

## Morphological Characterization of Gadik Sheep in North East Part of Afghanistan

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### ABSTRACT

The Gadik sheep, the local breed in Afghanistan, is reared mainly for meat. The sheep is a native breed in Badakhshan and Panjshir provinces of Afghanistan and has good adaptation to cold weather and mountainous regions. It also plays a vital role in the income of households, this study investigated the documentation and morphological traits of the sheep, a survey was conducted during the research that examined the sheep's habitat, body biometry, management procedures, and reproductive and productive performance. To examine the sheep's morphological characteristics, 40 sheep 20 ewes and 20 rams from one to four years old had their morphological features measured. Morphological characteristics that are included in measurements are: head and neck traits; back and tail traits; teats and testes; height, length, and depth traits; coat covert; and coloring. Gadik had a characteristically three-color coat: brown, white, and black. All data were collected from 40 flocks, with an average of  $28.1 \pm 1.9$  heads per flock. They lambd twins at about  $45.0 \pm 3.33\%$  and remain single, and they also followed a restricted breeding pattern, i.e., they got just one lambing per year in the spring but others lambd twice per year. The flocks graze for  $10 \pm 0.2$  h daily during the summer. Shearing was done twice a year, in spring and fall, with an average wool production of  $0.4 \pm 0.02$  kg/clip animal.

Gadik is a small breed among other sheep breeds in Afghanistan and possesses a small, thin, short-tail sheep with an average weight of  $25.35 \pm 0.0$  kg (males:  $26.6 \pm 0.40$  kg; females:  $24.1 \pm 0.40$  kg) and a slightly convex nose. Males had horns, Females were hornless. Birth weight averaged  $1.2 \pm 4.39$  kg. The average body length was  $50.85 \pm 0.03$  cm. Sex and age were important contributors to differences in most traits; however, location differences also affected a few of the traits. Location differences existed for weight traits, and animals at Wiyar and Bashar were slightly bigger and heavier as compared to Shedo, Dashar, and Sarchashma villages. Animals had medium-sized heads with a slightly bulging forehead, a tapering face, and shining eyes. Rams carried horns,  $21.9 \pm 0.44$  cm long, affected by sex and age. In mature males, horns run backward and grow outward somehow spirally. The adult population had fully developed, floppy (semi-pendulous), laterally protruded, and free of any pricks, small-sized ears with an average length of  $7.00 \pm 0.13$  cm and a blade width of  $7.00 \pm 0.12$  cm, and was affected by age and sex factors. Lambs in Wiyar and Bashar had higher respective body weights, while lambs in Shedo, Dashar, and Sarchashma were inferior to those in the remaining villages.

**Keywords-** Documentation, Morphological, Gadik sheep, Badakhshan, Shughnan.

### I. INTRODUCTION

Afghanistan has a variety of sheep breeds, important from the commercial point of view; there are two types of native sheep breeds i.e., Fat-tailed and Fat-rumped (Rahman & Rahman, 2013). The Fat-tailed breeds include Baluchi, Gadai or Gadik (Panjsher Gadik

and Wakhan Gadik), Ghiljai or Ghilzai, Hazaragi, Kandahari or Qandahari, Morkaraman (triple purpose red color, originated from Turkey, but presently also found in Iran and Afghanistan (Zafar, 2018). The Fat-rumped breeds comprise Afghan Arabi (A.A) and Turki. Among the exotic sheep breeds found in Afghanistan, Marco Polo's sheep have been documented. Baluchi

breed sheep originated in southwestern Pakistan and seem to be introduced centuries ago by the Pakistani nomads who used to come to Afghanistan for grazing in the summer season. Baluchi sheep are in Pakistani areas of Baluchistan also known as Mengali, Taraki, Shinwari, Araghi, Farahani, Kermani, and Khorasani (Zewdu & Haile, (2009).

In the North-Eastern parts of Afghanistan, Turki sheep were found these animals are mostly brown with a low yielder of poor-quality wool. However, its mutton production was higher due to its large size. The average Turki sheep's live weight was around 50 -55 kg. Turki sheep were also introduced to Pakistan by the migratory flocks and also with refugees of the Afghan-Russia war. In Pakistan, the said breed is known as Balkhi (Ibrahim et al., 2011).

