Effects of non-genetic factors on growth traits and age at first lambing in Corriedale sheep

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ABSTRACT

Data pertaining to Corriedale sheep (4,367 birth records) spanning over a period of 25 years from 1989 to 2013 was analyzed with the Mixed Model Least Square and Maximum Likelihood algorithms to assess fixed effects of year, sex, type of birth and age of dam on various growth traits and age at first lambing. The averages were 3.69, 12.16, 17.65, 22.45, 34.59 and 893.41 for birth weight (BW), weaning weight (WW), 6 month body weight (W6), 12 month body weight (W12), 18 month body weight (W18) and age at first lambing (AFL) respectively. The overall least square means (kg) for BW, WW, W6, W12, W18 and AFL (day) were 3.20±0.091, 11.05±0.408, 16.06±0.452, 21.69±0.722, 33.425±0.776 and 882.50±11.33 respectively. Year of birth had a highly significant influence on all the studied traits. The effect of type of the birth was significant on BW, WW, W6 but non-significant on W12, W18 and AFL. Sex of the lamb had a significant effect on BW, WW, W6 and W12 and non-significant effect on W18. Dam age had a significant effect on all the body weight traits except W18. It also had a significant effect on AFL. The overview of the study reveals that the non-genetic factors affected growth traits and age at first lambing therefore should be taken into consideration while evaluating the performance of the animals. The germplasm of the Corriedale breed which is a mutton breed of sheep can be improved by selection of good animals and improving the management conditions.

Keywords: Corriedale, Growth traits, Least square means, Non-genetic factors

Sheep is an important species of livestock and contributes around 12.71% of the total livestock population in India (Anonymous 2012). It contributes greatly to the agrarian economy, especially the livelihood of a large proportion of small and marginal farmer and landless labourers (Lalit et al. 2016). The state is home to many sheep breeds like Gaddi, Changthangi, Bakerwal, Gurezi, Poonchi, Karnah, Malluk, Purgi etc. However, the production potential of these breeds was low therefore improvement programmes in the State were started around 1940 with cross breeding experiments. Pure bred nucleus herds were maintained at various stations which have been subjected to selection for various economically important traits. Initially the programme was directed towards improvement of wool traits however, experiments were later started to have sheep for dual purpose. Accordingly, the Corriedale breed was imported around 1970s which is known for its good mutton conformation, good wool characteristics, relative early maturity and having good range characteristics. These sheep were imported and reared at experimental Mountain Research Station for Goat and Sheep, SKUAST-K, India. Growth and reproduction traits are quantitative traits governed by polygenic inheritance.

Factors such as sex of the animal, health status, birth type, animal’s own age, reproductive status and farm location are among the major factors influencing traits in animals. Therefore the present study was carried out to investigate the effects of some non-genetic factors on the growth traits and age at first lambing. Multiple studies in this regard (Das et al. 2014, Khan et al. 2017, Sudan 2017, Hamadani et al. 2019) have reported the performance of exotic sheep breeds and their crosses concerning native breeds under Indian conditions.

MATERIALS AND METHODS

The data sets were collected from Mountain Sheep and Goat Research Station, SKUAST-K, Shuhama, Kashmir pertaining to a Corriedale flock, spanning over a period of 25 years from 1989 to 2013. Data were suitably classified to study the major effect of non-genetic factors like year of birth, type of birth, age of dam and sex. The mean, standard errors and coefficient of variations (CV %) of performance traits were computed statistically (Snedecor and Cochran 1994). As the data was with unequal and disproportionate subclass frequencies, therefore it was non-orthogonal and to overcome this problem, least square analysis of variance technique was used to study the effect of various factors influencing the traits under study. Data were analysed using
Mixed Model Least Squares and Maximum Likelihood Computer Programme PC-2 (Harvey 1990). The following general mathematical model was used to determine the effect of non-genetic factors on the traits under consideration:

\[ Y_{ijklm} = \mu + G_i + T_j + R_k + D_l + \epsilon_{ijklm} \]

where \( Y_{ijklm} \) is the observation for the studied trait of \( m \)th animal of \( i \)th gender, \( j \)th type of birth and \( k \)th age of dam; \( G_i \), fixed effect of gender (1=female and 2=male); \( T_j \), fixed effect of type of birth (1=single; 2=twin); \( R_k \), fixed effect of age of dam (2, 3, 4, 5, 6, 7, 8, ≥9 years); \( D_l \), random residual error assumed to be NID \((0, \sigma^2)\).

