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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.

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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:

$$Y_{ijklm} = \mu + G_i + Tj + R_k + D_l + \varepsilon_{ijklm}$$

where Y_{ijklm}, observation for the studied trait of m^{th} animal of i^{th} gender, j^{th} type of birth and k^{th} year and l^{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 year (from 1989 to 2013); D_l, fixed effect of age of dam (2, 3, 4, 5, 6, 7, 8, ≥9 years); ε_{ijklm}, 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*. 1983). 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.

Table 1. Descriptive statistics of different body weights and age at first lambing in Corriedale flock

Trait	No. of records	Mean	SD	CV%
Birth wt (kg)	4367	3.69	0.673	18.23
Weaning wt (kg)	3433	12.16	2.696	22.17
Six month wt (kg)	2830	17.65	3.272	18.53
Twelve month wt (kg)	2034	22.45	3.790	16.88
Eighteen month wt (kg)	733	34.59	4.511	13.04
Age at first lambing (days)	817	893.41	166.51	18.63

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 during different years, 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 breds on BW, WW, W6, W12 and Al-bar *et al.* (2002) in Dhamari 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 in 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

Non-genetic factor	N	BW (kg)	N	WW (kg)	N	W6 (kg)	N	W12 (kg)	N	W18 (kg)	N	AFL (days)
Overall mean	4367	3.203±0.092	3433	11.058±0.408	2830	16.062±0.453	2034	21.692±0.722	733	33.425±0.776	817	882.500±11.330
Birth year		*		*		*		*		*		*
1989	245	3.614±0.141^{f}	222	10.394±0.621^{cde}	217	18.208±0.775^{fgh}	204	23.328±1.088^{ghi}	192	38.342±0.326^{e}	100	774.238±55.353^{bc}
1990	264	3.545±0.141^{ef}	252	12.234±0.623^{fgh}	243	19.443±0.775^{hi}	220	23.933±1.092^{hi}	197	35.696±0.321^{d}	95	896.833±55.901^{def}
1991	323	3.497±0.137^{ef}	289	13.218±0.605^{gh}	242	20.012±0.754^{i}	225	22.863±1.071^{fgh}	96	34.035±0.460^{cd}	60	902.204±54.320^{efg}
1992	307	3.449±0.134^{ef}	252	9.119±0.590^{bc}	193	16.581±0.739^{def}	175	21.917±1.058^{def}	41	31.415±0.704^{ab}	34	1064.870±52.861^{j}
1993	286	3.154±0.133^{bcd}	%	%	%	%	%	%	%	%	%	%
1994	232	2.865±0.133^{ab}	134	7.175±0.592^{a}	84	12.038±0.762^{ab}	50	18.305±1.116^{ab}	%	%	26	1041.378±51.724^{j}
1995	159	2.795±0.136^{a}	127	10.302±0.588^{cde}	9	15.877±1.137^{cde}	9	29.508±1.420^{k}	%	%	27	1019.259±53.140^{hi}
1996	140	3.128±0.127^{bcd}	124	8.288±0.548^{ab}	100	13.601±0.668^{bcd}	50	20.261±1.010^{cd}	%	%	6	699.505±62.518^{a}
1997	175	2.901±0.125^{ab}	137	9.394±0.541^{bc}	127	13.221±0.648^{bc}	101	17.306±0.947^{a}	%	%	33	1010.541±37.575^{hi}
1998	164	3.038±0.121^{bc}	142	11.210±0.520^{def}	102	11.476±0.632^{a}	48	17.761±0.958^{a}	%	%	11	931.294±45.748^{efg}
1999	34	2.805±0.217^{a}	24	14.169±0.964^{hi}	22	18.091±1.188^{fgh}	17	19.357±1.857^{bc}	8	35.895±1.595^{d}	6	693.337±141.261^{a}
2000	171	2.870±0.115^{ab}	146	11.364±0.495^{efg}	145	11.592±0.574^{a}	101	18.751±0.861^{ab}	20	31.081±1.009^{ab}	46	818.274±22.915^{bc}
2001	156	3.170±0.117^{bcd}	134	13.920±0.499^{hi}	108	13.387±0.596^{bc}	88	19.563±0.861^{bc}	54	32.704±0.614^{bc}	40	949.412±23.438^{efg}
2002	146	3.250±0.119^{cde}	113	11.576±0.512^{efgh}	106	18.937±0.603^{ghi}	97	22.649±0.888^{fgh}	%	%	40	930.077±25.781^{efg}
2003	139	3.355±0.122^{def}	107	11.052±0.522^{def}	93	19.471±0.619^{hi}	89	22.401±0.902^{efg}	%	%	22	974.310±30.904^{gh}