Badakhshan Province is one of the vulnerable provinces in Afghanistan, located in the farthest north-eastern part of the country between Tajikistan, northern Pakistan, and China it is a mountainous province; according to its geographical location has a safe environment for various wild animals such as Marco Polo sheep, Markhur deer, Snow leopard etc. It covers an area of 44,059 sq. km (Provincial disaster management committee, 2013).

There are various sheep breeds and a few of them are local and indigenous breeds like Gadik sheep, as mentioned above Gadik sheep is the fat-tailed sheep, it is normally called Wakhan Gadik, but it is not just in Wakhan district, it has high adaptation in bordering districts such as Shughnan, Ishkashim, Zibak and Darvaz. According to geographical classification, Gadik sheep is a local and acclimation breed, its extinction level is not clear (Zafar, 2018). The Gadik sheep breed is a local breed that has unique social and economic value as well as cultural value (Zewdu & Haile, 2009). The objectives of this study were to identify and understanding the management and husbandry practices of the Gadik sheep in Badakhshan province as well as identification and better understanding of the morphological characteristics of Gadik sheep.

## II. MATERIALS AND METHOD

The studies were carried out in three steps:

### *Field Survey a Sampling Strategy*

This research took place in Shughnan district of Badakhshan province in Afghanistan, First the census survey, then finding the farm practices and finally characterization of Gadik sheep (for morphological characters). The breed population size was estimated along with the general information about the herd size, breed characterization and performance. These herds were thoroughly studied on the basis of their breeding history, breeding strategy, geographical location. Morphological identification points were used, for the identification of purebred animals, as individual shepherd.

### *Flock Composition and General Data Collection*

In this study, at first, five villages were randomly chosen from fifteen villages. In every village, 8 herders have been selected who had pure Gadik sheep breed, discuss and distributed questionnaire, 40 individuals were selected randomly for measuring of their morphological characterizations.

### *Morphological Characterization and General Trait Measurement*

In this study, about 40 sheep from five villages randomly were studied, 20 heads of sheep were male and 20 females (from 1-4 years old). The measured traits are: head shape, ear shape, body measurement, tail shape, tail length, body height, testes and teats shape and dimension, body weight, the color of the body, and existence/nonexistence of horns and body weight. The live body weight of each animal was measured using a scale, measuring frame (locally designed), measuring tape, meter sticks, Vernier Caliper, and digital camera (8 mega-pixels), early in the morning before the animals were fed to avoid biases on certain traits due to feed intake (Raja et al., 2012).

### *Statistical Analysis*

Most of qualitative data were analyzed by SPSS software version of 26 and univariate analyses were performed using generalized linear model in R software. Non-parametric data were analyzed using chi-squared statistic and the continuous data through GLM. Least square means were computed for each variable in the model. Metric traits were analyzed using a linear model having effects of location (1-5), sex (1-2), age (1- 4).

## III. RESULTS AND DISCUSSION

**Population structure:** Gadik sheep the native breed of Badakhshan is rearing in some bordering districts like Wakhan, Zebak, Ishkashim, Shughnan, Maymay, Nosay, Kof, Janmarch and Khahan. In Shughnan and other bordering districts most of sheep breeds belong to Gadik, and other breeds have very little population. There is about 77.8% pure breed of Gadik sheep and 13.33% is Turki breed and other breeds have very less population. Due to increase demand for mutton, some of the shepherds preferred to out cross their light weight Gadik sheep (25 kg) with heavy weight Turki sheep (50-55 kg). However, due to less adaptation of Turki sheep to Shughnan weather (cold) and its complex geographical most of the shepherds practiced pure breeding of their Gadik sheep flocks.

After gathering the data, it was found that around 42.5 % of the herders have goat and sheep however, from the table we can understand that about 27.5% of the herders have cattle +sheep + goat and less of the herders have only sheep (Table 1). Because whole the geographical area of Badakhshan is not pave just for sheep, herders can't solve their life affairs just by sheep flocks, also the herders have cattle for using their milk,

meat and working aims, people used the male cattle for plow of lands and work as thresher.

