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Growth and prolificacy performance of Garole sheep raised under semi-arid conditions

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ABSTRACT

The growth and prolificacy performance of Garole sheep reared under semi-arid conditions at ICAR-Central Sheep and Wool Research Institute, Avikanagar, Rajasthan was evaluated in the present study. The body weight records of 1,058 lambs and prolificacy records of 624 ewes collected over a period of 19 years (1997–2015) were analyzed. The overall least squares mean for body weights at birth (BWT), 3 month (3WT), 6 month (6WT), 9 month (9WT), 12 month (12WT), pre-weaning (0–3 month) average daily gain (ADG1) and post weaning (3–6 month) average daily gain (ADG2) were 1.18±0.02 kg, 6.42±0.12 kg, 9.87±0.18 kg, 11.77±0.25 kg, 13.74±0.32 kg, 56.87±1.22 g and 40.19±1.39 g, respectively. The effect of sex of lamb, period of birth and dam weight at lambing were significant for all growth traits. Significant variation in growth performance, multiple birth and litter size was observed over the period. The body weight and average daily gain of Garole sheep improved over the years. In last 15 years, improvement ranging from 19.56 to 29.51% was observed for various growth traits studied. The multiple births in Garole ewes were 58.01% with a litter size of 1.68 at birth. The prolificacy and litter size in semi-arid conditions were similar to the native tract especially in initial period. Period of lambing and weight of dam at lambing significantly affected litter size at birth. Results showed that Garole performed well in the semi-arid conditions and can be successfully reared in these conditions with updated management.

Key words: Body weight, Daily gain, Garole sheep, Litter size, Prolificacy

Livestock populations in the world occur in a wide variety of environments to which they have been well adapted and large variation is observed in their physical and functional characteristics as well as in their levels of productivity. Low production or small size is itself an adaptive attribute as it is an advantage in hot climates but many a times their low genetic potential is confounded by the low standard of management under which indigenous livestock are usually kept (Mpfou 2002). Garole sheep is found in the Sundarban region of West Bengal of India. They are also distributed in Sundarban area in the southern part of Bangladesh (Islam and Shahjalal 2001). It is a small sized breed known for its prolificacy and adaptation to the saline marshy land of Sundarban region. They are highly fecund, which regularly produce twins and triplets (Pan and Sahoo 2008).This breed is mainly reared for meat production. The breed is known for its high prolificacy and has been utilized in various breeding experiment to improve the prolificacy of non-prolific sheep breeds in India. In native tract, the reports are available on performance of this breed (Ghalsasi and Nimbkar 1993, Singh and Bohra 1996, Pan and Sahoo 2008). Several studies on performance in semi-arid region were reported earlier (Sharma *et al*. 1999, Mishra *et al*. 2005, Mishra *et al*. 2006). Present study was undertaken to evaluate the growth and prolificacy performance and various factors affecting them in Garole sheep reared under semi-arid conditions of Rajasthan.

MATERIALS AND METHODS

The Garole sheep flock was developed at ICAR-Central Sheep and Wool Research Institute (CSWRI), Avikanagar by procuring of these animals in year 1997 and 2000 from its native tract and its subsequent rearing, breeding and management in semi-arid conditions of Rajasthan. All the animals were maintained under semi-intensive management on similar grazing/feeding regime. The feeding, breeding and healthcare management followed at the farm were similar to those reported by Mishra *et al.* (2006). The body weight records of 1058 lambs born during 1997 to 2015 and prolificacy record of ewe lambed were collected from the data register maintained at the ICAR-CSWRI, Avikanagar. The data were classified into four periods comprising years 1997 to 2000 (period 1), 2001 to 2004 (period 2), 2005 to 2009 (period-3) and 2010 to 2015 (period 4). The lambing in different month was grouped into three

