carnicella *et al*., 2008) suggested their consideration in formulating strategies for genetic improvement of goats to help the goat breeders to minimize the losses.

The present study was conducted to determine various genetic and non-genetic factors influencing lactation traits and also for estimation of genetic parameters. Selection criteria are also discussed to make appropriate breeding programme for bringing consistent genetic improvement in the flock of Sirohi goats under field conditions.

MATERIALS AND METHODS

Experimental information: The detailed information of all the animals on production trait was collected from farmer's flock under field condition, which were maintained under All India Coordinated Research Project (AICRP) on Sirohi goats, Livestock Research Station (LRS), Navania, Udaipur,

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Table 1. Least-squares means and S.E. for milk production (lit.) of Sirohi goat

Factors \ Traits	90 Days M. Y.	150 Days M. Y.	Total M. Y.	Lactation Length (Days)	Dry Period (Days)
Overall mean (μ)	61.79 ± 2.48 (1892)	90.96 ± 2.58 (1405)	91.08 ± 2.56 (1405)	150.75 ± 0.72 (1405)	151.63 ± 14.25 (1384)
Sire	**	**	**	**	**
Cluster	**	**	**	**	**
Vallabhnagar	49.48 ± 3.61^{a} (29)	78.09 ± 4.14^{a} (27)	78.92 ± 4.14^{a} (27)	149.47 ± 1.24^{a} (27)	100.18 ± 26.24^{a} (27)
Railmagra	55.65 ± 2.76^{b} (302)	82.94 ± 3.04^{b} (244)	83.16 ± 3.03^{a} (244)	153.31± 0.88^{b} (244)	117.72 ± 17.98^{a} (244)
Devgarh	78.85 ± 2.60^{d} (1114)	114.21 ± 2.77^{d} (914)	114.53 ± 2.75^{d} (914)	150.74 ± 0.78^{ba} (914)	251.64 ± 15.80^{c} (893)
Nathdwara	59.38 ± 4.82^{b} (15)	86.44 ± 5.71^{b} (13)	87.56 ± 5.74^{ba} (13)	147.10 ± 1.76^{a} (13)	127.00 ± 37.45^{ab} (13)
Bhadsoda	65.60 ± 2.89^{c} (432)	93.10 ± 3.28^{cb} (207)	94.22 ± 3.28^{cb} (207)	153.10 ± 0.96^{b} (207)	161.60 ± 19.82^{b} (207)
Season	**	**	*	**	NS
Rainy	60.61 ± 2.50^{a} (666)	89.35 ± 2.62^{a} (543)	89.49 ± 2.60^{a} (543)	150.87 ± 0.73^{b} (543)	145.24 ± 14.59 (537)
Winter	62.65 ± 2.49^{ba} (961)	90.71 ± 2.63^{a} (646)	91.12 ± 2.61^{b} (646)	151.55 ± 0.73^{c} (646)	153.67 ± 14.61 (635)
Summer	62.11 ± 2.55^{b} (265)	92.80 ± 2.70^{b} (216)	92.62 ± 2.68^{b} (216)	149.82 ± 0.76^{a} (216)	155.97 ± 15.22 (212)
Year of birth	**	**	**	**	**
2007-08	57.95 ± 2.59^{a} (226)	88.92 ± 2.76^{a} (213)	89.93 ± 2.75^{a} (213)	153.31 ± 0.78^{c} (213)	126.08 ± 15.76^{a} (208)
2008-09	60.94 ± 2.61^{b} (221)	90.27 ± 2.79^{ab} (193)	90.32 ± 2.77^{a} (193)	150.52 ± 0.79^{ba} (193)	130.39 ± 15.96^{a} (189)
2009-10	61.27 ± 2.60^{b} (234)	88.32 ± 2.80^{a} (165)	88.30 ± 2.78^{a} (165)	150.63 ± 0.79^{ba} (165)	143.16 ± 16.05^{a} (157)
2010-2011	61.26 ± 2.56^{b} (381)	90.03 ± 2.70^{a} (318)	90.29 ± 2.69^{a} (318)	150.52 ± 0.75^{b} (318)	179.06 ± 15.25^{c} (314)
2011-2012	62.99 ± 2.57^{c} (399)	92.25 ± 2.74^{b} (269)	91.99 ± 2.72^{ba} (269)	149.87 ± 0.77^{a} (269)	161.11 ± 15.51^{b} (269)
2012-2013	66.34 ± 2.59^{d} (431)	95.96 ± 2.83^{c} (247)	95.62 ± 2.82^{b} (247)	149.56 ± 0.81^{a} (247)	169.98 ± 16.31^{bc} (247)
Parity	**	**	**	NS	**
1st	51.87 ± 2.54^{a} (573)	75.43 ± 2.70^{a} (417)	75.33 ± 2.68^{a} (417)	150.16 ± 0.76 (417)	86.57 ± 15.21^{a} (415)
2nd	61.17 ± 2.52^{b} (434)	89.91 ± 2.66^{b} (349)	90.06 ± 2.64^{b} (349)	150.88 ± 0.74 (349)	133.05 ± 14.85^{b} (348)
3rd	65.12 ± 2.53^{c} (332)	96.24 ± 2.68^{c} (264)	96.39 ± 2.66^{c} (264)	150.68 ± 0.75 (264)	172.46 ±15.06^{c} (257)
4th	65.30 ±2.56^{c} (239)	97.59 ± 2.75^{c} (176)	97.85 ± 2.73^{c} (176)	151.29 ± 0.77 (176)	193.94 ± 15.60^{d} (171)
≥ 5th	65.50 ± 2.58^{c} (314)	95.63 ± 2.79^{c} (199)	95.75 ± 2.78^{c} (199)	150.72 ± 0.79 (199)	172.11 ± 16.02^{c} (193)
Type of birth	*	NS	NS	NS	NS
Single	62.48 ± 2.48^{b} (1454)	91.34 ± 2.58 (1108)	91.40 ± 2.56 (1108)	150.59 ± 0.72 (1108)	154.58 ± 14.22 (1093)
Multiple	61.11 ± 2.52^{a} (438)	90.58 ± 2.67 (297)	90.75 ± 2.65 (297)	150.90 ± 0.75 (297)	148.68 ±14.96 (291)
Regression on weight of dam at kidding	**	**	**	NS	**
Regression coefficient (b) (kg/kg)	1.23 ± 0.15	0.80 ± 0.21	0.76 ± 0.21	0.10 ± 0.06	4.55 ±1.44