The statistical significance of various fixed effects in the least squares model was determined by ‘F’ test. For significant effects, the differences between pairs of levels of effects of period were tested by Duncan’s multiple range test (DMRT).

RESULTS AND DISCUSSION

**Descriptive statistics:** Descriptive statistics for various production traits is presented in Table 1. The coefficient of variations (CV%) of all the traits under study was low indicating that the traits had low variability. The lower coefficients of variation for W18 compared to other body weights may be due to limited data for the trait. The least squares means are presented in Table 2. The least square mean of birth weight observed in the present study was in agreement with the values reported by various workers in Corriedale breed of sheep (Labusca et al. 1993). The average birth weight obtained in present study was slightly lower than those reported for this breed.

**Least square means:** Least square mean of weaning weight obtained in the current study was in consonance with the value (11.92 kg) reported for Corriedale breed by Zhang et al. (1991). However, higher weaning weights (WW) of 19.00, 22.80, 26.1, 19.50±0.08 and 25.3 kg had been reported in this breed by Labusca et al. (1983). Such a variation in weaning weight of Corriedale sheep may be due to differences in age at weaning, management practices, and availability of nutritious grasses and genetic potential of parental stocks. The overall least square means for 12 and 18 month body weight were very low as compared to values reported by Zhang et al. (1991) in same breed. Lower weight may be caused by environmental differences. The overall least square mean for age at first lambing was similar to that reported by Bhat et al. (2009) in Corriedale. However, lower estimates of 597.2±12.6, 735.67±1.13 and 691.45±15.45 days were reported by Awemu et al. (2000) in Yankasa ewes, Khan et al. (2002) in Rambouillet and Mohammadi et al. (2011) in Afshari breed of sheep. Besides breed differences, trait is largely influenced by the environment which partially explains the variation among the reported estimates.

**Year of birth:** Year of birth had a highly significant (P<0.01) effect upon all body weight traits studied herein and age at first lambing and was the greatest source of variation for all studied traits. The significant difference in the body weight among the years may be due to difference in the availability of the good quality feed, fodder, grazing resources, environmental conditions, managerial skills, culling and selection intensities and difference in flock structure over the years. This highlighted the need for taking measures to improve and sustain high level of management for full and consistent exploitation of the genetic potential of this flock as was also suggested by Rather et al. (2019). Significant effect of year of birth was seen on body weight traits. Similar results were seen in Gaddi and its half breeds on BW, WW, W6, W12 and Al-bar et al. (2002) in Dhami sheep in Yemen. With respect to effect of year of birth on AFL, our results are in alignment with those of Bhat et al. (2009), in Corriedale breed; Gbangboche et al. (2006) in Djallonke ewes and Mohammadi et al. 2011 in Afshari breed of sheep. Jose et al. (2015) had reported non-significant effect of year of birth on AFL on Pelibuey sheep. The non-significant effect may partially be attributed to shorter period of study for only few years where probability of environmental variations are lower compared to longer periods. Peak values for BW, WW, W6, W12 and W18 (Table 2) were recorded in 1989, 2012, 1991, 1995 and 1989, respectively. These results indicated that management of the flock along with other environmental conditions was more favourable in these years. The lowest AFL was recorded in 1999 which indicates better provision of environmental conditions in that year. It is also supplemented by the observations of improvement in all other body weights in that year compared to immediate preceding and succeeding years (Table 2). In general, body weights showed a decline after 1990 which may be due to relatively poor environmental conditions and probably reduced genetic variation in the flock because of continuous selection and use of rams from same gene pool over the years.