**Table 1. Types of farm animals in Shughnan district Badakhshan province**

Animals	Frequency	Percent
Cattle	5	12.5
Only sheep	3	7.5
Goat & Sheep	17	42.5
Only goat	4	10
Cattle +sheep +goat	11	27.5
TOTAL	40	100

**Flock size and structure:** In Shughnan district every household has small flocks of Gadik sheep with a mean value of  $28.1 \pm 1.9$  individual per flock (Table 2), and it is not similar to Hazaragie sheep flocks such as Hazaragie sheep flocks size is  $28.7 \pm 1.5$  (Musavi et al., 2013). But this is not comparable with the flock sizes reported for other Afghani sheep populations like Karakul sheep (average flock size for Karakul in Afghanistan is 1000 heads) (Khan & Iqbal, 2001). However, the average flock size was smaller than other sheep populations in the world e.g. Indian sheep breeds Shahabadi (Asamoah & Sam, 2016) and Coimbatore (Devendran et al., 2010) and Pakistani sheep breeds (Ibrahim et al., 2011). Gadik sheep flocks were composed of ewes, with a mean value of breeding rams, castrated rams, no castrated rams, most of herders prefer castrated rams and said castrated rams are calm, getting fast weight and have good market. They castrated their rams after yearling, castrated procedure implemented by some men who learnt it from veterinarians and it has been done by burdizzo. The community of Gadik sheep flocks is comparable to Hazaragie sheep flocks (Musavi et al., 2013). But lambs are separated from rams and ewes and always dependently grazed. Average ewe to ram ratio was 15:1, however, this was highly variable, as one breeding ram was used per flock, irrespective of flock size. Ewe to ram ratio was comparable with Indian Shahabadi sheep (Chandran et al. 2013). However, lower than Pakistani sheep breeds, Balkhi, Hashtnagri and Michni (Ibrahim et al., 2011).

**Table 2. The average of Gadik sheep number in a flock.**

Size of Gadik sheep flock	Mean $\pm$ SD
Flock size	$28.1 \pm 1.9$
Ewes	$11.9 \pm 1.5$
Ram/s per flock	$2.9 \pm 0.9$
Lambs	$9.1 \pm 0.9$

**Husbandry practices:** Sheep were appointed under the movable shepherding system i.e. flocks are in spring kept near city and while pasture low land finished moving to

mountain area the duration moving different place. Majority of Gadik sheep farmers were small, landholder and the main occupation are shepherding. Some farmers also hold goats and cattle along with sheep. Animal husbandry practices in the region were based on a little input, little output system.

**Grazing:** Gadik sheep flocks grazing in 3 seasons of the year (spring, summer, and fall). Graze close to the ground, but they utilize different resources on a pasture, it grazed 6 months in the year (3 months in summer, 2 months in autumn and 1 months in spring this is similar to Hazaragie sheep (Musavi et al. 2013) The flocks were allowed to graze up  $2.5 \pm 1.1$  km for  $10 \pm 0.2$  hours every day. Grazing on pasture when will be started which the climate should be rarely warm and there is no snow and snow bank from the last year, about 3 months they grazed on the pasture where is near the villages, after grazing they returned to the pen by shepherds every day, but for 3 months left the villages and carried to transhumant. The grazing system is continuous grazing, they used the pasture repeatedly during the year.

Flocks usually grazed on the hilly, lawn pasture, road side and hill tops as communal not individual. Where pasture condition was ranked middle for 80% of the land; however, a fraction of the land (1.0%) on high elevation had good pasture. The quality of pasture was reportedly good in 3 month of summer, but poor in spring and fall it is so close to Hazaragate lands and pastures (Musavi et al., 2013). Hazarajat and Badakhshan weather and climate is close together so in these regions herders kept sheep flocks at pen and fed them for 6 months. Grazing System of Gadik sheep and Hazaragie sheep is completely different from karakul sheep, karakul sheep grazes all seasons (khan & Iqbal, 2001) in law and hilly pastures. During winter karakul sheep, sometimes need to feed with hay, wheat straw, tree leaves and barley and also in winter some weak sheep keeping at home (Khan & Iqbal, 2001).

At transhumant Gadik sheep are controlled and managed by few women and their family members, there is just one person as shepherd and it is different in the year some years there is not just one person but sheep carry on pasture by two or three people as shift category. At transhumant the weather should be warm and forages increasing, sheep are grazing enough and got full completely, sheep produced much milk and wool. Women process milk and change it to other milk products.

