

Morphometric Characterization Of Goat Genetic Populations And Their Production System In Nuwakot, District, Nepal

Maheshwar Dahal¹ and Dharmendra Rawat²

¹Nepal Agricultural Research Council, Kathmandu, Nepal

²Himalayan College Of Agricultural Sciences And Technology, Kathmandu Nepal

Abstract

The study was carried out to access the production system and morphometric traits of goats and to understand the phenotypic association among morphometric traits in goat of Nuwakot district during April to July 2023. A total of 20 households were surveyed among them 11 from Panchakanya and 9 from Shivapuri municipality by random sampling by using structured questionnaire. Body measurements were collected from 104 goats with the help of developed format. Collected data were entered and coded in excel and analyzed using mixed model least square and maximum likelihood computer program developed by Harvey (1990). The quantitative traits such as body weight, body length, rump height, wither height, ear length, thigh diameter and chest girth. Other traits location, age, sex, breed, type of birth, and color were also determined. The results of the study showed that the linear body traits and body weight were significantly affected ($P < 0.001$) by age and sex. All morphometric traits are higher in case of male than female except ear length. Similarly, all quantitative traits increased with the increase in age of the goats with the highest values found in two years and >3 years and lower in one-year goats. Also, the morphometric traits were significantly ($P < 0.01$) affected by breed. The results revealed that the both Jamunapari and Boer cross had higher morphometric values among other breeds and lower in khari breeds. The highest correlation was found between the body weight and chest girth (0.774) and body length (0.677). From this study, we may conclude that there is positive and strongly association between the linear body measurements and body weight which would provide the information regarding the genetic improvement, cross breeding and breeders and ultimately aid in goat production.

Key words: Age, different breeds, goats, sex and Measurements

Date of Submission: 01-12-2023

Date of Acceptance: 10-12-2023

I. Introduction

Nepal is agri-based country with 65% of population based on agricultural that contributes 35% GDP and comprises of crop, livestock, and fooder trees. The contribution of livestock to national GDP is significant i.e 24.01% and 3.19% from the goats. According to MOALD (2021/22) the total goat population is about 13,442,614 and in 2021/22 is 13,990,703. According to MOALD (2021/22) the total net production of meat is 512,788 metric tonnes among goat meat production is about 74,241 metric tonnes. Goat plays an important role in economic of nation by increased in GDP. The average annual increment in goat population in year (2021/22) is 4.08%.

Goat farming is in Nepal is popular among rural farmers because of low investment requirements. About 49.8% households rear goats with average holdings 3/ households (CBS 2012). Based on data obtained from government of Nepal 2021 there is increasing trend of major livestock; however, goat population is increasing much rapidly as compared to other livestock. According to the (FAOSTAT, 2021), Asia has a largest number of the goats in the world which accounts about 52.60% of the total goat population, Nepal is ranked 20th position in the world and 8th position in Asia. Nepal has a decent variety of goat species. There are four indigenous goat breeds; they are Sinhal in high and low mountains, Chyangra in mountain, Khari across hills and mid hills and terai is mainly found in the lower plains. Also we have various exotic goat breeds example Boer, Jamunapari, Beetal, Barbari, Sannen are most important exotic breeds which are used for various purpose. The primary reason is that the native breeds have lower outputs and productivity potential than exotic breeds (Bhattari *et al.*, 2019). Commercial goat production is increasing day by day as the demand for meat is growing. Body weight is an important economic traits especially in goats in determining the required feed volume, medicine dose, and market price of an animal, as well as enhancing farm profitability (Eyduran *et al.*, 2017).

Goat production system

Goat production system has been found to be impacted by geographical region, feed available, climate and human resources. Aryal (2003), reported the two major system of goat production, transhumance system and stationary system. In transhumance system, large flock of goat are raised in high altitude during summer and taken down to lower hills to avoid cold during winter season. Semi intensive system is widely practiced by small marginal farmers and rural people. In this system goats are allowed to graze for some hours daily and are supplemented with concentrate. In this system goats are allowed to graze for average 3-4 hours (Neopane, 2012). In intensive system goat rearing with total stall feeding. Farmers use the cut and carry method supplementing grains and agricultural by products with concentrate feed.

This study is mainly designed to understand productive performances of goats in Sivapuri and panchakanya municipality of Nuwakot District of Nepal and also access the morphometric traits of goat population and their production system. Hence, the research was designed to access the production system and phenotypic characterization of goats in Nuwakot district.

