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Genetic parameters of biometric traits in Deccani sheep

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Abstract
The current investigation was taken up to evaluate the genetic parameters like heritability estimates, genetic correlations, phenotypic correlations and linear regression analysis of ten different biometrical measurements at different age periods in the Deccani flock comprising of 300 animals which were maintained at Livestock Research Station, Mahabubnagar in Telangana State. The heritability estimates of Deccani sheep at different age groups recorded were very low for height at withers, heart girth and paunch girth which ranged 0.01±0.00 to 0.19±0.03 while the heritability estimates were low to moderate for body length and chest depth which ranged 0.06±0.00 to 0.33±0.04. The genetic and phenotypic correlations of the different biometrical measurements at different ages were positive and ranged from 0.15±0.04 to 0.99±0.06 and from 0.18±0.06 to 0.99±0.02. The R^2 values generated from the backward regression analysis for determining the prediction equations for body weight from biometrical measurements varied from 0.184 to 0.198, 0.147 to 0.177, 0.230 to 0.242 and 0.364 to 0.380 at different pre and post weaning age groups of 90, 180, 270 and 360 days of age. The biometrical measurements like Height at withers, rump height, body length, hip width, heart girth, Paunch girth and fore-cannon bone length had significant influence on the body weight.

Keywords: Biometry, deccani, sheep, heritability, correlations, regression

Introduction

Deccani is an important sheep breed with its breeding tract spread across the Deccan Plateau. They are medium-sized animals with predominantly black colour. This breed is well-suited to the harsh climate of the Deccan plateau and is capable of long-distance migration being traditionally reared by the shepherd communities. India currently ranks second in the World in sheep population and Telangana state ranks first in the country. There is little selection of breeding rams, and much inter-mating among neighbouring sheep breeds which is causing the low productivity in this breed. The weight of a sheep fluctuates due to the various managemental conditions and physiological conditions like pregnancy, filled gut, lactation etc. The linear measurements are less affected by these different factors and allow for the growth comparisons of different body parts at any stage of growth of the animal. Mathematical equations can be developed for actual weight estimation using biometric measurements which are very useful in the field conditions. Thus, the present study was conducted to estimate the genetic parameters of ten different biometrical measurements at different age periods in Deccani sheep for its breed improvement.

Materials and Methods

In this study 300 purebred Deccani lambs which were born to 15 sires were evaluated for ten different biometrical measurements pertaining to different age groups. The animals were housed in sheds made of mud floor and asbestos sheets as the roof. Sheep were grazed from 9.00 am to 5.00 pm daily by the semi-intensive method. The feeding given to the lambs was green fodder @ 3 kg per animal and concentrate mixture (CP 18%) @ 300 gm/animal. The body weights were recorded in grams (gm) using a digital weighing balance with 50 gm accuracy and the following ten biometrical measurements were recorded in centimeters (cm) by using a measuring tape, every fortnight from birth to one year of age.

- Height at withers was measured as the distance from the surface of the platform on which the sheep stands to the withers.
- Rump height was measured as the distance from the surface of the platform on which the sheep stands to the rump.
- Body length was measured as the distance from base of the tail to the base of the neck up to the first thoracic vertebrae.

- Heart girth was measured as the circumferential measurement taken around the chest just behind the forelegs and withers.
- Paunch girth was measured as the circumferential measurement taken around the Paunch just before the hind legs
- Chest depth was measured as the distance from backbone at the shoulder to the brisket between the forelimbs.
- Chest width was measured as the distance between the outer edges of right and left side of the sternum in between the forelimbs.
- Fore-cannon bone length was measured as the length of the metacarpal bone.
- Hip width was measured as the distance between the outer edges of the major hip bones on both sides.
- Thigh circumference was measured as the midpoint between the hock and pin bone on the right rear leg.

The data was corrected for significant non genetic effects before it is was utilized for estimation of the genetic parameters. Heritability was estimated by the paternal half sib correlation method (Becker, 1984). The Genetic, Phenotypic and Environmental correlations among different biometrical traits were estimated by Minimum Variance Quadratic Unbiased Estimator (MIVQUE). The relationship between the ten different biometrical measurements and body weights were studied by linear regression analysis using SPSS 15 software to develop the prediction equations for live body weight at different ages of sheep at 90, 180, 270 and 360 days.

