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Growth performance and effect of non-genetic factors affecting growth traits in Garole sheep

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Body weights of lambs at different ages are the reflection of the adaptability and economic viability of the animal and hence may be used as criteria for the selection among breeds and the individual within breeds (Singh *et al*. 2006). As the number of non-genetic factors affect the growth traits, adjustment of data for different non-genetic factors for the growth traits are necessary. The Garole sheep, a micro sheep breed of India, is known for its bi-annual lambing, high prolificacy rate, high mothering instincts, adaptability to marsh saline as well as hot and humid climatic condition, grazing on aquatic weeds and grass in knee-dip water and resistance to different common diseases (Sahana *et al*. 2001, Banerjee 2008) and are widely distributed in the Sundarban region of South 24-Paragans district in West Bengal, India. Very less information is available on growth traits of Garole sheep. Therefore, the present study was undertaken to the study the effect of different environmental factors (viz., year of birth, season of birth, parity of doe, sex and birth status of lamb) on growth traits in Garole sheep.

Data on body weights were collected from an experimental flock of Garole sheep, maintained under the State Livestock Farm, Kalyani, West Bengal, India, under the Centrally Sponsored Scheme "Conservation of Garole Sheep" over a period of 4 years (2008–2011). The traits considered for the present study were birth weight (BW), 3-month weight (W3M), 6-month weight (W6M), 9-month weight (W9M) and 12-month weight (W12M). Ewes were first exposed to rams at 12 to 14 months of age and hand-mated to selected sires. The Garole ewes breed round the year with two lambing peaks between December to February and August to September. Breeding generally occurred in May and June and again in October and November; lambing therefore normally occurred in October and November and in March and April. One breeding ram was normally allowed to mate with 20 to 25 ewes, and breeding rams were used for approximately 3 years. On average, an ewe lambed twice in every 1 or 1.6 years. Multiple birth is common, mostly twins and triplets. Ewes also give birth to quadruplets. At lambing, both lambs and dams were weighed. Each lamb was identified by a metal ear tag after birth and the lambing date, sex and birth type of each lamb were recorded. Lambs were kept with their dams in individual pens for 3 to 4 days after birth. Lambs were kept indoors during the suckling period, and were normally weaned at 3 months of age. Animals were vaccinated against peste des petits for ruminants (PPR), enterotoxaemia and haemorrhagic septicaemia (HS).

Data were analyzed using the mixed model least-squares analysis for fitting constants (Harvey 1990). The following model was used for different growth traits:

$$Y_{jklmno} = \mu + Y_j + A_k + X_l + P_m + T_n + e_{jklmno}$$

where, $Y_{ijklmno}$ is the record for the o^{th} animal, μ is the overall mean, Y_j is the fixed effect of the j^{th} year of birth, A_k is the fixed effect of the k^{th} season of birth, X_l is the fixed effect of the l^{th} sex of lamb, P_m is the fixed effect of the m^{th} parity of ewe, T_n is the fixed effect of the n^{th} birth status of lamb and e_{jklmno} is the residual error element with standard assumptions. To compare the different sub-groups means, Duncan's multiple range test (DMRT) as described by Kramer (1957) was applied.

The overall least-squares means for BW, W3M, W6M, W9M and W12M of animals were 1.02±0.02, 3.65±0.12, 6.27±0.23, 8.00±0.29 and 10.09±0.29 kg, respectively (Table 1). The overall least-squares means for body weights at different ages obtained in this study were well comparable with other studies (Sahana *et al*. 2001, Nimbkar *et al*. 2003) for this breed. The weights of lambs at all ages were significantly influenced by birth-year of lambs in this study. Similarly, the significant effects of birth-year of lambs in growth traits in other sheep breeds were reported by several research workers (Vivekanand *et al.* 2014, Nirban *et al.* 2015, Tohidi *et al.* 2017). The significant variations in body weights at all ages among lambs in different years may be attributed to differences in management, selection of rams and environmental conditions such as ambient temperature, humidity, rainfall etc. Significant ($P<0.01$) variations of

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Table 1. Least-squares means and their standard errors of different growth traits in Garole sheep