II. MATERIALS AND METHODS

Study area :

Nuwakot district, a part of Bagmati province is one of the seventy-seven districts of Nepal. The district with Bidur as its district headquarters, covers an area of 1121 square kilometer. It is located at just 75 km west from Kathmandu. It has total population 265,981 (2021). the total number of municipality is twelve among them ten are rural municipality and remaining two are urban municipality.

The research was conducted in two rural municipality, panchakanaya rural municipality and shivapuri rural municipality of Nuwakot district, Nepal. Panchakanaya rural municipality is located at 27° 53' 46N latitude 85° 18' 49E longitude at altitude of 1276masl and Shivapuru municipality is located at 27°45' to 27°52' N latitude 85°13' to 85°18' E longitude.

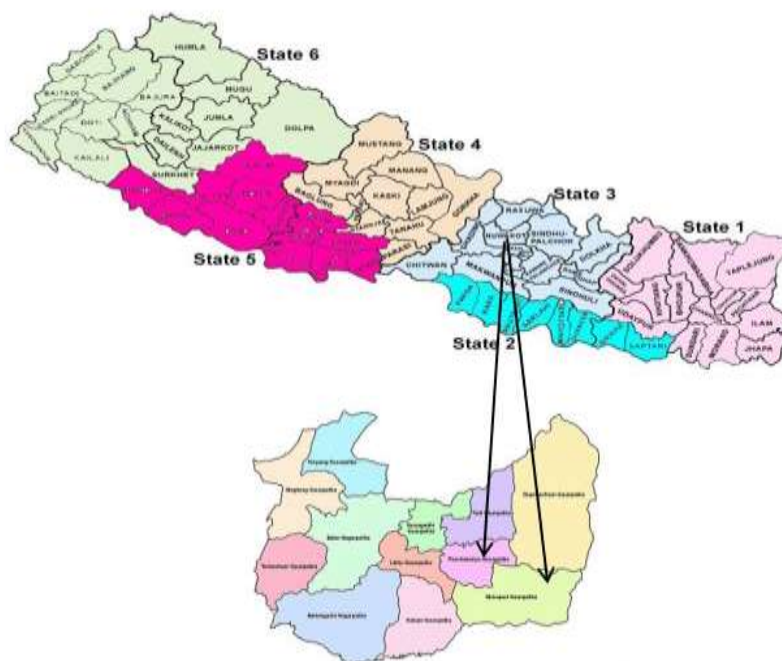


Figure 1. Map showing the study site

Experimental animals

The research was conducted on 104 goats breed among them female(85) and male(19). The study was conducted on two rural municipality for morphometric data collection and 16 household for the production system which includes housing system, breeding system, feeding system etc. The various goats breeds are used for samples such as khari, boer cross, jamaunpari cross and mixed.

Table 1. Total goat population in study area

Municipality	Male goat	Female goat	Total goat
Panchakanya rural Municipality	7	43	50
Shivapuri rural Municipality	12	42	54
Total goat	19	85	104

Monomorphic data collection:The production system, parity, age, and type of birth were determined by direct interviewing owners and qualitative traits like coat color, and sex was determined by direct visual observation. A linear body measurement (body length, heart girth, rump height, wither height, thigh circumference and ear length) was measured by the measuring tape and live weight of goats was taken by the suspended spring balance and also weight measuring tape.

Body measurements collection:A linear body measurements and live body weight were taken of 104 goats breed in sampling sites. The various parameters was measured such as, live body weight, wither height, rump height, heart girth, thigh circumference and ear length. The goat production system was assessed by discussing or interviewing directly with the farmers. The data was collected from the sixteen household through the direct interview with farmers by using semi- structured questionnaire.

Statistical analysis: The recorded data were coded and entered into the Microsoft Excel program and spss v 20. various sorts of statistical analysis were applied depending on the nature of the data. Production system, sex, age, type of birth, color, breed, and location were fitted as independent variables whereas dependent variables were fitted as live body weight and linear body measurements (BL, HG, WH, RH, EL, TC). To study the effect of non - genetic factors on body weight and linear body measurements, the data were analyzed by Mixed Model Least-square and Maximum Likelihood Computer Program PC-2 statistical package developed by Harvey (1990). Data regarding the production system of goat were analyzed using Microsoft Excel. The relationship between body weight and linear body measurement traits were assessed through the Pearson's coefficients of correlation using SPSS v.20 computer software package. Model used for analysis of body weight and linear body measurements traits was:

$$X_{abcdefg} = \mu + K_a + L_b + M_c + N_d + O_e + P_f + e_{abcdefg}$$

Where $X_{abcdefg}$ = Observation of measured variables

μ = overall mean of all the animal in the study

K_a = effect due to location (a = Panchakanya, Shivapuri)