Results and Discussion

Heritability of Biometrical measurements

Height at withers: Heritability estimates (Table 1) among Deccani sheep recorded were very low which ranged from 0.01±0.00 to 0.08±0.00 from birth to 360 days while Mandal *et al.* (2008) [5], Jafari *et al.* (2014) [4] and Panda *et al.* (2014) [7] reported heritabilities in the range of 0.14 to 0.54 in Muzaffarnagari, Makooei and Orissa local sheep.

Body length: Heritability estimates (Table 2) recorded were very low to moderate which ranged from 0.04±0.00 to 0.33±0.04 from birth to 1 year age. More or less similar range of 0.10 to 0.54 heritability estimates were reported by Mandal *et al.* (2008) [5], Jafari *et al.* (2014) [4] and Panda *et al.* (2014) [7] in Orissa local sheep, Makooei and Muzaffarnagari sheep.

Heart girth: Heritability estimates (Table 3) recorded from birth to 1 year age were very low which ranged from 0.01±0.00 to 0.18±0.09. A range of 0.07 to 0.36 was reported by Mandal *et al.* (2008) [5] and Jafari *et al.* (2014) [4] in Muzaffarnagari and Makooei sheep, whereas Panda *et al.* (2014) [7] in Orissa local sheep reported higher estimates ranging from 0.30 to 0.54.

Paunch girth: Heritability estimates (Table 4) were very low which ranged from 0.01±0.00 to 0.19±0.03 from birth to 1 year. Whereas Panda *et al.* (2014) [7] reported the heritability to be in the range of 0.30 to 0.54 in Orissa local sheep.

Chest depth: Heritability estimates (Table 5) were very low to moderate which ranged from 0.06±0.00 to 0.25±0.03.

Genetic and Phenotypic correlations of Biometrical measurements

Height at withers: The genetic and phenotypic correlations (Table 1) from birth to 360 days of age recorded were positive and medium to high which ranged from 0.31±0.04 to 0.98±0.03 and 0.30±0.06 to 0.97±0.01, respectively. Similar findings of moderate to high genetic and phenotypic correlations were reported by Ravimurugan *et al.* (2013) [8] in Kilakarsal, Jafari *et al.* (2014) [4] in Makooei and Panda *et al.* (2014) [7] in local Orissa sheep which ranged from 0.11 to 0.81.

Body length: Genetic and phenotypic correlations (Table 2) from birth to one year of age recorded were positive and medium to high which ranged from 0.36±0.06 to 0.99±0.06 and 0.34±0.05 to 0.98±0.02, respectively. Similar moderate to high genetic and phenotypic correlations were reported by Ravimurugan *et al.* (2013) [8] in Kilakarsal, Jafari *et al.* (2014) [4] in Makooei and Panda *et al.* (2014) [7] in Orissa local sheep which ranged from 0.11 to 0.81.

Heart girth: Genetic and phenotypic correlations (Table 3) at different age periods recorded were positive and moderate to high and ranged from 0.25±0.04 to 0.99±0.03 and 0.33±0.06 to 0.97±0.02, respectively. Similar moderate to high correlations were reported by Ravimurugan *et al.* (2013) [8] in Kilakarsal, Jafari *et al.* (2014) [4] in Makooei sheep and Panda *et al.* (2014) [7] in Orissa local sheep which ranged from 0.11 to 0.83.

Paunch girth: Genetic and phenotypic correlations (Table 4) at different age periods were positive and moderate to high which ranged from 0.25±0.06 to 0.99±0.03 and 0.27±0.06 to 0.98±0.03, respectively. Moderate to high genetic and phenotypic correlations were also reported by Ravimurugan *et al.* (2013) [8] in Kilakarsal and Panda *et al.* (2014) [7] in local Orissa sheep which ranged from 0.11 to 0.76.

Chest depth: The genetic and phenotypic correlations (Table 5) at different age periods ranged from 0.15±0.04 to 0.98±0.07and 0.18±0.06 to 0.99±0.02, respectively. Similar positive correlations were also reported by Cam *et al.* (2010) [3] in Karayaka sheep which ranged from 0.76 to 0.87.