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season classes i.e winter from November to February, summer from March to June and monsoon from July to October. At lambing, both lambs and dams were weighed and the lambing date, sex and type of birth of each lamb were recorded. Animals were treated in the same way in different seasons with respect to management and concentrate supplementation. Different economic traits used for the analysis were body weights at birth (BWT), 3 month (3WT), 6 month (6WT), 9 month (9WT),12 month (12WT), pre-weaning (0–3 month) average daily gain (ADG1) and post-weaning (3–6 month) average daily gain (ADG2). Least squares procedure (General Linear Model SPSS 15) was used to analyze the effect of various factors on different growth traits. The fixed effects considered in the model were sex of lamb, type of birth, parity of dam, season of lambing and period of lambing. For studying type of birth effect, data of lambs born as quadruplets were merged with triplets born lambs due to fewer numbers of observations. Similarly, all the lambs born to dam in 5^{th} parity and above were grouped in one class for analyzing parity effect. Dam age at lambing and dam weight at lambing was taken as covariate. The ewe prolificacy in different period was also analyzed. The frequencies of multiple birth and litter size were calculated on the basis of number of live lambs born per ewe per lambing. The effect of various factors on litter size at birth was analyzed using GLM of SPSS. The linear model included season of lambing, period of lambing and parity of dam as a fix effect and damage at lambing and dam weight at lambing as a co-variable.

RESULTS AND DISCUSSION

Growth performance: The R^2 value of the model, least squares means for body weights and effect of different factors are depicted in Table 1. The model applied explained 44.20, 40.20, 43.70, 41.0 and 40.5% variations in the body weights at birth (BWT), 3 month (3WT), 6 month (6WT), 9 month (9WT) and 12 month (12WT) of age. The overall least square means for BWT, 3WT, 6WT, 9WT and 12WT were 1.18±0.02 kg, 6.42±0.12 kg, 9.87±0.18 kg, 11.77±0.25 kg and 13.74±0.32 kg, respectively. The body weight recorded in present study was higher than the reports of Nimbkar *et al.* (1998), Sharma *et al.* (1999), Mishra *et al.* (2006), Pan and Sahoo (2008). Sharma *et al.* (1999) reported 0.82, 5.29, 7.47 and 11.54 kg body weight at birth, 3, 6, and 12 months age respectively; whereas, Mishra *et al.* (2006) reported body weights of 1.06, 5.86, 8.97, 11.42 and 13.67 kg at birth, 3, 6, 9 and 12 months age, respectively for Garole sheep in semi-arid conditions.

The effect of sex of lamb was significant (P≤0.01) for all body weights. Males were significantly heavier compared to females. Mishra *et al.* (2006) also reported significant effect of sex on all body weights except birth

Table1. Least Squares (±SE) means of body weight (kg) in Garole sheep

Particular	Birth wt. (BWT)	3 month wt. (3WT)	6 month wt. (6WT)	9 month wt. (9WT)	12 month wt.(12WT)
Overall mean	1.18±0.02 (1058)	6.42±0.12 (619)	9.87±0.18 (489)	11.77±0.25 (401)	13.74±0.32 (313)
Sex	**	**	**	**	**
Male	1.21±0.02 (550)	6.61±0.13 (328)	10.23±0.21 (251)	12.33±0.29 (192)	14.38±0.32 (137)
Female	1.15±0.02 (508)	6.23±0.14 (291)	9.51±0.18 (238)	11.21±0.30 (209)	13.10±0.32 (176)
Type of birth	**	**	**	**	**
Single	1.41±0.02 (263)	7.40±0.16 (173)	10.74±0.25 (137)	12.60±0.33 (114)	14.71±0.42 (87)
Twin	1.16±0.02 (579)	6.86±0.13 (341)	9.77±0.20 (268)	11.86±0.27 (222)	14.10±0.37 (177)
Triplet	0.97±0.03 (216)	5.80±0.21 (105)	9.10±0.33 (84)	10.85±0.46 (65)	12.42±0.58 (49)
Parity	NS	NS	NS	NS	**
1	1.14±0.03 (342)	6.67±0.20 (172)	9.67±0.31 (137)	11.51±0.45 (108)	13.58±0.56 (83)
2	1.15±0.02 (269)	6.60±0.16 (169)	9.71±0.24 (139)	11.54±0.33 (112)	12.58±0.43 (87)
3	1.18±0.03 (195)	6.43±0.18 (125)	9.43±0.28 (98)	10.85±0.39 (79)	12.84±0.49 (60)
4	1.22±0.04 (120)	6.73±0.25 (77)	10.25±0.41 (58)	12.39±0.55 (47)	14.79±0.67 (87)
≥5	1.21±0.05 (132)	6.08±0.32 (76)	10.28±0.51 (57)	12.55±0.66 (55)	14.91±0.79 (45)
Season	**	NS	**	**	NS
Winter	1.16±0.02 (533)	6.37±0.13 (291)	10.50±0.20 (221)	12.37±0.27 (194)	13.03±0.35 (147)
Summer	1.13±0.03 (140)	6.36±0.24 (64)	10.10±0.38 (56)	12.26±0.54 (43)	13.34±0.73 (28)
Monsoon	1.25±0.02 (385)	6.62±0.14 (264)	9.00±0.23 (212)	10.68±0.32 (164)	13.95±0.40 (138)
Period	**	**	**	**	**
Period-1	1.06±0.03 (205)	6.03±0.20 (102)	8.81±0.31 (87)	10.58±0.41 (72)	12.93±0.49 (60)
Period-2	1.11±0.02 (439)	6.04±0.14 (256)	9.31±0.23 (214)	11.24±0.32 (166)	12.84±0.41 (145)
Period-3	1.19±0.03 (232)	6.07±0.18 (143)	9.94±0.32 (90)	11.97±0.40 (87)	13.74±0.55 (55)
Period-4	1.36±0.043 (182)	7.54±0.21 (118)	11.41±0.33 (98)	13.28±0.47 (76)	15.46±0.60 (53)
Regression of dam age at lambing	NS	NS	NS	NS	NS
Regression of dam weight at lambing	**	**	**	**	**
R^2	44.20	40.20	43.70	41.00	40.50