NOTE: No. of observations are given in parentheses. Estimates with different superscripts differ significantly. ** = Highly significant (P≤0.01), * = Significant (P≤0.05), NS = Non-significant

Table 2. Estimates of heritability (on diagonal), genetic correlation (above diagonal) and phenotypic correlation (below diagonal) among milk production trait in Sirohi goats

Trait	90 Days Milk Yield	150 Days Milk Yield	Total Milk Yield	Lactation Length	Dry Period
90 Days Milk Yield	0.652 ± 0.101	0.684 ± 0.008	0.671 ± 0.011	-0.205 ± 0.151	0.650 ± 0.049
150 Days Milk Yield	0.515 ± 0.013	0.614 ± 0.108	0.596 ± 0.001	-0.034 ± 0.149	0.594 ± 0.039
Total Milk Yield	0.601 ± 0.010	0.696 ± 0.010	0.594 ± 0.106	0.048 ± 0.150	0.498 ± 0.038
Lactation Length	-0.042 ± 0.030	0.071 ± 0.027	0.150 ± 0.026	0.475 ± 0.095	0.032 ± 0.169
Dry Period	0.588 ± 0.017	0.502 ± 0.020	0.602 ± 0.017	0.093 ± 0.026	0.391 ± 0.087

Note: Phenotypic correlations are highly significant tested by't' test.

(Rajasthan) born during 2007-2013. Under this project all Sirohi breeders were identified in the field. Elite Sirohi bucks were distributed among selected flocks maintained by farmers of Udaipur, Rajasamand and Chittorgarh districts of Rajasthan. Selected male kids were purchased from farmer's flocks on the basis of higher body weight and 60-90 days milk yield of respective dams. Breeding bucks properly tagged were reared and maintained at LRS under AICRP, Vallabhnagar during off breeding season and distributed to identified farmers during breeding season. Different bucks were rotated among farmers in different breeding seasons. The kids born out of such mating were tagged and their pedigree records were maintained at LRS, Vallabhnagar.

Rearing and management: The Sirohi goats of studied area were maintained under field grazing (Extensive system). Goats remained on pasture every day six to eight hours for grazing. Various types of tree, shrubs and grasses were available in pastureland of project area during different seasons of the year. Most of the goat keepers used un-chaffed dried fodder and un-soaked concentrate in semi-stall feeding.

Data classification: The data were classified into five clusters of three districts *viz*., (1) Vallabhnagar cluster of Udaipur district, (2) Railmagra, (3) Devgarh, (4) Nathdwara clusters of Rajasamand district, and (5) Bhadsoda cluster of Chittorgarh district, three seasons of birth *viz*. (1) rainy (July-October), (2) winter (November-February) and (3) summer (March-June), 6 years of birth from April month of the year up to March month of next calendar year, year 1 (2007-08), year 2 (2008-09), year 3 (2009-10), year 4 (2010-11), year 5 (2011-12), and year 6 (2012-13), five parity (1, 2, 3, 4, and ≥5), two types of birth:(1) single and (2) multiple and two sex:(1) Male and (2) female.