Regression of Body weight on Biometrical measurements

The regression analysis was done to know the relationship between the body weight and body measurements in Deccani lambs. Backward linear regression analysis was conducted for prediction of body weight at weaning period of 90 days and the post weaning period of 180, 270 and 360 days of age based on body measurements. The R^2 values (Table 6) ranged from 0.184 to 0.380 and the body measurements with significant influence were height at withers, rump height, body length, hip width, heart girth, paunch girth and fore-cannon bone length. Prediction equations involving body measurements revealed R^2 values by various authors ranging from 0.61 to 0.792 by Ravimurugan *et al.*, 2013 [8] in Kilakarsal, Musa *et al.*, 2012 [6] in Sudanese sheep and Cam *et al.*, 2010 [3] & Alemayehu *et al.*, 2010 [1] in Ethiopian Highland sheep. Cam *et al.* (2010) [3] & Alemayehu *et al.* (2010) [1] further opined that the measurement of heart girth was the easiest way to use for live weight prediction of body weight under field conditions. In the present study, the R^2 value recorded were 0.380 with body measurements like hip width, heart girth and paunch girth at 360 days of age, which is less when compared to the findings mentioned above.

Table 1: Heritability estimates (on diagonal), and genetic correlations (above diagonal) and phenotypic correlations (below diagonal) of the Height at Withers (HAW) among the Deccani lambs.

	HAW0	**HAW15**	**HAW30**	**HAW45**	**HAW60**	**HAW75**	**HAW90**	**HAW180**	**HAW270**	**HAW360**
HAW0	0.02±0.00	0.95±0.08	0.85±0.04	0.85±0.03	0.70±0.04	0.67±0.04	0.59±0.04	0.38±0.05	0.36±0.03	0.31±0.04
HAW15	0.93±0.02	0.05±0.00	0.94±0.04	0.91±0.02	0.75±0.03	0.74±0.03	0.66±0.04	0.48±0.05	0.46±0.02	0.41±0.05
HAW30	0.82±0.03	0.93±0.02	0.08±0.00	0.93±0.02	0.75±0.04	0.78±0.04	0.71±0.03	0.52±0.04	0.50±0.04	0.45±0.04
HAW45	0.82±0.03	0.90±0.02	0.91±0.02	0.01±0.00	0.89±0.05	0.89±0.05	0.80±0.09	0.54±0.03	0.53±0.12	0.48±0.08
HAW60	0.66±0.04	0.72±0.04	0.71±0.04	0.86±0.05	0.02±0.00	0.92±0.04	0.88±0.04	0.54±0.00	0.55±0.02	0.51±0.03
HAW75	0.63±0.04	0.72±0.04	0.75±0.04	0.87±0.03	0.89±0.02	0.05±0.00	0.96±0.08	0.52±0.04	0.52±0.00	0.49±0.01
HAW90	0.55±0.05	0.60±0.04	0.64±0.04	0.72±0.03	0.81±0.03	0.91±0.02	0.06±0.00	0.55±0.04	0.55±0.04	0.53±0.07
HAW180	0.35±0.06	0.45±0.05	0.49±0.05	0.50±0.05	0.50±0.05	0.49±0.07	0.49±0.06	0.04±0.00	0.98±0.01	0.95±-0.06
HAW270	0.38±0.06	0.46±0.05	0.50±0.05	0.52±0.05	0.53±0.06	0.52±0.05	0.52±0.07	0.96±0.04	0.07±0.00	0.98±0.03
HAW360	0.30±0.06	0.40±0.06	0.44±0.05	0.47±0.05	0.49±0.05	0.49±0.05	0.50±0.05	0.93±0.08	0.97±0.01	0.01±0.00

Table 2: Heritability estimates (on diagonal), and genetic correlations (above diagonal) and phenotypic correlations (below diagonal) of Body Length (BL) among the Deccani lambs.