**Shearing practices:** Gadik sheep are shorned twice a year in May when Gadik flocks are in villages and graze in the near pastures also the weather suitable and in September when Gadik flocks are in transhumant. Herders in Shughnan district and in other bordering districts of Badakhshan don't shear their sheep in winter because the weather is cold and has bad effect on their sheep health. This process was done by women most of time, they done it by blade sheare by hands, shearing of one individual takes about  $10.1 \pm 1.9$  minute and depend

on animal and tool condition. The blade shearer is made from metal, the process is the same to report by (Musavi et al., 2022). Same shearing rehearsal are famous for Indian (Devendran et al., 2010) and Pakistani (Ibrahim et al., 2011) sheep populations, however other Indian sheep breeds are sheared 3 times a year (Chandran et al., 2013). **Breeding practices:** Both the restricted and continuous breeding programs were followed in Gadik sheep similar to Pakistani sheep breeds (Ibrahim et al. 2011). Hazaragie sheep (Musavi et al., 2013). About half of the flocks (50.5%) followed restricted breeding pattern (once a year, autumn breeding), resulting in 1 lambing per year during spring. In the remaining flocks, ram stayed always in the flock and they lambed twice per year. Although, lambing can occur throughout the year under this system, most of the lambing was reported during spring and fall seasons. This continuous breeding strategy in Gadik's flocks was similar to the uncontrolled and random mating practice followed by some Indian shepherds in their flocks (Devendran et al., 2010). The Gadik's shepherds were satisfied with their sheep hence used only pure Gadik ram for breeding except very few 41% shepherds used breeding ram their own flock, Age of ram at first breeding raised in (18 months) (Table 3). The findings shown that existence of more breeding rams in the flock not need and important because most of the time the flocks are communally, different herds along with each other, ewes have big chance to mate with rams in the area. one head ram is efficient for their ewes and it is similar to Hazaragie sheep in Afghanistan (Musavi et al., 2013).

Ewes of Gadik got mature between 12 and 20 months of ages depending on feeding and welfare process. Gadik sheep and in general sheep fed on quality forages and grain and mineral supplementation mature much faster. Their estrus cycle averages 17 days; rams are kept together with the flock to ensure high pregnancy rates. One ram will be sufficient for 15 to 40 ewes. Gestation averages about 165 days.

**Table 3.** Reproductive performance of Gadik sheep in flocks

Size of Gadik sheep flock	Mean ±SD
Age at first lambing (months)	18.3±0.7
Gestation length (month)	5.8±0.0
Lambing efficiency (%)	97.1±0.3
Lambing twice/yrs. (%)	45.0±3.33
Litter size %	1.08±0.03
Twining rate%	9.2±0.4
Triplets rate%	0.3±0.1
Age of ram (month)	17.1±0.6
Serving period of ram(month)	6.1±0.6

**Health management and disease prevalence:** About 20% of the flocks take normal vaccination versus common diseases, respects, none of them were de-

wormed. Vaccine is administered by NGOs and foreigner officials. Facility of veterinary services is limited. Mortality level in lambs and adults were in accommodation with Hazaragie breed (Musavi et al., 2013), Indian Coimbatore sheep flocks (Devendran et al., 2010), however, higher than Indian Shahabadi sheep (Chandran et al., 2013). and Pakistani sheep breeds (Ibrahim et al., 2011). Pneumonia, foot rot and Mastitis are the contagious disease among Gadik sheep. In village aren't any animal clinic or any medical centers so herders faced to a lot of challenges and sheep mortality is over (Taylor, 1998).