Traits studied: Five production traits were considered for analysis, viz. 90 days milk yield (90 DMY), 150 days milk yield (150 DMY), total milk yield (TMY), lactation length (LL) and dry period (DP). Repeated records of these traits were obtained for analysis.

Statistical methods: The data on production traits were analyzed through mixed model least-squares and maximum Likelihood Computer Program PC 2, Harvey. To study the effect of various genetic and non-genetic factors on production traits the statistical model used was as under:

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

Where,

$Y_{ijklmno}$= Performance record of the oth progeny of ith sire belonging to jth cluster, kth season of birth, lth year of birth, mth parity and nth type of birth

μ = Overall population mean

ai = Random effect of ith sire

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

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

Dl = Fixed effect of lth year of birth (l = 1, 2, 3, 4, 5, 6)

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

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

b ($DW_{ijklmno} - \overline{DW}$) = The regression of the trait on dam's weight at kidding

eijklmno= Random error NID (0, σ2)

Duncan's multiple range test as modified by Kramer (1957) was used to make pairwise comparison among the least-squares means.

Estimation of heritability

The heritability was estimated by sire component of variance-covariance obtained from the paternal half-sib analysis. The standard error of heritability was estimated as per Swiger *et al*. (1964).

Genetic and phenotypic correlations: The genetic and phenotypic correlations among traits were calculated from the analysis of variance and covariance among sire groups.

RESULTS AND DISCUSSION

The overall least-squares means for production traits 90 days milk yield (90 DMY), 150 days milk yield (150 DMY), total milk yield (TMY), lactation length (LL) and dry period (DP) were 61.79 ± 2.48 lit., 90.96 ± 2.58 lit., 91.08 ± 2.56 lit., 150.75 ± 0.72 days and 151.63 ± 14.25 days respectively (Table 1).

Effect of sire: The random effect of sire was highly significant (P≤0.01) on 90 days milk yield, 150 days milk yield, total milk yield, lactation length and dry period. The result is in agreement with the findings of Pathodiya *et al*. (2008) on dry period and Pathodiya *et al.* (2010) in Sirohi goats. Sire significantly affected the production traits indicating existence of additive genetic variability among these traits and significant influence of sire might be attributed to relative merits of the sires used.

Effect of cluster: Cluster-wise variation in 90 days milk yield, 150 days milk yield, total milk yield, lactation length and dry period was highly significant (P≤0.01). Similar observations were in accordance with Gokhale *et al.,* (1997), Mandal *et al.* (2010) and Tyagi *et al.* (2013) for production traits. These differences may be attributed to differences in managemental practices between clusters. Significantly highest 90 days milk yield, 150 days milk yield and total milk yield was observed in Devgarh cluster compared with other four clusters and lowest estimates in Vallabhnagar cluster. Railmagra cluster have highest Lactation length followed by Bhadsoda and Devgarh. Total milk production was highest in Devgarh cluster but lactation length was highest in Railmagra cluster, it indicates Devgarh cluster animals performing better than Railmagra cluster. Dry period was least in Vallabhnagar cluster and highest in Devgarh cluster, huge difference was seen in dry period of these two clusters, however Devgarh cluster have almost second position lactation length. The longer dry period indicated failure of does to conceive within 40 days of parturition. Reason for this may be the problem of infertility. Devgarh cluster animals need to provide good managemental practices and balance nutritional ration which subside the breeding problems like repeat breeding and also need to watch on estrous period, artificial insemination and embryo transfer techniques.

Effect of season: Influence of season of birth was highly significant ($P \leq 0.01$) on 150 days milk yield and lactation length, significant ($P \leq 0.05$) 90 days milk yield and total milk yield. This finding is in agreement with Gokhale *et al.,* (1997) on lactation yield, Swami *et al.* (2005) on lactation yield, Prasad *et al.* (2005) on total milk yield, Gurjar *et al.* (2005), Mandal *et al.* (2010) and Tyagi *et al.* (2013) on all lactation traits. Non-significant effect of season was reported by Singh and Ramachandran (2007) on all production traits, Pathodiya *et al.* (2008) on dry periods.

The lowest and highest 150 days milk yield and total milk yield were observed in goats kidded during rainy and summer season respectively. The lactation length of goats kidded during winter season was higher than those kidded during summer and rainy season. The total milk yield of goats kidded during summer and winter was 3.50% and 1.82% higher as compared to goats kidded during rainy season. Significantly lower lactation performance of Sirohi goats kidded during rainy season might be attributed to climatic stress of higher humidity and rainfall during rainy season. Non-significant variation was observed in the dry periods of Sirohi goats born during all three seasons. These seasonal differences in lactation performance calls for implementation of mating plans with proven bucks to minimize seasonal differences and fulfilling demand of goat milk throughout the year.