	BL0	**BL15**	**BL30**	**BL45**	**BL60**	**BL75**	**BL90**	**BL180**	**BL270**	**BL360**
BL0	0.04±0.00	0.97±0.06	0.89±0.01	0.87±0.14	0.75±0.03	0.69±0.03	0.60±0.04	0.36±0.09	0.38±0.04	0.36±0.06
BL15	0.96±0.02	0.06±0.00	0.95±0.03	0.93±0.04	0.80±0.05	0.74±0.08	0.62±0.06	0.39±0.07	0.41±0.05	0.39±0.05
BL30	0.88±0.03	0.95±0.02	0.10±0.01	0.94±0.13	0.80±0.02	0.74±0.09	0.63±0.03	0.42±0.01	0.44±0.03	0.43±0.04
BL45	0.86±0.03	0.93±0.03	0.93±0.02	0.22±0.03	0.93±0.02	0.87±0.02	0.76±0.02	0.53±0.08	0.55±0.04	0.53±0.03
BL60	0.73±0.04	0.79±0.04	0.80±0.03	0.92±0.02	0.33±0.04	0.94±0.01	0.86±0.01	0.63±0.02	0.65±0.04	0.63±0.04
BL75	0.68±0.04	0.72±0.05	0.72±0.04	0.86±0.03	0.93±0.02	0.30±0.06	0.96±0.02	0.72±0.03	0.73±0.03	0.71±0.04
BL90	0.57±0.05	0.59±0.05	0.59±0.05	0.74±0.04	0.84±0.03	0.94±0.02	0.24±0.04	0.79±0.04	0.79±0.10	0.78±0.03
BL180	0.34±0.05	0.37±0.05	0.42±0.05	0.52±0.05	0.60±0.05	0.66±0.04	0.73±0.05	0.18±0.04	0.98±0.02	0.97±0.01
BL270	0.37±0.06	0.41±0.06	0.45±0.06	0.53±0.05	0.60±0.05	0.65±0.05	0.71±0.05	0.96±0.02	0.19±0.04	0.99±0.06
BL360	0.35±0.06	0.39±0.05	0.44±0.07	0.51±0.05	0.58±0.05	0.63±0.05	0.69±0.07	0.94±0.03	0.98±0.02	0.26±0.01

Table 3: Heritability estimates (on diagonal), and genetic correlations (above diagonal) and phenotypic correlations (below diagonal) of Heart Girth (HG) among the Deccani lambs.

	HG0	**HG15**	**HG30**	**HG45**	**HG60**	**HG75**	**HG90**	**HG180**	**HG270**	**HG360**
HG0	0.12±0.08	0.94±0.06	0.73±-0.03	0.65±0.08	0.57±0.06	0.55±0.01	0.51±0.08	0.29±0.05	0.28±0.04	0.24±0.04
HG15	0.93±0.02	0.18±0.09	0.89±0.06	0.83±0.06	0.74±0.07	0.72±0.02	0.68±0.05	0.48±0.04	0.47±0.05	0.44±0.05
HG30	0.74±0.04	0.88±0.03	0.16±0.10	0.97±0.09	0.90±0.06	0.88±0.03	0.84±0.08	0.70±0.03	0.69±0.04	0.68±0.04
HG45	0.65±0.04	0.81±0.03	0.96±0.01	0.08±0.00	0.96±0.04	0.94±0.02	0.89±0.01	0.75±0.04	0.74±0.03	0.72±0.10
HG60	0.56±0.05	0.72±0.04	0.88±0.02	0.95±0.05	0.13±0.01	0.96±0.06	0.93±0.09	0.78±0.03	0.76±0.04	0.74±0.03
HG75	0.55±0.05	0.70±0.04	0.87±0.03	0.93±0.02	0.96±0.02	0.12±0.02	0.97±0.03	0.80±0.02	0.78±0.03	0.76±0.02
HG90	0.51±0.05	0.65±0.04	0.82±0.03	0.88±0.03	0.92±0.02	0.96±0.01	0.16±0.02	0.84±0.02	0.82±0.03	0.80±0.01
HG180	0.36±0.06	0.50±0.05	0.70±0.05	0.74±0.04	0.77±0.04	0.79±0.04	0.82±0.04	0.01±0.00	0.99±-0.02	0.96±-0.05
HG270	0.37±0.06	0.50±0.05	0.70±0.05	0.71±0.05	0.72±0.05	0.73±0.05	0.75±0.04	0.94±0.03	0.05±0.00	0.98±0.03
HG360	0.33±0.06	0.46±0.06	0.69±0.05	0.69±0.05	0.70±0.05	0.71±0.05	0.73±0.05	0.92±0.04	0.97±0.02	0.01±0.00

Table 4: Heritability estimates (on diagonal), and genetic correlations (above diagonal) and phenotypic correlations (below diagonal) of Paunch Girth (PG) among the Deccani lambs.

