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Documentation and morphology of Hazaragie sheep native to central Afghanistan

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ABSTRACT

Hazaragie, an important sheep breed in Afghanistan, is reared mainly for mutton. A survey was conducted in the breeding tract to study habitat, body biometry, management practices and reproductive and productive performance of Hazaragie sheep. Flocks (99) having on average 28.7 ± 1.5 heads/flock were studied. Out of these flocks, 44 animals were sampled randomly for morphological characteristics. About half of the flocks followed restricted breeding pattern i.e. they get just one lambing/year in the spring, however the remaining half of the flocks efficiently (84.8 ± 1.7%) lambed twice per year. The flocks graze for 11.0 ± 0.1 h daily during summer. Shearing is done twice in a year spring and fall with the average wool production of 0.5 ± 0.01 kg/clip animal. The diseases mostly affected young stock and approximately 28.3 ± 1.8% lambs died per flock on an average during the last year. The breed is small in size with an average body weight of 35.0 ± 1.2 kg, body length 45.8 ± 0.6 cm and body height 65.7 ± 0.6 cm. Most of the animals are black, however, variation to brown, red, white and admixture of these colors is also present. Both sexes are generally polled, having flat forehead and predominantly pendulous ears. The breed possesses broad fat tail, sometimes bilobed, having a short tail switch. Differences were observed in a few morphometric traits in different age and sex sheep categories.

Key words: Breeding, Morphology, Morphometric traits, Hazaragie, Performance characterization, Sheep population

Sheep were among the first animals to be domesticated by humankind, sources provide a domestication date between nine and eleven thousand years ago (Ryder 1983). There are many wild breeds of sheep *(Ovis orientalis*) in the mountains from Afghanistan to Armenia which are thought to be the ancestors of the domesticated sheep. Other wild species of sheep e.g. Asiatic *(O. orientalis)* and European *(O. musimon)* mouflon, and urial *(O. vignei)* are also thought to be the ancestors of today's domesticated sheep (Hiendleder *et al.* 1998). According to Rashiq (2004) there are about 8.8 million sheep in Afghanistan, belonging to different native breeds i.e. Karakul, Arabi, Turki, Ghiljai, Baluchi, Kandahari, Gadik and Hazaragie. These breeds are well adapted to the agroclimatic conditions of their home tracts. Unfortunately most of these breeds have not been documented for their characteristics.

Sheep are mainly ketp on grazing for most part of the year. Shepherds migrate with their flocks from plains to hilly areas during summer for grazing. Winter pastures are available in the east and north of the country, where the climate is relatively warm. In other parts of the country, under severe weather conditions during winter, the animals are provided with shelter and are stall-fed at home with roughages, hay, straw and tree leaves. Concentrate supplementation is also provided to weak animals for about 2 months of feed scarcity (Khan and Iqbal 2001). Pastures in Afghanistan are estimated to cover around 40 million ha Afghanistan's nearly 60% of the total land area, and animal husbandry produces an essential component of rural income. About 15 million ha of lowlands and steppes are used for winter grazing, while 25 million ha of mountainous lands serve as spring and summer pastures (Azimi 2007).

Generally livestock breeds are still needed to be characterized in most of the developing countries. Local breeds, that have adopted specific characters for survival in a certain environment, are extensively crossbred in order to obtain heavier-sized offspring resulting in loss of genetic diversity and reduction in effective population size (Taberlet *et al*. 2011). In some cases local breeds get extinct or are at the risk of extinction before their characteristics are properly described and studied. Information about the morphology and performance characteristics of indigenous breeds helps in developing reliable and sustainable selection programs for livestock breeding (FAO 2007).

The Hazaragie population and breed is documented, but none of the previous documents have defined the

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characteristics of this breed. The present study was focused on the identification of purebred flocks of Hazaragie sheep in central Afghanistan, evaluation of performance of these flocks under different management practices and morphological characterization of randomly selected individuals from these flocks.

MATERIALS AND METHODS

Field survey for identifying purebred flocks: The study encompass a field survey of Panjab district which is part of the breeding tract of Hazaragie sheep in the central Afghanistan. Hazaragie flocks at the villages and remote areas were visited, as per sampling strategy. These flocks were thoroughly studied on the basis of their breeding history, breeding strategy and geographical location. Previously described morphological traits (Masson 1996) and local shepherds were consulted for the identification of purebred animals.

Flock composition and general data collection: Personal interviews were conducted with shepherds and information was collected for every purebred flock present in the area. General information for each flock i.e. flock size, breed, shepherding system, flock structure, breeding plan, management practices, reproductive performance, feeding regime, health problems, mortality and marketing was recorded on a pre defined questionnaire.