L_b = effect due to breed (b = Khari, Boer cross and Jamanapuri cross)

M_c = effect due to sex (c = Male, Female)

N_d = effect due to birth type (Single, Twin)

O_e = effect due to age (e = upto 1 year, 1-2 years and >3 years)

P_f = effect due to color (f= black, white and mixed)

$e_{abcdefg}$ = (random residual error)

III. Results

Morphometric measurements and live body weight

The study revealed that the overall mean least square mean values and standard error of the mean of body weight, heart girth, rump height, wither height, body length, thigh diameter and ear length in the current study was 34.09±10.70kg, 71.76±8.93cm, 67.14±7.05cm, 62.01±7.19cm, 60.40±8.15cm, 26.13±4.55cm and 22.21±3.52cm respectively. The obtained data analysis of this showed significant difference (p<0.001) among live body weight and other linear body measurements with respect to breed, sex, age whereas there was no significant difference with type of birth, location and color respectively.

The overall mean least square mean values and standard error of the mean body weight and linear body measurements traits of goats in the study area by location, breed, sex, color, type of birth and age are presented in table 2.

Table 2: Least square mean (LSM)±standard errors of live body weight and different body measurement by location, production system, sex, birth type, color and age of goats

S. N	Factors	N	Body weight	Heart girth	Body length	Wither height	Rump height	Thigh diameter	Ear length
	Overall mean	104	34.09±10.70	71.76±8.93	60.40±8.15	62.01±7.19	67.14±7.05	26.13±4.55	22.21±3.52
	CV	104	23.87	9.48	11.28	9.75	8.10	14.92	14.08
	R²	104	0.48	0.48	0.38	0.37	0.47	0.35	0.30
1.	Location								

	Sivapuri	50	39.95±1.84	74.77±1.54	62.57±1.54	63.64±1.37	69.44±1.23	29.38±0.88	21.79±0.71
	Panchakanya	54	36.84±1.91	73.83±1.60	58.58±1.60	61.59±1.42	67.81±1.28	26.20±0.91	21.56±0.73
	Level of significance (p>0.05)		NS	NS	NS	NS	NS	NS	NS
2.	Breed								
	Khari	33	34.48±2.05	70.28±1.71	58.37±1.71	60.06±1.52	66.01±1.37	26.27±0.98	20.03±0.78
	Jamunapari cross	34	40.38±2.04	76.08±1.71	62.34±1.71	64.62±1.52	72.00±1.36	29.30±0.98	24.27±0.78
	Boer cross	37	40.33±2.01	76.54±1.68	61.02±1.68	63.18±1.49	67.86±1.34	27.80±0.96	20.74±0.77
	Level of significance (p>0.05)		**	**	**	**	**	**	**
3.	Sex								
	Male	20	42.72±2.37	77.37±1.98	61.80±1.98	64.94±1.76	71.15±1.58	29.21±1.13	21.48±0.91
	Female	84	34.07±1.44	71.23±1.20	59.36±1.20	60.29±1.07	66.11±0.96	26.37±0.69	21.87±0.55
	Level of significance (p>0.05)		***	***	***	***	***	***	NS
4.	Colour								
	Brown	38	36.25±1.94	72.72±1.62	59.53±1.62	62.29±1.44	68.12±1.29	27.50±0.93	21.71±0.74
	Black	14	39.53±2.77	75.59±2.32	64.54±2.32	64.90±2.06	71.39±1.85	28.50±1.32	21.96±1.06
	White	20	39.24±2.20	73.69±1.84	58.86±1.84	61.42±1.63	66.91±1.47	26.19±1.05	20.38±0.84
	Mixed	32	38.56±2.04	75.19±1.70	59.39±1.70	61.86±1.51	68.18±1.36	28.98±0.97	22.65±0.78
	Level of significance (p>0.05)		NS	NS	NS	NS	NS	NS	NS
5.	Type of Birth								
	Single	46	37.25±1.97	73.65±1.65	59.84±1.65	62.06±1.46	68.52±1.32	27.88±0.94	21.27±0.75
	Twin	58	39.53±1.75	74.95±1.47	61.31±1.47	63.18±1.30	68.73±1.17	27.70±0.84	22.09±0.67
	Level of significance (p>0.05)		NS	NS	NS	NS	NS	NS	NS
7.	Age								
	Up to 1 year	35	28.51±2.16	67.26±1.80	53.97±1.80	57.11±1.60	62.70±1.44	25.49±1.03	20.75±0.83
	1 to 2 years	21	43.65±2.39	75.92±1.99	62.94±2.00	63.39±1.77	70.09±1.59	29.31±1.14	22.32±0.91
	>3 year	48	43.02±1.77	79.72±1.48	64.82±1.48	67.36±1.31	73.09±1.18	28.57±0.84	21.97±0.68
	Level of significance (p>0.05)		***	***	***	***	***	***	***