2004	165	3.329±0.120^{def}	155	12.129±0.506^{fgh}	147	17.120±0.594^{efg}	86	21.965±0.907^{def}	%	%	39	839.373±26.570^{def}
2005	125	3.231±0.125^{cde}	107	11.336±0.529^{efg}	105	16.117±0.622^{cde}	85	25.312±0.918^{j}	%	%	44	828.217±28.158^{cd}
2006	148	3.268±0.125^{cde}	117	11.736±0.530^{efgh}	74	18.354±0.659^{fgh}	47	23.940±0.975^{hi}	%	%	35	890.091±28.825^{de}
2007	182	3.469±0.121^{def}	148	11.906±0.516^{efgh}	139	18.279±0.610^{fgh}	100	21.159±0.913^{cde}	33	33.956±0.785^{bc}	45	969.657±27.791^{fgh}
2008	166	3.507±0.123^{ef}	153	9.821±0.517^{bcd}	135	16.610±0.612^{def}	106	22.782±0.917^{fgh}	%	%	36	909.946±27.750^{fghi}
2009	189	3.154±0.138^{bcd}	158	9.246±0.578^{bc}	131	17.156±0.702^{efg}	59	22.616±1.055^{fgh}	17	29.997±1.094^{a}	5	941.414±85.094^{efg}
2010	123	3.033±0.147^{bc}	104	9.987±0.609^{bcd}	56	13.232±0.799^{bc}	25	21.216±1.266^{cde}	17	32.425±1.094^{ab}	12	797.187±65.218^{bc}
2011	111	3.113±0.149^{bcd}	97	11.222±0.618^{def}	71	18.437±0.778^{fgh}	%	%	34	34.023±0.774^{cd}	21	728.432±60.187^{ab}
2012	93	3.252±0.166^{cde}	89	14.693±0.675^{i}	84	16.211±0.839^{cde}	20	23.410±1.535^{ghi}	20	31.081±1.009^{ab}	14	843.351±77.982^{cd}
2013	124	3.290±0.198^{def}	102	9.906±0.798^{bcd}	97	12.036±0.993^{ab}	32	18.616±1.886^{ab}	24	33.875±0.921^{bc}	20	727.018±97.803^{ab}
Type of birth		**		**		*		NS		NS		NS
single	4307	3.645±0.083^{b}	3386	11.923±0.375^{b}	2794	16.853±0.394^{b}	2012	21.891±0.650^{a}	719	33.446±0.569^{a}	806	889.069±26.997^{a}
twin	60	2.761±0.115^{a}	47	10.193±0.503^{a}	36	15.270±0.606^{a}	22	21.493±0.920^{a}	14	33.404±1.021^{a}	11	875.949±37.569^{a}
Sex		**		**		**		**		NS		
female	2179	3.112±0.092^{a}	1736	10.775±0.410^{a}	1445	15.663±0.456^{a}	1111	21.193±0.724^{a}	509	32.865±0.782^{a}	%	%
male	2188	3.295±0.092^{b}	1697	11.342±0.411^{b}	1385	16.460±0.456^{b}	923	22.191±0.727^{b}	224	33.985±0.804^{a}	%	%
Age of dam(years)		**		**		**		**		NS		*
2	565	2.690±0.094^{a}	442	10.303±0.415^{ab}	366	15.140±0.466^{ab}	283	20.936±0.725^{ab}	137	33.845±0.380^{a}	121	849.958±18.329^{a}
3	893	3.085±0.092^{bc}	682	11.336±0.407^{cd}	581	16.358±0.453^{b}	438	21.871±0.712^{bc}	164	33.855±0.411^{a}	159	848.063±16.257^{a}
4	835	3.304±0.092^{cd}	652	11.489±0.406^{cd}	526	16.601±0.452^{b}	375	22.307±0.712^{c}	154	33.265±0.377^{a}	157	845.143±15.966^{a}
5	733	3.381±0.092^{cd}	592	11.668±0.405^{de}	488	16.611±0.452^{b}	336	22.233±0.711^{c}	100	32.495±0.445^{a}	135	841.492±16.205^{a}
6	598	3.430±0.093^{cd}	484	11.614±0.409^{de}	382	16.510±0.457^{b}	267	22.040±0.715^{bc}	80	33.095±0.532^{a}	121	847.695±16.395^{a}
7	434	3.364±0.094^{cd}	344	11.151±0.412^{bcd}	298	16.386±0.461^{b}	202	21.947±0.723^{bc}	49	33.675±0.571^{a}	72	838.958±18.304^{a}
8	214	3.289±0.098^{bc}	167	11.047±0.432^{bc}	131	16.566±0.495^{b}	100	22.127±0.755^{bc}	33	33.965±0.922^{a}	35	877.415±24.902^{ab}
≥ 9	95	3.079±0.152^{bc}	70	9.853±0.730^{a}	58	14.323±0.867^{a}	33	20.074±1.408^{a}	16	33.205±0.919^{a}	17	1111.272±62.738^{b}

Values with same superscripts in a column under a subgroup do not differ significantly P>0.05; *, Significant 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 upto 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 endocrinal system (type and quantity of hormone secretion, especially sex hormones) can explain the significant influences of gender (Aghaali-Gamasaee *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 pre pubertal 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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