**Productions:** Gadik sheep actually is reared for producing of meat, milk and wool in Badakhshan province, it has tasting and zest meat with a few fat, most of the fat has been stored in scraps and wattle, production of meat and wool are considerable importance for herders in this province hence they have economic value, getting weight is belong to good feeding program and good environment, a ram which reached to 4 years old has about 18.2±1.8 kg meat, it is comparable to Hazaragie sheep (Musavi et al., 2013). Gadik's fleece compared to other sheep breeds in Afghanistan is soft, but the color is mostly white and brown and percentage of black is partly low. Average fleece production (0.5±0.01 kg/animal/clip) was comparable to Indian Shahabadi (Chandran et al., 2013). and Pakistani Michni sheep, however, less than Balkhi and Hashtnagri (Ibrahim et al. 2011). Most of the fleece (54%) wasted, but the remaining raw fleece was sold in local market on a price of 15.8± 0.1 AFN/kg. it is cheaper than Hazaragie sheep fleece (Musavi et al., 2013). Mean lactation length was 90.5 ± 1.3 days with mean milk yield 0.5 ± 0.1 liter/ewe/day. However, milk yield was higher during summer and an ewe produced on average 0.7±0.2-liter milk/day. The lactation length was not similar to Pakistan Michni sheep, however, was shorter than other Pakistani (Ibrahim et al., 2011) and Indian sheep (Raja et al., 2012). Milk production was higher than Pakistani and Indian sheep.

Also it should be pointed that milk producing is various in a day for example it is less in the morning much in launch and the peak of milk production can reach to about 0.8 liters during the day and it depends on feeding regime, management and environment affections.

Income generation and sheep marketing: Wool market is badly affected in Afghanistan since the last 2 decades, and it generates very little income (Thomson et al., 2005). Mostly sheep and 1-year-old lambs are sold for middlemen. Sheep are also preferred for sacrifice in religious occasions However, the prices goes up before religious occasion, due to increase in demand. Average selling price was highest for rams followed by ewes and lowest for lambs (Table 4). The prices reported were in accordance with the prices reported for lambs (Thomson et al., 2005).



Gadik sheep mostly sold in Eid Qurban, Eid Ramazan and New Year or Nawruz occasionally sold when were sick or infected to disease, were aging, non-productive, cash need at home. Gadik sheep mostly sold

to butchers and middlemen. The average price of a lamb in Badakhshan province specifically in Shughnan district is  $1733.3 \pm 223.6$  AF.

**Table 4. Number of animals consumed and average price of lamb, ewe and ram of Gadik sheep**

Type of animal	Consumed at home (N)	Sold	Average price (AFN)
Lamb	$3.0 \pm 0.1$	$6.0 \pm 0.5$	$1733.3 \pm 223.6$
Ewe	$1.5 \pm 0.5$	$2.1 \pm 0.4$	$2535.6 \pm 513.1$
Ram	$1.1 \pm 0.4$	$1.2 \pm 0.6$	$4091.1 \pm 209.8$

Coat Color and Coverings: Most Gadik sheep had three types of coat colors, such as brown (49.1%), white (25.9%), black (25%) and a mix of them. Wool covered the whole body except the face, limbs, udder, teats, and testes, where the limbs, head, and belly were covered with hair. The percentage distribution of color on different bodies is given in (Table 5). Most of the body parts of Gadik sheep are completely covered with fleece, which is probably an adaptation to the cold environment of the area. The fat-tail of Gadik sheep is covered with fleece. Hooves are tightly in contact with the foot in all of the animals, and it is similar to Hazaragie sheep (Musavi et al., 2013). Having different coat colors in various parts of the body and a lack of fleece in some parts of the body are too similar and significantly comparable to Hazaragie sheep, the breed of Afghanistan

(Musavi et al., 2013). And Kutta sheep, the native sheep breed from northern Pakistan (Ahmad, 2008)). In Afghanistan, sheep breeds have different coat colors; hence, Karakul sheep, the famous and economically important individual, has a majority black and grey color, but white, sapphire, and mixtures of those colors are also found. And also, the majority of its body is covered with fleece except the face, ear, and head, which are covered with hair. It is exactly the same as the Gadik sheep, and it isn't comparable in wool production. 2-2.5 kg per clip with Gadik sheep that produced 0.4-0.5kg per clip (Musavi et al., 2022). If we consider the Hazaragie sheep breed, it also has black, brown, white, and red colors that can be differentiated from Gadik sheep (Musavi et al., 2013).