Note: NS:non significant (p>0.05), ***: significant at 0.1% level(p<0.001) and **: significant at 1%(p<0.01)

Effect of age:

Table 3. Showing the age wise body weight and linear body measurements

Age	N	Body weight	Heart girth	Body length	Wither height	Rump height	Thigh diameter	Ear length
up to 1 year	35	28.51±2.16	67.26±1.80	53.97±1.80	57.11±1.60	62.70±1.44	25.49±1.03	20.75±0.83
1 to 2 years	21	43.65±2.39	75.92±1.99	62.94±2.00	63.39±1.77	70.09±1.59	29.31±1.14	22.32±0.91
>3 yrs	48	43.02±1.77	79.72±1.48	64.82±1.48	67.36±1.31	73.09±1.18	28.57±0.84	21.97±0.68

Results of this study revealed significance difference (p<0.001). The above table shows that the mean body weight of 1-year goats was 28.51±2.16kg, upto 2 years 43.65±2.39kg and >3 years was 43.02±1.71kg respectively. The highest body weight was found on upto 2 years goats and >3 years goats. Similarly, heart girth was found highest 79.72±1.48cm in >3 years goats and then upto 2 years and lowest on upto 1 year. Body

length, wither height, rump height was also highest on >3 years and then upto 2 years and lowest on upto 1-year goats and there was slight difference on the thigh diameter and ear length which is given table3.

Effect of breed:

Table 4. weight and linear body measurement of different breed of goat

Breed	N	Body weight	Heart girth	Body length	Wither height	Rump Height	Thigh diameter	Ear Length
Khari	33	34.48±2.05	70.28±1.71	58.37±1.71	60.06±1.52	66.01±1.37	26.27±0.98	20.03±0.78
Jamunapari cross	34	40.38±2.04	76.08±1.71	62.34±1.71	64.62±1.52	72.00±1.36	29.30±0.98	24.27±0.78
Boer cross	37	40.33±2.01	76.54±1.68	61.02±1.68	63.18±1.49	67.86±1.34	27.80±0.96	20.74±0.77

Overall mean body weight and linear body measurements of each goat breeds are presented on above table. The current research revealed that the breed of an animal had an effect on (p<0.001) on the body weight and linear body measurements. Jamunapari cross breed and Boer cross had a higher value for all the quantitative traits then khari.

There is no significant difference between Jamunapari cross and Boer cross in heart girth but there was variation with Khari breeds. The heart girth of Jamunapari cross, Boer cross and Khari was 76.08±1.71cm, 76.54±1.68cm and 70.28±1.71cm respectively. The study revealed that body length of Boer cross, Jamunapari cross, and Khari was 61.02±1.68cm, 62.34±1.71cm and 58.37±1.71cm respectively and similarly wither height was 63.18±1.49cm, 64.62±1.52cm and 60.06±1.52 cm. Rump height had a significant difference within breeds. Jamunapari cross had a highest rump height 72.00±1.36cm, Boer cross 67.86 ±1.34cm and Khari 66.01±1.52 cm respectively. Thigh diameter had a significant difference among breeds, Jamunapari cross had a slightly higher thigh values followed by Boer cross and then Khari. The thigh diameter of Jamunapari, Boer cross and Khari was 29.30±0.98cm, 27.80±0.98cm and 26.27±0.98cm. Ear length did not show any significant difference between Khari and Boer cross, 20.03±0.78cm and 20.74±0.77cm respectively but Jamunapari cross had highest ear length that was 24.27±0.78cm.