Figures within parentheses are number of observations. **P<0.01; *P<0.05; NS, non-significant.

weight. The effect of type of birth of lambs significantly affected the growth performance in Garole sheep. Mishra *et al.* (2006) also reported significant effect of type of birth on all body weights except 12WT in Garole sheep. The single born lambs recorded highest growth, followed by twin born lambs. The triplet born lambs attained lowest body weight at all stages of growth. The single born lambs were 45.36, 27.59, 17.25, 16.13 and 18.44% heavier compared to triplet born lambs at birth, 3, 6, 9 and 12 months age, respectively. The differences were higher at birth and it narrowed as stage of the growth advanced. The higher differences observed up to weaning may be attributed to dependency of lambs on dam and sharing of resources between litter mates. Nimbkar *et al.* (1998) reported lower birth, 3, 6, 9 month body weights but higher 12 month weight for single and twin born compared to present findings. Mishra *et al.* (2006) reported lower body weights for single, twin and triplet born lambs compared to present study. Effect of parity was significant only for 12WT. The effect of season of birth was significant (P<0.01) for BWT, 6WT and 9WT only. Lambs born in the winter recorded higher 6WT and 9WT. Effect of period was significant on all body weight traits. For the period-1, BWT, 3WT, 6WT, 9WT and 12WT were 1.06±0.03, 6.03±0.20, 8.81±0.3, 10.58±0.41 and 12.93±0.49 kg, respectively; and the corresponding figures for the period-4 were 1.36±0.03, 7.54±0.21, 11.41±0.33, 13.28±0.47 and 15.46±0.60 kg, respectively. In last 15 years, improvement of 28.30, 25.04, 29.51, 25.51 and 19.56% was observed in BWT, 3WT, 6WT, 9WT and 12WT, respectively, which clearly show adaptability of this breed in semi-arid conditions. As the environment improves, either by natural factors or through good management and increased inputs, the improvement of local breeds through selection can be considered (Mpofu 2002). The effect of dam age at lambing was nonsignificant for all body weight traits. Ewe/dam weight at lambing significantly affected the body weights at different growth stages. Mishra *et al.* (2006) also observed significant effect of dam weight at lambing on body weights. The effect of these factors on body weight can be explained in part by differences in endocrine system of male and females, type of birth, sharing of resources between litter-mates, limited uterine space in young ewes, differences in maternal behaviour and mothering ability of ewes in different parity and differences in availability of nutrient in different season and periods.