**Table 5. Gadik sheep coat color on different parts of body (%)**

Body parts	Color		
	Black	White	Brown
Forehead	22.5	30	47.5
Face	22.5	25	52.5
Ear	25	32.5	42.5
Neck	27.5	35	37.5
Loin	22.5	25	52.5
Back	22.5	25	52.5
Belly	27.5	17.5	55
Limbs	30	17.5	52.5
Mean	25	25.9	49.1

Head, Neck, Back and Tail Traits: Estimated marginal means of the majority of morphometric traits and the effect of location, sex, and age are presented in (Table 6). Gadik sheep possess a small size and a thin, short tail, with an average weight of  $25.35 \pm 0.0$ kg (males:  $26.6 \pm 0.40$  kg; females:  $24.1 \pm 0.40$  kg), as shown in (Table 7). And had a roman convex nose. Teeth are right on pad in all of the individuals. Location differences existed for weight traits and animals at Bashar and Wiyar were slightly bigger and heavier as compared to Shedooj, Dashar, and Sarchashma Villages because the two villages have wide pastures with rich wet fodders. Also,

when they fed at the pen, they had enough hay in the winter and continued up to the spring.

Animals had medium-sized heads with a slightly bulging forehead, a tapering face, and shining eyes. The skull was comparatively wide and narrowed at the lower facial parts, and the head was  $12.2 \pm 0.22$  cm long in females and  $12.3 \pm 0.05$  cm long in males, which was affected by location ( $P < 0.001$ ), age ( $P < 0.001$ ) The mean mouth width was  $8.7 \pm 0.22$  cm in females and  $8.8 \pm 0.05$  cm in males and was affected by age ( $P < 0.001$ ) and location  $p < 0.001$  Ewes were characteristically polled; however, rams carrying horns had a mean length, which was affected by sex and age but wasn't affected

by location. In mature males, horns ran backward and grew outward somehow spirally. Horns were black, cylindrical-shaped, roughly triangular in cross section, and pointed at the tip, and these traits are completely matched with Kutta sheep (Ahmad et al., 2009). The adult population had fully developed, floppy (semi-pendulous), laterally protruded, and free of any pricks, small-sized ears with an average length of  $7.3 \pm 0.25$  cm in females and  $6.7 \pm 0.43$  cm in males, and had the same size blade width, which was affected by age, sex, and location. The head is supported by the neck, which has a length of  $19.2 \pm 0.24$  cm in females and  $21.0 \pm 0.05$  cm in males. It also has a girth of  $19.9 \pm 0.33$  cm in females and  $21.0 \pm 0.05$  cm in males, which is affected by location,

sex, and age. The back was slightly curved downward, ending in a thin tail, with a mean length  $16.3 \pm 0.33$  cm in females and  $15.1 \pm 0.19$  cm in females  $25.1 \pm 0.70$  affected by age and sex and not by location; it was comparable to Kutta sheep (Ahmad et al., 2009).

Body size and weight: Gadik sheep is the smallest breed among sheep in Afghanistan (Khan& Iqbal, 2001), if it is compared to other sheep breeds of Afghanistan (Karakul: 40–45, Arabi: 45–50, and Turki: 50–55 kg) (Khan& Iqbal, 2001). And India (Munjal: 44, Muzaffarnagri: 40 kg) (Raja et al., 2012). Hazaragie (35–40) (Musavi et al., 2013). Afghan Baluchi and Kandhari sheep have reported an average weight of 35 kg, which is also heavier than Gadik sheep.

**Table 6. Factors affecting different body measurements in Gadik sheep**

Traits	N	Environmental factors		
		Age	Sex	Location
Head length	40	***	NS	***
Mouth width	40	***	NS	***
Ear blade width	40	***	***	NS
Ear length	40	***	***	NS
Neck length	40	***	***	***
Neck girth	40	***	***	*
Body length	40	***	**	**
Body girth at heart	40	***	NS	NS
Body girth at belly	40	***	NS	NS
Body depth at heart	40	***	**	***
Body depth at belly	40	***	NS	***
Rump width at front	40	***	NS	**
Rump width at belly	40	***	*	***
Rump length	40	***	**	*
Tail length	40	***	*	NS
Body height at wither	40	***	NS	***
Body height at rump	40	***	NS	***
Body weight	40	***	*	***
Horns	20	***	***	NS
Teats length	20	***	NS	NS
Distance b/t two teats	20	***	NS	NS
Scrotal circumference	20	***	NS	*
Testes length	20	***	NS	**