	PG0	**PG15**	**PG30**	**PG45**	**PG60**	**PG75**	**PG90**	**PG 180**	**PG 270**	**PG 360**
PG0	0.08±0.00	0.93±0.03	0.73±0.05	0.65±0.08	0.59±0.04	0.57±0.02	0.52±0.02	0.28±0.01	0.27±0.01	0.25±0.06
PG15	0.91±0.02	0.05±0.00	0.90±0.03	0.84±0.03	0.78±0.07	0.75±0.06	0.69±-0.08	0.49±0.03	0.48±0.03	0.46±0.03
PG30	0.71±0.04	0.89±0.02	0.08±0.00	0.97±0.02	0.94±0.04	0.91±0.04	0.87±0.04	0.74±0.02	0.73±0.07	0.73±0.09
PG45	0.62±0.04	0.81±0.03	0.96±0.01	0.08±0.00	0.98±0.03	0.96±0.05	0.92±0.05	0.80±0.08	0.78±0.08	0.77±0.08
PG60	0.55±0.05	0.75±0.04	0.92±0.02	0.98±0.05	0.13±0.01	0.97±0.09	0.95±0.04	0.82±0.04	0.81±0.06	0.79±0.05
PG75	0.52±0.05	0.72±0.04	0.89±0.02	0.95±0.02	0.97±0.03	0.14±0.02	0.98±0.09	0.83±0.05	0.82±0.04	0.80±0.02
PG90	0.47±0.04	0.65±0.04	0.84±0.03	0.90±0.02	0.93±0.01	0.97±0.01	0.19±0.03	0.86±0.06	0.85±0.05	0.83±0.04
PG180	0.30±0.05	0.50±0.05	0.75±0.04	0.80±0.05	0.81±0.05	0.82±0.04	0.84±0.04	0.01±0.00	0.99±0.04	0.97±0.06
PG270	0.29±0.06	0.49±0.05	0.74±0.05	0.79±0.05	0.80±0.04	0.80±0.05	0.82±0.05	0.98±0.03	0.01±0.00	0.99±0.03
PG360	0.27±0.06	0.47±0.05	0.74±0.05	0.77±0.05	0.78±0.05	0.78±0.05	0.80±0.05	0.97±0.04	0.99±0.01	0.01±0.00

Table 5: Heritability estimates (on diagonal), and genetic correlations (above diagonal) and phenotypic correlations (below diagonal) of Chest Depth (CD) among the Deccani lambs.

	CD0	**CD15**	**CD30**	**CD45**	**CD60**	**CD75**	**CD90**	**CD180**	**CD270**	**CD360**
CD0	0.06±0.00	0.92±0.06	0.74±0.08	0.74±0.07	0.65±0.06	0.61±0.04	0.53±0.08	0.18±0.05	0.18±0.01	0.15±0.04
CD15	0.91±0.04	0.12±0.01	0.91±0.08	0.88±0.01	0.77±0.08	0.75±0.08	0.68±0.09	0.28±0.03	0.28±0.02	0.25±0.03
CD30	0.74±0.04	0.90±0.02	0.22±0.03	0.94±0.04	0.83±0.05	0.83±0.03	0.77±0.08	0.43±0.04	0.39±0.05	0.37±0.04
CD45	0.68±0.04	0.86±0.03	0.88±0.02	0.22±0.04	0.95±0.04	0.91±0.09	0.82±0.07	0.37±0.03	0.35±0.03	0.32±0.06
CD60	0.59±0.04	0.76±0.04	0.77±0.03	0.95±0.04	0.15±0.02	0.93±0.02	0.83±0.06	0.31±0.04	0.29±0.02	0.28±0.03
CD75	0.60±0.05	0.73±0.04	0.79±0.03	0.85±0.02	0.87±0.02	0.21±0.05	0.94±0.02	0.49±0.05	0.47±0.04	0.44±0.02
CD90	0.51±0.05	0.64±0.04	0.71±0.04	0.72±0.03	0.73±0.03	0.92±0.02	0.18±0.02	0.60±0.05	0.56±0.05	0.52±0.04
CD180	0.20±0.06	0.28±0.05	0.41±0.05	0.32±0.05	0.27±0.05	0.47±0.05	0.57±0.04	0.16±0.01	0.97±0.03	0.94±0.05
CD270	0.22±0.06	0.31±0.05	0.40±0.05	0.32±0.05	0.28±0.06	0.46±0.03	0.55±0.05	0.95±0.03	0.25±0.03	0.98±0.07
CD360	0.18±0.06	0.28±0.06	0.37±0.05	0.33±0.05	0.30±0.05	0.43±0.05	0.51±0.05	0.92±0.04	0.99±0.02	0.19±0.01