**Type of birth:** Type of birth had a highly significant (P<0.01) effect on body weight from birth up to weaning which started to decline thereafter with significant effect (P<0.05) only on W6 and non-significant effect on W12, W18 and AFL. The results are in agreement with those of El-Wakil et al. (2013) with respect to BW, WW and W6. The lower birth and weaning weights of twin born lambs may be attributed to competition for uterine space and nutrition during prenatal stage followed by similar
Table 2. Least squares means for various non-genetic factors influencing production traits in Kashmir Corriedale sheep

| Birth year | N  | BW (kg) | N  | WW (kg) | N  | W6 (kg) | N  | W12 (kg) | N  | W18 (kg) | N  | AFL (days) |
|------------|----|---------|----|---------|----|---------|----|---------|----|---------|----|-----------|
| 1989       | 463| 3.20±0.092 | 3433| 11.05±0.408 | 2830| 16.06±0.453 | 2034| 21.69±0.722 | 733| 33.42±0.776 | 817| 882.50±11.330 |
| 1990       | 245| 3.61±0.141 | 222| 10.39±0.621 | 217| 18.20±0.775 | 204| 23.32±1.088 | 192| 38.32±3.326 | 100| 774.23±55.353 |
| 1991       | 264| 3.54±0.141 | 252| 12.23±0.623 | 243| 19.44±0.775 | 220| 23.93±1.092 | 197| 35.69±3.321 | 95| 896.83±55.901 |
| 1992       | 323| 3.49±0.137 | 289| 13.21±0.605 | 242| 20.01±0.751 | 225| 22.86±1.071 | 96| 34.05±4.660 | 60| 902.20±54.320 |
| 1993       | 307| 3.44±0.134 | 252| 9.11±0.590 | 193| 16.58±0.739 | 175| 21.91±0.508 | 41| 31.41±0.704 | 34| 1064.87±52.861 |
| 1994       | 286| 3.15±0.134 | 134| 7.17±0.592 | 84| 12.03±0.762 | 50| 18.30±1.116 | 26| 1041.37±51.724 |
| 1995       | 232| 2.86±0.133 | 127| 10.30±0.599 | 9| 15.87±1.137 | 127| 25.11±2.017 | 27| 1019.25±53.140 |
| 1996       | 159| 2.79±0.136 | 124| 8.28±0.549 | 100| 13.60±0.668 | 50| 20.26±1.010 | 6| 699.50±56.218 |
| 1997       | 140| 3.18±0.127 | 138| 9.39±0.541 | 127| 13.22±0.618 | 101| 18.75±0.861 | 33| 1010.54±5.751 |
| 1998       | 175| 2.90±0.127 | 142| 11.21±0.520 | 82| 19.09±1.188 | 17| 19.35±2.175 | 8| 35.89±1.539 |
| 1999       | 178| 2.87±0.115 | 146| 11.34±0.495 | 145| 11.59±0.574 | 101| 18.75±0.861 | 30| 1.18±1.010 |
| 2000       | 156| 3.17±0.117 | 134| 13.92±0.499 | 108| 13.38±0.596 | 88| 19.56±0.861 | 54| 32.70±0.614 |
| 2001       | 143| 3.25±0.119 | 113| 11.56±0.512 | 106| 18.93±0.603 | 97| 22.64±0.889 | 49| 930.07±25.781 |
| 2002       | 139| 3.35±0.122 | 107| 11.15±0.522 | 93| 19.47±0.619 | 89| 22.40±1.002 | 22| 97.41±3.040 |
| 2003       | 164| 3.39±0.120 | 155| 12.12±0.506 | 147| 17.10±0.594 | 20| 21.96±0.907 | 39| 839.37±2.570 |
| 2004       | 147| 3.23±0.125 | 107| 11.36±0.529 | 105| 16.17±0.622 | 85| 25.31±0.918 | 44| 828.21±2.850 |
| 2005       | 125| 3.46±0.121 | 117| 11.73±0.530 | 74| 18.35±0.659 | 23| 29.40±0.976 | 35| 890.90±2.825 |
| 2006       | 148| 3.45±0.121 | 148| 11.96±0.516 | 139| 18.27±0.610 | 100| 21.59±0.913 | 33| 33.95±0.785 |
| 2007       | 182| 3.50±0.123 | 153| 9.82±0.517 | 135| 16.61±0.612 | 106| 22.78±2.017 | 36| 909.94±2.750 |
| 2008       | 189| 3.15±0.138 | 158| 9.24±0.578 | 131| 17.56±0.702 | 59| 22.61±1.055 | 17| 99.97±1.049 |
| 2009       | 123| 3.03±0.147 | 104| 9.98±0.609 | 56| 13.23±0.799 | 25| 21.26±1.266 | 12| 797.18±6.218 |
| 2010       | 111| 3.11±0.149 | 97| 11.22±0.618 | 71| 18.43±0.778 | 34| 34.02±3.774 | 21| 78.24±2.017 |
| 2011       | 93| 3.25±0.166 | 89| 14.69±0.675 | 84| 21.61±0.830 | 30| 21.40±1.535 | 14| 834.35±1.792 |
| 2012       | 124| 3.29±0.198 | 102| 9.06±0.798 | 97| 12.03±0.993 | 32| 18.61±1.888 | 24| 33.87±0.921 |