**Table 7. Least square mean for head and neck traits (cm) in Gadik sheep**

Traits	Sex	N	Age class(years)				Overall
			1	2	3	4	
Head length	♀	2	10±0.0	11.2±0.44	13.2±0.44	14.2±0.44	12.2±0.22
		0	0				
	♂	2	11.2±0.44	13.2±0.44	14.2±0.44	12.3±0.05	
		0	.54				

<i>Mouth width</i>	♀	20	7±0.00	8.2±0.44	9.2±0.44	10.2±0.44	8.7±0.22
	♂	20	7.4±0.54	8.2±0.44	9.2±0.44	10.2±0.44	8.8±0.05
						0	
<i>Ear blade width</i>	♀	20	6.4±0.54	7.2±0.44	7.3±0.97	8.2±0.44	7.3±0.25
	♂	20	5.6±0.54	7.2±0.44	6.6±1.34	7.2±0.44	6.7±0.43
<i>Ear length</i>	♀	20	6.4±0.54	7.2±0.44	7.3±0.97	8.2±0.44	7.3±0.25
	♂	20	5.6±0.54	7.2±0.44	6.6±1.34	7.2±0.44	6.7±0.43
<i>Neck length</i>	♀	20	14.4±0.54	16±0.00	22±0.00	24.2±0.44	19.2±0.24
	♂	20	13.4±0.54	15.2±0.44	20.2±0.44	23.2±0.44	21.0±0.05
<i>Neck girth</i>	♀	20	15.8±1.09	17.2±0.44	21.2±0.44	25.2±0.44	19.9±0.33
	♂	20	16.4±0.54	18.2±0.44	23.2±0.44	26.2±0.44	21.0±0.05
<i>Horns length</i>	♂	20	19.8±1.30	21±1.58	23.4±1.14	23.6±0.54	21.9±0.44

**Body Height, Length and Depth:** The mean body height at the withers was 49.9±0.89 cm in females and 50.8±0.89 cm in males, and the rump was 52.1±1.15 cm in females and 53.3±1.33 cm in males, affected by age (P<0.001) and location (P<0.001) (Tables 6 and 8). The withers and back were generally flat. Body length averaged 50.1±0.64 cm in females and 51.6±0.68 cm in males, affected by age (P<0.001), sex (p<0.01) and location (p<0.01). Average body girth at the heart 63.9±0.55 cm in females and 65.1±0.68 cm in males, respectively, affected only by age (P<0.001) and average body girth at the belly was 65.5±0.75 cm in females and 66.2±0.95 cm in males, also affected only by age p<0.001 and it was similar to Kutta sheep (Ahmad et al., 2009). Heart girth and heart belly were a few inches higher in females. Body depth at heart was 22±0.44 cm in female and 23.4±1.94 cm in male, affected by age p<0.001, sex p<0.01 and location p<0.001 and belly was

22.7±0.13 cm in female and 23.3±0.22 cm in male affected by age and location.

The bony frame seemed apparently firm enough to support the animal in grazing over steep flanks and in escaping from wild predators, if any. Rump length was 14.8±0.22 cm in females and 15.2±0.48 cm in males, wide down at the distal end and comparatively wider at the front. 13.8±0.36 cm in females and 13.4±0.48 cm in males, and narrow down at the distal end (11.6±0.22 cm in females and 11.9±0.48 cm in males). Rump length was affected by location (P<0.5), age (P<0.001), sex (P<0.001). Rump width at the front was affected by age (P<0.001), and location p<0.01 whereas rump width at the belly was additionally affected by sex (P<0.5), age (p<0.001) and location (p<0.001). Tail length was 16.3±0.33 cm in females and 15.1±0.19 cm in males and was affected by age (p<0.001) and sex (p<0.5), Tail length was different in males and females, hence ewes

had a longer tail than rams. Body weight is an important trait of the animal; it was  $24.1 \pm 0.40$  kg in females and

$26.6 \pm 0.40$  kg in males. It was affected by age ( $p < 0.001$ ), sex ( $p < 0.05$ ) and location ( $p < 0.001$ ).