Table 6: Linear regression equations for body weight (Y) predicted at different ages based on ten different biometrical measurements in Deccani lambs

Age (days)	Regression equations	R^2
90	$Y=0.20+0.15X3^{**} + 0.19X9^{**}$	0.184
	$Y= -1.01+0.15X_3^{**} + 0.2X_6 + 0.17X_9^{**}$	0.188
	$Y= -1.48+0.04X_1 + 0.12X_3^{**} + 0.2X_6 + 0.16X_9^{**}$	0.191
	$Y= -1.87+0.05X_1 + 0.13X_3^{**} + 0.2X_6 + 0.19X_9^{**} - 0.03X_{10}$	0.193
	$Y= -1.81+0.05X_1 + 0.13X_3^{**} + 0.4X_6 - 0.02X_7 + 0.19X_9^{**} - 0.02X_{10}$	0.195
	$Y= -1.16+0.04X_1 + 0.12X_3^{**} + 0.4X_6 - 0.02X_7 + 0.04X_8 + 0.17X_9^{**} - 0.03X_{10}$	0.196
	$Y= -1.23+0.04X_1 + 0.12X_3^{**} + 0.05X_5 + 0.4X_6 - 0.02X_7 + 0.04X_8 + 0.17X_9^{*} - 0.03X_{10}$	0.197
	$Y= -1.15+0.03X_1 + 0.02X_2 + 0.12X_3^{**} + 0.05X_5 + 0.4X_6 - 0.02X_7 + 0.04X_8 + 0.16X_9^{*} - 0.04X_{10}$	0.198
	$Y= -1.25+0.03X_1 + 0.02X_2 + 0.12X_3^{**} + 0.1X_4 + 0.06X_5 + 0.4X_6 - 0.02X_7 + 0.04X_8 + 0.16X_9^{*} - 0.04X_{10}$	0.198
180	$Y=5.02^{**}+0.06X_1^{**} + 0.29X_5^{**} + 0.16X_9^{**}$	0.147
	$Y=3.65+0.06X_1^{**} + 0.6X_4 + 0.29X_5^{**} + 0.15X_9^{**}$	0.155
	$Y=3.99^{*}+0.06X_1^{**} + 0.5X_4^{*} + 0.32X_5^{**} - 0.03X_7 + 0.15X_9^{**}$	0.163
	$Y=4.24^{*}+0.07X_1^{**} + 0.5X_4^{*} + 0.32X5^{**} - 0.03X_7 + 0.19X_9^{**} - 0.04X_{10}$	0.170
	$Y=4.35^{**}+0.11X_1^{*} - 0.3X_3 + 0.5X_4^{*} + 0.31X_5^{**} - 0.03X_7 + 0.20X_9^{**} - 0.04X_{10}$	0.173
	$Y=5.02^{**}+0.10X_1^{*} - 0.4X_3 + 0.5X_4^{*} + 0.29X_5^{**} - 0.03X_7 + 0.05X_8 + 0.18X_9^{**} - 0.05X_{10}$	0.175
	$Y=5.10^{**}+0.10X_1^{*} + 0.02X_2 - 0.4X_3 + 0.5X_4^{*} + 0.29X_5^{**} - 0.03X_7 + 0.05X_8 + 0.17X_9^{**} - 0.06X_{10}$	0.177
	$Y=4.90^{**}+0.10X_1^{*} + 0.02X_2 - 0.4X_3 + 0.5X_4^{*} + 0.29X_5^{**} + 0.1X_6 - 0.04X_7 + 0.05X_8 + 0.17X_9^{**} - 0.06X_{10}$	0.177
Age (days)	**Regression equations**	**R^2**
270	$Y=3.31+0.07X_1^{**} + 0.2X_4 + 0.47X_5^{**} + 0.08X_9^{*}$	0.226
	$Y=3.45+0.07X_1^{**} + 0.4X_4^{*} + 0.48X_5^{**} - 0.02X_7 + 0.09X_9^{*}$	0.230