Effect of sex

Sex of an animal had a considerable effect (p< 0.001) on all morphological traits. The overall mean body weight of male and female goat was found to be 42.72±2.37kg and 34.07±1.44kg. Similarly heart girth, body length, wither height, rump height and thigh diameter of male and female was 77.37±1.98cm, 61.80±1.98cm 64.94±1.76cm 71.15±1.58cm 29.21±1.13cm and female was 71.23±1.20cm, 59.36±1.20cm, 60.29±1.07cm, 66.11±0.96cm and 26.37±0.69cm respectively. The ear length did not show any significant difference with the male and female goats. The ear length of male was 21.48±0.91cm and female was 21.87±0.55cm respectively.

Correlation between linear body measurements and body weight of goats:

All the morphological traits showed positive and strong (p<0.01) associations with live body weight ranging from 0.251 to 0.774. due to the strong and positive correlation between body weight and linear body measurements an increase in one of the linear body measurements would result in a corresponding increase in body weight also. The highest correlation was observed between body weight and heart girth (0.774) followed by rump height (0.631), body length (0.677), wither height (0.631), thigh diameter (0.552) and lowest correlation was observed between ear length (0.251) and body weight.

Table 5. Phenotypic correlation among metamorphic traits of the goat population

	BW	HG	RH	WH	BL	TD	EL
Body weight	1	.774**	.626**	.631**	.675**	.552**	.251*
Heart girth		1	.631**	.648**	.677**	.549**	.189
Rump height			1	.606**	.728**	.485**	.366**
Wither height				1	.731**	.420**	.279**
Body length					1	.454**	.348**
Thigh diameter						1	.329**
Ear length							1

** Correlation is significant at 0.01 level (2- tailed) *Correlation is significant at 0.05 level (2- tailed)

Production system: Housing system: Majority of farmers have adopted the semi-intensive system in both the rural municipality followed by the traditional system and very less farmers adopt the intensive system. In both sites the majority of farmers have raised goat on small scale followed by subsistence farm.

Feeding system: The major sources of the green forages and fodder was pasture land in both municipalities followed by the self- cultivated grass and then governmental forest in Shivapuri and

Panchakanaya rural municipality. There are various types of fodder and green forages are available. Some farmers have also cultivated the fodder in their own land. Napier (*Pennisetum purpureum*), Taki(*Bauhinia purpurea*), Kutmiro (*listea polyantha*), ipil-ipil (*Leuceana leucocephala*) Kimbu (*Morus alba*).

Table 6. Available fodder in research site

SN	Fooder name	season
1.	Super napier(<i>Pennisetum purpureum</i>)	All season
2.	Taki (<i>bauhinia purpurea</i>)	Dry winter
3.	Kutmiro (<i>listea polyantha</i>)	Dry winter
4.	Ipil-ipil (<i>leuceana leucocephala</i>)	All season
5.	Kimbu (<i>morus alba</i>)	All season

Breeding system

In both municipality, farmers have adopted crossbreeding local goats(Khari) with Boer, Jamunapari. The main breeding system was followed by each municipality was one buck per herd and then followed by the natural way of mating. Artificial insemination was not practiced at both rural municipalities. There was no particular season for mating however shrawan – Bhadra and mangh – fagun was the most prevalent month of the years with frequent birth.

IV. Discussion

Linear body measurements

Effect of breed

The study revealed that the mean body length and wither height of Khari was 58.37 ± 1.71 cm and 60.06 ± 1.52 cm. A similar value of 59.96 ± 0.98 cm body length and 61.9 ± 1.03 cm wither height were reported in khari by Bhattari (2020).but the heart girth of khari 70.28 ± 1.71 cm which is higher than Bhattari, which was 65.04 ± 1.17 cm. The mean body weight and body length of Khari was 34.48 ± 2.05 kg and 58.37 ± 1.71 cm which is higher than the sapkota, et al, (2014), indigenous goats of Lamjung District but the chest girth was 77.21 ± 1.71 cm which was higher than our results 70.28 ± 1.71 cm. The mean body weight and heart girth of Jamunapari cross was found 40.38 ± 2.04 kg and 76.08 ± 1.71 cm which is higher than the Das and Yadav(2015),research on productive performance of Jamunapari goat under semi-intensive system. The mean body weight of Boer was 40.33 ± 2.01 kg which is higher thanthe, (Adhikari *et al.*, 2017) in a study of performance of Boer 50% kids reported that the body weight was 33.66 ± 5.29 kg. The heart girth of Jamunapari cross and Boer cross was 76.08 ± 1.71 cm and 76.54 ± 1.68 cm which was similar to 77.57 ± 1.65 cm “Dahal and Azad”, study on productive, reproductive and morphological traits of buck in different Eco-zones of Lumbini province. From our analysis mean body weight was 34.09 ± 10.7 kg. Similarly, HG, RH, WH, BL, TD was 71.76 ± 8.93 cm, 67.14 ± 7 cm, 62.01 ± 7.19 cm, 60.40 ± 8.15 cm, and 26.13 ± 4.55 cm respectively. In term of body weight, rump height, wither height, thigh diameter values are higher than Prajawati (2021), on phenotypic characterization of Tanahu District but less in terms of heart girth and body length. The body length of Khari was 58.37 ± 1.37 cm was found which is similar to 57.88 ± 0.34 cm by Gautam (2017).