* Values with same superscripts in a column under a subgroup do not differ significantly P>0.05; ** Significance difference at P<0.05; *** Significant difference at P<0.01; NS, Non-significant difference.
competition for dam’s milk after birth till weaning. It is an established fact that about 80% of variability in birth weight is attributed to maternal factors. The effect started to decline after weaning and differences narrowed down with advancement of age due to compensatory growth in and absence of role of dam’s milk. This is corroborated by diminishing effect up to W6 and non-significant effect beyond it. The results are on expected line as with advancing age the animal’s genotype is expressed more and more and influence of maternal factors gets diminished from birth to subsequent ages.

Our results with respect to effect of type of birth on AFL are in agreement with those of Mengistie et al. (2011) in Washera sheep but contrary with those of Mohammadi et al. (2011) in Afshari sheep and Awemu et al. (2000) in Yankasa ewes wherein, the authors had reported that type of birth significantly affected the AFL. Besides breed and environmental differences, these differences may partially be explained by relatively lower ages at first lambing reported by these workers. At lower ages, the animal is still influenced by mothering ability of dam and therefore type of birth may still exhibit its influence on production.

**Sex of lamb:** The sex of the lamb had highly significant (P<0.01) effect on all body weight traits except W18, wherein the difference between males and females was non-significant. These findings are in conformity with those of Mandal et al. (2012) in Muzafaranagri sheep up to weaning weight; Balasubramanyam et al. (2012) in Madras Red sheep for BW up to W12. Males, in general, were found to be heavier than females at all ages. Similar results had been reported by Bhadula and Bhat (1980) in Muzaffarnagri sheep. Physiological characteristics and endocrinial system (type and quantity of hormone secretion, especially sex hormones) can explain the significant influences of gender (Aghaali-Gamasasee et al. 2010). The higher anabolic effect of testosterone in males is one of the reasons of higher growth in them. Retention of heavier ram lambs for breeding and disposal of slow growing and surplus male lambs after one year of age may be possible reason for the male hoggets being heavier than females for W18 age.

**Age of dam:** Age of dam had highly significant (P<0.01) effect on all growth traits except W18, wherein it was non-significant. In general, present study revealed that all body weight traits showed an increase in magnitude with advancement in age of the dam up to 6 years, followed by a decrease beyond 7 years. Young ewes tended to produce smaller lambs. Primiparous ewes are not at their mature weight and share resources to complement their growth in addition to fetal growth and this could affect the lamb weight. Mothering ability, such as milk yield increases with parity, as ewes up to 5–6 lactations are usually larger and produce more milk. The same results were reported by Fadili et al. (2000) on the Moroccan Timahdit sheep and El-Wakil et al. (2013) in Barki sheep. AFL: AFL was significantly (P<0.05) affected by the age of the dam (Table 2) and tended to increase in females born from dams aged 8 years and above. These results agree with those of Bhat et al. (2009) in Corriedale breed and Annett et al. (2011) in Scottish Blackface with dam age having significant (P<0.05) effect on this trait. The results may be explained by the fact that all body weight traits and AFL revealed a negative correlation in current study, so it is expected that animals born from older ewes will show a delay in attainment of sexual activity compared to those born from younger dams. Dam age has an influence on prepubertal growth traits by way of differential uterine environment and milk production capacity which in turn influence the attainment of sexual activity and AFL in their progeny. The positive correlation between body weight and sexual maturity is also an established fact.

From the present study, we conclude that the non-genetic factors affected growth traits and age at first lambing therefore should be taken into consideration while evaluating the performance of the animals. The germplasm of the Corriedale breed under temperate agro-climatic conditions of Jammu and Kashmir can be improved by improving the management conditions and by the employing appropriate selection strategies for choosing only the best animals as parents for the next generation.

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