Average daily gain: The R^2 value of the model, least squares means for average daily gain and effect of different factors are depicted in Table 2. The model applied explained 33.30 and 27.30% variations in the pre-weaning (ADG1) and post-weaning (ADG2) average daily gains. The pre-weaning and post-weaning average daily gains recorded in this study were higher than the previous reports of Mishra *et. al.* (2006) for Garole sheep in semi-arid conditions. The effect of sex of lamb was significant on ADG1 and ADG2. Mishra *et al.* (2006) also reported significant effect of sex of lambs on ADG1 but reported non-significant effect of sex of lamb on ADG2. Males recorded higher pre-weaning and post-weaning growths compared to females. The type of birth of lambs significantly affected ADG1 but its effect on ADG2 was non-significant in Garole sheep. Mishra *et al.* (2006) also reported similar effect of type of birth on ADG1 and ADG2. The single born lambs recorded higher ADG1 but lower ADG2 compared to twin and triplet born lambs. The difference in pre-weaning and post-weaning average daily gains between single and twin born lamb may be attributed to higher compensatory growth for the twin/ triplet born lambs in post-weaning phase. Effect of parity was significant (P≤0.05) for ADG1 and ADG2.The effect of season of birth was significant (P≤0.01) for ADG2 and non-significant for ADG1. Lambs born in the monsoon months recorded lowest ADG2. Effect of period was significant on ADG1 and ADG2. For the period-1, ADG1 and ADG2 were 53.40±2.11and 37.70±2.33 g, respectively. For the period-4, ADG1 and ADG2 were 67.94±2.19 and 47.26±2.50 g, respectively. In last 15 years, improvement of 27.23 and 25.36%, was observed in ADG1 and ADG2, respectively. The effect of dam age at lambing was nonsignificant on ADG1 and significant on ADG2. Dam weight at lambing significantly affected ADG1 and ADG2.

Table 2. Least squares (±SE) means of average daily gain (g) in Garole sheep

Particular	0-3 months average daily gain (ADG1)	3-6 months average daily gain (ADG2)
Overall mean	56.87±1.22 (619)	40.19±1.39 (479)
Sex	*	**
Male	58.47±1.40 (328)	42.80±1.61 (245)
Female	55.26±1.48 (291)	37.57±1.70 (234)
Type of birth	**	NS
Single	65.03±1.65 (173)	39.45±1.89 (130)
Twin	53.39±1.32 (341)	40.19±1.50 (267)
Triplet	52.18±2.20 (105)	40.42±2.52 (82)
Parity	*	*
1	60.25±2.14 (172)	34.67±2.34 (131)
2	54.75±1.67 (169)	38.88±1.81 (139)
3	57.26±1.87 (125)	35.63±2.15 (96)
4	59.70±2.65 (77)	43.92±3.09 (57)
5 and above	52.38±3.40 (76)	47.83±3.87 (56)
Season	NS	**
Winter	56.55±1.33 (291)	46.64±1.55 (218)
Summer	56.53±2.57 (64)	42.86±2.88 (56)
Monsoon	57.52±1.51 (264)	31.07±175 (205)
PERIOD	**	**
Period-1	53.40±2.11 (102)	37.70±2.33 (85)
Period-2	53.41±1.52 (256)	36.41±1.71 (210)
Period-3	52.71±1.93 (143)	44.38±2.39 (88)
Period-4	67.94±2.19 (111)	47.26±2.50 (96)
Regression of dam age at lambing	NS	NS
Regression of dam weight at lambing	**	**
R^2	33.30	27.30

Figures within parentheses are number of observations. **P≤0.01; * P≤0.05; NS, non-significant.

Mishra *et al.* (2006) also reported significant effect of dam weight at lambing on ADG1 and ADG2 in Garole sheep.