Effect	BW (kg)	W3M (kg)	W6M (kg)	W9M (kg)	W12M (kg)
Overall mean	1.02±0.02 (538)†	3.65±0.12 (295)	6.27±0.14 (288)	8.00±0.29 (198)	10.09±0.29 (150)
Year of birth					
2008	1.04^{ab}±0.05 (22)	3.97^{a}±0.27 (22)	6.63^{a}±0.28 (21)	9.21^{a}±0.45 (22)	11.24^{a}±0.53 (22)
2009	1.08^{a}±0.02 (119)	3.77^{a}±0.16 (85)	6.41^{a}±0.17 (82)	7.25^{b}±0.31 (74)	9.67^{b}±0.32 (58)
2010	0.97^{b}±0.02 (181)	3.72^{a}±0.14 (152)	6.00^{b}±0.15 (150)	7.56^{b}±0.29 (102)	9.37^{b}±0.33 (70)
2011	0.98^{b}±0.02(216)	3.12^{b}±0.21(36)	6.05^{ab}±0.18(35)	–	–
Season of birth					
Winter (Nov - Feb)	0.94^{a}±0.02 (147)	3.70^{a}±0.16 (82)	6.62^{a}±0.17 (75)	7.84±0.36 (42)	9.51^{b}±0.39 (41)
Summer (Mar - June)	1.06^{b}±0.02 (166)	4.07^{a}±0.16 (68)	6.13^{b}±0.16 (104)	8.27±0.34 (45)	10.81^{a}±0.37 (41)
Rainy (July-Oct)	1.05^{b}±0.02 (225)	3.17^{b}±0.15 (145)	6.06^{c}±0.17 (109)	7.89±0.30 (111)	9.96^{ab}±0.35 (68)
Parity of ewe					
1	0.93^{a}±0.02 (179)	3.61±0.15 (103)	6.35^{a}±0.16 (95)	8.39±0.24 (84)	10.35±0.32 (69)
2	1.03^{b}±0.02 (136)	3.73±0.16 (90)	5.95^{ab}±0.17 (87)	7.73±0.27 (73)	9.72±0.37 (56)
3	1.03^{b}±0.03 (107)	3.85±0.17 (72)	6.46^{a}±0.18 (60)	7.94±0.33 (37)	10.20±0.48 (25)
4	1.08^{b}±0.03 (116)	3.39±0.23 (30)	6.32^{b}±0.22 (46)	7.92±0.79 (04)	-
Sex of lamb					
Male	1.04^{a}±0.02 (260)	3.83^{a}±0.14 (149)	6.49^{a}±0.15 (146)	8.43^{a}±0.30 (101)	10.70^{a}±0.33 (71)
Female	0.99^{b}±0.02 (278)	3.47^{b}±0.14 (146)	6.05^{b}±0.15 (142)	7.56^{b}±0.31 (97)	9.48^{b}±0.32 (79)
Birth status of lamb					
Single	1.13^{a}±0.02 (256)	4.18^{a}±0.12 (144)	6.75^{a}±0.11 (158)	8.78^{a}±0.28 (103)	10.72^{a}±0.29 (72)
Twin	1.03^{b}±0.02 (252)	3.53^{b}±0.10 (139)	6.03^{b}±0.10 (121)	7.61^{b}±0.26 (87)	9.48^{b}±0.26 (70)
Triplet	0.89^{c}±0.04 (30)	3.23^{b}±0.31 (12)	6.04^{b}±0.36 (09)	7.60^{b}±0.58 (08)	10.07^{ab}±0.70 (08)

†Figures in parentheses indicate number of observation. Means with different superscripts differed significantly (P<0.05) from each other.

body weights at all ages except weight at 9-month of age were observed among animals born in different seasons. Similar result was observed by Ganesan *et al*. (2013) in Madras Red sheep. Significant effect of season of birth on 3 months body weight in Muzzafarnagari sheep was observed by Mandal *et al.* (2012). In this study, lambs born in winter season had lower body weights at birth, 3-month and 12 months of age as compared to lambs born in other seasons. Parity of ewes had only significant (P<0.01) influence on birth weight and 6 month weight of this breed. Lambs born from younger ewes had lesser birth weight than those lambs born from older ewes. The significant effect of parity on birth weight of lambs of other sheep breeds was also observed by Vivekanand *et al.* (2014) and Nirban *et al.* (2015) in Magra and Marwari sheep, respectively. Sex-wise analysis of body weights of Garole lambs revealed that male lambs excelled in body weights at all ages than their female counterparts. The result is well comparable to the findings of Vivekanand *et al.* (2014), Nirban *et al.* (2015) and Tohidi *et al.* (2017) in Magra Marwari and Iran-Black sheep, respectively. The birth status of lambs also showed a significant effect on body weights of Garole lambs at all ages. Lambs born as singles had higher weights at all ages than those lambs born as twins or triplets. Similar findings were also observed by Mandal *et al.* (2012) and Tohidi *et al*. (2017) in Muzaffarnagari and Iran-Black sheep, respectively.

SUMMARY

In the present study, the average weights of Garole lambs at birth, 3-month, 6-month, 9-month and 12-months of age were 1.02±0.02, 3.65±0.12, 6.27±0.14, 8.00±0.29 and 10.09±0.29 kg, respectively. Year of birth had a significant effect on weights of lambs at all ages. There were significant variations in all growth traits among lambs born in different seasons. Parity of ewes had only significant effect on birth weight and 6-month weight of lambs. Male lambs exhibited significantly higher body weights at all ages than their female counterpart. Lambs born as singles showed higher growth at all ages as compared to lambs born as twins or triplets.

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