	$Y=3.63+0.08X_1^{**} + 0.4X_4^{*} + 0.48X_5^{**} - 0.02X_7 + 0.10X_9^{*} – 0.01X_{10}$	0.232
	$Y=3.73^{*}+0.07X_1^{**} + 0.03X_2 + 0.4X_4^{*} + 0.48X_5^{**} - 0.02X_7 + 0.09X_9 – 0.03X_{10}$	0.236
	$Y=3.85^{*}+0.11X_1^{**} + 0.03X_2 - 0.4X_3 + 0.5X_4^{*} + 0.46X_5^{**} - 0.02X_7 + 0.09X_9 – 0.03X_{10}$	0.239
	$Y=4.29^{*}+0.11X_1^{**} + 0.03X_2 - 0.4X_3 + 0.4X_4^{*} + 0.46X_5^{**} - 0.02X_7 + 0.05X_8 + 0.08X_9 – 0.04X_{10}$	0.242
	$Y=4.41^{*}+0.11X_1^{**} + 0.03X_2 - 0.4X_3 + 0.5X_4^{*} + 0.46X_5^{**} - 0.1X_6 - 0.02X_7 + 0.05X_8 + 0.08X_9 – 0.04X_{10}$	0.242
360	$Y= 1.26+0.97X_5^{**} + 0.07X_6^{**}$	0.364
	$Y= -0.38+0.98X_5^{**} + 0.06X_6^{**} + 0.07X_9$	0.370
	$Y= 0.11+0.99X_5^{**} + 0.09X_6^{**} - 0.04X_7 + 0.08X_9$	0.374
	$Y= -1.02+0.04X_1 + 0.99X_5^{**} + 0.08X_6^{**} - 0.05X_7 + 0.07X_9$	0.378
	$Y= -0.79+0.04X_1 - 0.02X_2 + 0.99X_5^{**} - 0.05X_7^{**} + 0.07X_9$	0.379
	$Y= -0.73+0.03X_1 - 0.02X_2 + 0.01X_4 +1.00X_5^{**} + 0.09X_6^{**} -0.05X_7 + 0.07X_9$	0.379
	$Y= -0.08+0.03X_1 - 0.03X_2 + 0.01X_4 + 1.00X_5 + 0.09X_6 - 0.05X_7 + 0.07X_9 + 0.00X_{10}$	0.380
	$Y= -0.94+0.03X_1 - 0.03X_2 + 0.01X_4 + 1.00X_5 + 0.09X_6 - 0.05X_7 - 0.01X_8 + 0.07X_9 + 0.01X_{10}$	0.380

Y= Body weight, X_1 = Height at withers, X_2 = Chest Depth, X_3 = Rump Height, X_4 = Body Length, X_5 = Hip width, X_6 = Heart Girth, X_7 = Paunch Girth, X_8 = Chest Width, X_9 = Fore- Cannon Bone Length and X_{10} =Thigh Circumference.

* Significant ($p \leq 0.05$); ** Significant ($p \leq 0.01$)

Conclusion

The production performance of Deccani sheep can be boosted and optimum output can be obtained by following the best manage mental practices. The heritability estimates in the present study were low to medium which gives us much scope for genetic improvement through selective breeding. The genetic and phenotypic correlations estimated were mostly positive which gives a chance for the breeder to go for indirect selection of the animals.

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