**Table 8. Least square mean for body measurement traits (cm) and body weight (kg) in Gadik sheep**

Traits	Sex	N	Age class(years)				Overall
			1	2	3	4	
Body length	♀	20	46.6±1.81	46.2±0.44	52.2±0.44	55.4±0.89	50.1±0.64
	♂	20	47.6±1.81	48.2±0.44	53.2±0.44	57.2±0.44	51.6±0.68
Body girth at heart	♀	20	57.4±1.67	59.4±0.54	63.2±0.44	75.4±0.89	63.9±0.55
	♂	20	58.6±1.81	60.2±0.44	64.2±0.44	77.2±0.44	65.1±0.68
Body girth at belly	♀	20	59.4±1.94	61.2±0.44	64.2±0.44	77.2±0.44	65.5±0.75
	♂	20	60±2.34	61.2±0.44	65.2±0.44	78.2±0.44	66.2±0.95
Body depth at heart	♀	20	21.2±1.48	22±1.00	22.4±0.54	22.4±0.54	22±0.44
	♂	20	22±1.41	22.8±1.09	23.4±0.54	25.4±4.82	23.4±1.94
Body depth at belly	♀	20	21±0.70	23.2±0.44	23.2±0.44	23.2±0.44	22.7±0.13
	♂	20	21.6±0.89	23.2±0.44	24.2±0.44	24.2±0.44	23.3±0.22
Rump width at front	♀	20	12.6±0.89	13.2±0.44	14±0.00	15.2±0.44	13.8±0.36
	♂	20	13±1.41	12.2±0.44	13.2±0.44	15.2±0.44	13.4±0.48
Rump width at belly	♀	20	10.6±0.89	11.2±0.44	11.2±0.44	13.2±0.44	11.6±0.22
	♂	20	11±1.41	11.2±0.44	12.2±0.44	13.2±0.44	11.9±0.48
Rump length	♀	20	13.6±0.89	14.2±0.44	14.2±0.44	17.2±0.44	14.8±0.22
	♂	20	14±1.41	14.2±0.44	14.2±0.44	18.2±0.44	15.2±0.48
Tail length	♀	20	10.8±0.83	13.2±0.44	19.2±0.44	22±0.00	16.3±0.33
	♂	20	9.8±0.83	12.2±0.44	18.2±0.44	20.2±0.44	15.1±0.19
Body height at wither	♀	20	45.2±2.68	46.4±0.89	48.4±0.89	59.4±0.89	49.9±0.89
	♂	20	46.2±2.68	47.4±0.89	49.4±0.89	60.4±0.89	50.8±0.89
Body height at rump	♀	20	47.2±3.19	47.4±0.89	53.4±0.89	60.4±0.89	52.1±1.15
	♂	20	47.8±3.56	48.4±0.89	54.4±0.89	62.4±0.89	53.3±1.33



Body weight	♂	20	13.8±1.64	17.2±2.16	21.8±2.48	23.4±1.67	24.1±0.40
	♀	20	14.8±1.64	18.2±2.16	22.8±2.48	24.4±1.67	26.6±0.40

Teats and Testes: Ewes had two laterally placed teats with an average length of 2.01±0.04 cm, on average 5.98±0.20 cm apart (Table 9). Testes length was 11.05±0.22 cm, and the mean scrotal circumference was 23.85±0.19 cm in rams. Teats in ewes were laterally placed on the udder. Teat length increased with age. Gadik sheep had an average teat length of 1.62±0.13 cm,

which increased to 2.7±0.14 cm at the age of 4 years. Teat length was affected by age (p<0.001) and location had no effect on teat length. In males, testes had a mean length of 11.05±0.22 cm. Age and location were among the significant factors for the testes length and scrotal circumference in Gadik sheep breeding rams ranging in age from 1 to 4 years.

**Table 9. Least squares means for Teat and Testes Traits (cm) in Gadik sheep**

Traits	Sex	N	Age class(year)				Overall
			1	2	3	4	
Teats length (cm)	♀	20	<b>1.62± 0.13</b>	<b>1.74±0.11</b>	<b>1.98±0.04</b>	<b>2.7±0.14</b>	<b>2.01±0.04</b>
Distance b/t two teats (cm)	♀	20	4.38± 0.41	6.2±0.44	6.42±0.04	6.92±0.13	5.98±0.20
Scrotal circumference(cm)	♂	20	19.8±0.83	22.2±0.44	22.2±0.44	31.2±0.44	23.85±0.19
Testes length (cm)	♂	20	9.6±0.89	10.2±0.44	10.2±0.44	14.2±0.44	11.05±0.22

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