The variation on phenotype might be caused by the genetic variation among the different goat breed and the environment also plays a vital role in goat population in response to different body weight and linear body measurements traits (Cam, Olfal and Soydan, 2010). the higher values of body weight and other linear body measurements of Boer cross and Jamunapari cross are due to the large body size of Boer and Jamunapari and in case of Boer its gain weight rapidly. From our study shows that the there was differentiation among body weights and other linear body measurements among the different goats breed i.e khari, Boer cross and Jamunapari cross. It maybe due to the genetics factor and environmental factors such as chromosome, gene, proper production system includes breeding system, feeding system, bedding system, cross breeding and proper care and management.

Effect of sex:

From our results mean body weight of male and female was 42.72 ± 2.37 kg and 34.07 ± 1.44 kg respectively. Similarly the heart girth, body length rump height of male was 77.37 ± 1.98 cm, 61.80 ± 10.98 cm, 71.15 ± 1.58 cm and female was 71.23 ± 1.20 cm, 59.36 ± 1.20 cm, 66.11 ± 0.96 cm respectively. All the measurements are higher in male then female.

Dahaland Azad (2023) found overall body length of buck from one to four year age was found 78.01 ± 0.35 cm which is higher then our results and heart girth was 77.57 ± 1 cm which is similar to our results .

Effect of age :

All linear body measurements positively correlated with the age i.e body measurements increases with the age with the highest mean value was in older age groups(1-2 years and >3 years). the significant difference between the three age groups might be due to the fact that majority of goats 1-2 years and >3 years are female and I have collected matured goats. The mean weight of one year goat was 28.52 ± 2.16 kg which was less 38.76kg by M.H Azad and overall body length heart girth of buck from one to four year was 78.01 ± 0.35 cm and 77.57 ± 1.65 cm which is also higher then our results.

Correlation Coefficient:

From our results revealed that the heart girth as the strongly and positively correlated with the linear quantitative variables with the body weight which is also similar to the Das and Yadav, (2015). but there is highest correlation between heart girth and wither height (Sapkota *et al.*, 2014) and between the wither height and rump height (Inthuja, Paythnathan and Pragashan, 2018).

The high correlation coefficient values between linear body measurements and live body weight indicates that either or the combination of these quantitative traits could be used to estimate the live body weights of goats in the field of absence of weighing machine (Yemane, Melesse and Taye,2020). and selecting positively associated traits would be important to improve breeding programme and results in improvement in economically valuable traits. The strong association between the body weight and chest girth may be due to its constitute the larger parts of body such as, muscles, bones and viscera(Melesse *et al.*, 2013).

V. Conclusion and Suggestions

Based on the results of this study, it can be concluded that breed, age and sex are the most important factors that are the worthy to consider while improving the productivity of goat flock. Boer cross and jamunapari cross breed represents the higher among the other breeds. Among the other quantitative traits heart girth was found to be highly and positively correlated with the live body weight then the other linear body measurements which are moderately and positively correlated with the live body weight. Similarly, the linear body measurements traits increase the as the age increases also. The overall mean value of linear measurements and body weight increases upto 2 years and >3 years then up to 1year age goats. Similarly, all linear body measurements and weight was found to be high in case of male goats then female goats population.

From the production system analysis the majority of the households at both sites had adopted the semi-intensive system followed by traditional and intensive system. Boer cross and Jamunapari cross was found to be most preferred breeds among the both municipality due to the large sizes of Boer, good performance, good body weight increases, long ears and tasty and delicious meat.

This information is most important for the improving goat production system by knowing the most valuable and economically important traits with respect to body weight. It also aids in further, characterization, selection, improve in breeds, cross breeding and conservation strategies of different goat breeds.

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