Prolificacy: The prolificacy expressed in terms of multiple birth percentage is presented in Table 3. Overall frequency of multiple births was 58.01% with distribution of single, twin, triplet and quadruplets lambing as 41.99, 46.47, 10.10 and 1.44%, respectively. For all period except period-3, similar incidence of multiple birth was found. Twining was more common than single birth. Various studies reported similar pattern for twin birth in Garole sheep. Singh and Bohra (1996) reported 25–30% singles, 55–60% twins, 15–20% triplets and 1–2% quadruplets lambing in the farmers' flocks of native tract. Bose *et al.* (1999) reported incidence of single, twin, triplet and quadruplet birth as 41.63, 43.35, 14.85 and 0.21% . Sharma *et al.* (1999) observed percentage of ewe giving single, twin, triplet and quadruplet as 40.00, 53.33, 5.00 and 1.67% in semi-arid region of Rajasthan. Mishra *et al.* (2005) reported distribution of single, twin, triplet and quadruplets lambing as 33.51, 47.94, 17.01 and 1.55%, respectively in semi-arid conditions. However, Ghalsasi and Nimbkar (1993) reported higher multiple births (92.70%) compared to our observation, in native tract of Garole sheep. According to Pradeshi *et al.* (2008), differences observed in fecundity could be due to various factors, namely environmental conditions, ewe parity, selection etc.

Litter size at birth: The detail of litter size and factors affecting it are given in Table 4. Overall least square means of litter size at birth was 1.68, which was lower than the litter size of 1.74 reported by Bose *et al.* (1999), 1.87 by Nimbkar *et al.* (2003) in the native tract of this breed and 1.87 and 1.80 by Sharma *et al.* (2001) and Mishra *et al.* (2005) respectively, in semi-arid region. Pan and Sahoo (2008) reported litter size of Garole sheep in its native tract for first to ten parities. It ranged from 1.63 to 1.79 for majority of parities barring few.

The season of lambing, parity of dam, dam age at lambing did not have any significant effect on litter size at birth. Similar, to present findings, Gaskin *et al.* (2005) also reported non-significant effect of dam age at lambing on litter size at birth. In contrast to present findings, Vostrey and Milerski (2013), Deribe *et al.* (2014) reported significant effect of parity on litter size in sheep. For litter size, there were no differences (P≤0.05) regarding lambing season, which differs from that reported by Koycegiz *et al.* (2009), but it agrees with the report of Deribe *et al.* (2014) and Sánchez-Dávila *et al.* (2015). The period of lambing and dam weight at lambing significantly affected litter size at birth. The prolificacy and litter size were also similar to the native tract especially in initial period. The litter size of 1.81±0.07 for period-1 and 1.81±0.05 for period-2 was observed which was similar to prolificacy of Garole sheep in its native tract, i.e. Sunderban area of West Bengal and semi-arid conditions. In the later period, marginal decline in litter size was observed, it ranged from 1.49 to 1.62 between years 2005–15. The periodic variations observed in litter size may be attributed to different factors like environmental conditions, parity, selection etc. In agreement with present finding, Gbangboche *et al.* (2006) and Sánchez-Dávila *et al.* (2015) also reported significant effect of year of lambing on litter size.

The results obtained clearly show adaptability of Garole sheep in semi-arid conditions. The environmental factors served as significant sources of variation for performance of animals. Hence, due consideration should be given for these environmental factors in general management to minimize their effects. The Garole can be successfully maintained away from its native tract for its effective utilization for improving the prolificacy of non-prolific sheep.

Table 3. Incidence of multiple birth in Garole ewes

Period	Ewe lambed	Type of birth (%)				
		Single	Twin	Triplet	Quadruplet	Multiple birth
1997-2000	118	39.83	47.46	9.32	3.39	60.17
2001-2004	249	39.36	44.98	14.06	1.61	60.64
2005-2009	149	50.33	43.62	5.37	0.67	49.67
2010-1015	108	38.89	52.78	8.33	-	61.11
Overall	624	41.99	46.47	10.10	1.44	58.01

Table 4. Least squares (±SE) means of litter size at birth in Garole sheep

Particular	Litter size at birth
Overall mean	1.68±0.034 (624)
Parity	NS
1	1.67±0.08 (142)
2	1.70±0.07 (168)
3	1.64±0.06 (126)
4	1.71±0.08 (84)
≥5	1.69±0.10 (104)
Season	NS
Winter	1.68±0.04 (311)
Summer	1.67±0.07 (84)
Monsoon	1.69±0.05 (229)
Period	**
Period-1	1.81±0.07 (118)
Period-2	1.81±0.05 (248)
Period-3	1.49±0.06 (150)
Period-4	1.62±0.07 (108)
Regression of dam age at lambing	NS
Regression of dam weight at lambing	**

Figures within parentheses are number of observations; **P≤0.01; * P≤0.05; NS, non-significant.

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