Effect of year: Effect due to year of kidding were found to be highly significant ($P \leq 0.01$) on 90 days milk yield, 150 days milk yield, total milk yield, lactation length and dry period. Swami *et al.* (2005), Gurjar *et al.* (2005), Kumar *et al.* (2006), Singh and Ramachandran (2007) and Pathodiya *et al.* (2008) were reported significant effect on dry periods, Pathodiya *et al.* (2010) was reported significant effect on total Lactation milk yield and total lactation length. Tyagi *et al.* (2013) also reported significant effects of year of kidding on these traits. The 90 days milk yield was increasing from year 2007 to 2013. The 150 days milk yield and total milk yield were observed increasing order from year 2009 to 2013. Highest lactation length was observe in year 2007, then remain constant for three years and goes decrease in last two years. Dry period was increasing pattern up to 2011 and then decreases. The period differences might be due to variability in environmental conditions and differential availability of pastures during these periods.

Effect of parity: Parity wise variation in 90 days milk yield, 150 days milk yield, total milk yield and dry period was highly significant ($P \leq 0.01$), whereas lactation length was non-significant. The result is in agreement with the findings of Prasad *et al.* (2005), Kumar *et al.* (2006), Singh and Ramachandran (2007), Sabapara *et al.* (2010), Mandal *et al.* (2010) and Tyagi *et al.* (2013). Milk yield was lowest for animals kidding for first time. The 90 days milk yield was in increasing order from first parity to fifth and above parity. 150 days milk yield, total milk yield and dry period were increased up to fourth parity but slightly declined in fifth parity. Total milk yield was reached its maximum in the fourth parity. The lactation length did not differ significantly between parities. Increase in milk yield with increase in parity would be due to the growth and development of different body system, especially the udder. The decline in milk yield after the attainment of maximum milk production would occur due to senile change which set in with ageing and result in a decrease of functionally active tissue of the udder.

Effect of type of birth: Type of kidding had significant ($P \leq 0.05$) effect on 90 days milk yield. Similar results were observed by Gokhale *et al.,* (1997) and Gurjar *et al.* (2005). Non-significant difference was observed by Swami *et al.* (2005) on all lactation traits except daily milk yield and Mandal *et al.* (2010). The 90 days milk yield was higher in single born kids than the multiple.

Effect of dam's weight at kidding: The regression of dam's weight at kidding had significant ($P \leq 0.01$) effect on 90 days milk yield, 150 days milk yield, total milk yield and dry period, however non-significant on lactation length. These findings were in agreement to the observations of Swami *et al.* (2005) except lactation length and Singh and Ramachandran (2007). Pathodiya *et al.* (2010) was reported non-significant effect on production traits. The regression of dam's weight at kidding was significant on all production traits, which indicated that heavier does at kidding had higher 90 days milk yield, 150 days milk yield, total milk yield.

Genetic and phenotypic parameters for production traits: The results regarding estimated genetic and phenotypic parameters *viz*. heritability, genetic and phenotypic correlations of a population are presented in Table 2. The heritability estimates for production traits under study were of high magnitude. The heritability estimates for production traits ranged between 0.391 ± 0.087 to 0.652 ± 0.101. Similar results were also reported by Pathodiya *et al.* (2010). This indicates, sire used in the field have different in genetic potential. Therefore, these traits can be improved through approaching mass selection. The genetic correlation obtained was positive and high except lactation length with 90 and 150 days milk yield was negative correlation. The phenotypic correlation's except lactation length with 90 days milk yield (low and negative) was positive and high among production traits under study. The positive genetic correlation of 90 days milk yield and 150 milk yield with total milk yield indicated selection for higher total milk yield would increase milk yield and simultaneously provides a selection criterion in the early lactation.

Conclusion

The present study shows that cluster and year of birth are major source of variation for milk production performance of Sirohi goats in the field conditions. The sires used for breeding in the farmers flock has shown significant differences reflected on the growth and production performance of the progeny. Hence while redistribution sires in farmer's flock inferior sires should be culled on the basis of progeny proofs. Positive and high genetic correlations among milk production traits indicate that these traits were possibly governed mostly by same set of genes and effective selection on the basis of part production performance would lead to improvement in other correlated traits. Milk potential, variability among the breed and factors affecting production performance analyse in the present study flagstone the baseline information for further genetic improvement of Sirohi goats for milk production.

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