Morphological characterization and general trait measurement: Total number of 44 individual (six rams and 38 ewes) were sampled from different locations within the breeding tract for morphological characterization. The morphological observations and morphometric traits were recorded on the proforma, developed as per the guideline from the FAO (1986).

Statistical analysis: Per cent distribution and arithmetic means of flock and morphological data were calculated using computer software program SPSS 10.0. In additions, differences in performance parameters among flocks raised under different management practices, and in morphometric traits among different sheep categories were calculated using one-way analysis of variance (ANOVA) test in SPSS program.

RESULTS AND DISCUSSION

Little is known about the sheep production and their resources in Afghanistan. Hazaragie sheep, a small size mutton type fat-tailed breed found in central Afghanistan (completely mountainous area; from Kabul to Herat also called Hazarajat), contributes about 7% to the total sheep population in the country (Rashiq 2004). The breed is given the name because of the Hazara tribe, who keeps the sheep and is responsible for the development of Hazaragie flocks. The breed is well adapted to the cold environmental condition of region, where mean temperature falls to –15°C or lower in highest mountain areas in January; summer temperature vary from 0 to 26 depending on altitude, mean annual precipitation, which is mostly snowfall is about 40 cm (Peter and Blood 2001). Genetic characterization using simple sequence repeat (SSR) markers revealed high level of heterozygosity and allelic richness in Hazaragie population, suggesting that the breed has maintained its genetic diversity, purity and population size (Musavi *et al*. 2011). The description of their flock structure, breeding strategy, management practice, performance and morphology are discussed here.

Population structure: The total population of Hazaragie sheep in Afghanistan is reportedly 0.6 million (Rashiq 2004), majority of which is distributed in central Afghanistan (Mason 1996). According to FAO (2008) Bamyan province in central Afghanistan harbor 227,650 sheep heads distributed in 6 districts. Waras and Panjab districts in Bamyan province have pure Hazaragie sheep with a population density of 81,242 and 39,951 individuals, respectively. Other districts possess mixed Arabi, Hazaragie and crossbred populations.

Flocks (99: containing 1,251 heads) were selected randomly from the breeding tract (Panjab district) for data collection. Out of the total surveyed population 85% were pure Hazaragie animals (Fig. 1). Arabi rams used for crossbreeding with Hazaragie ewes were 2% of the total population. The remaining 13% were crossbred animals converted from pure Hazaragie due to continuous crossbreeding with Arabi. Due to increase demand for mutton, some of the shepherds preferred to out cross their light weight Hazaragie sheep (35 kg) with heavy weight Arabi sheep (45–50 kg). However, due to less adaptation of Arabi and their crossbred to the cold winter, most of the shepherds practiced pure breeding of their Hazaragie flocks. Based on

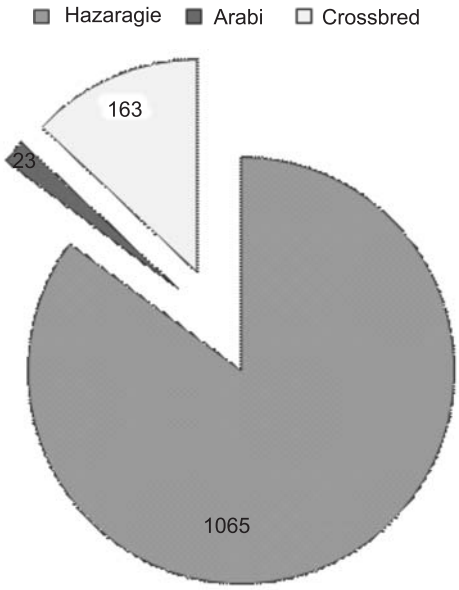

Fig. 1. Population of native Hazaragie and crossbred animals in Punjab district of Bamyan province.

Table 1. Mean size and flock structure of Hazaragie flock

Size of Hazaragie flock	Mean±SE
Flock size	28.7±1.5
Ewes	14.4±0.8
Ram/s per flock	1.0±0.0
Lambs/flock	13.4±0.8

the guideline laid by FAO (2007), the considerable pure breeding of Hazaragie sheep suggested that the population is out of risk of extinction; however, efforts are required for improved performance and development.

Flock size and structure: Hazaragie sheep in Panjab district of Afghanistan were raised in small flocks. Flock size ranged from 9 to 74 sheep with a mean value of 29 individuals per flock (Table 1). This is comparable with the flock sizes reported for other Afghani sheep populations except Karakul sheep (average flock size for Karakul in Afghanistan is 1000 heads) (Khan and Iqbal, 2001). However, the average flock size was smaller than other sheep populations in the world e.g. Indian sheep breeds Shahabadi (Chandran *et al*. 2013) and Coimbatore (Devendran *et al*. 2010) and Pakistani sheep breeds (Ibrahim *et al*. 2011).

The Hazaragie flocks were composed of ewes, breeding ram and lambs. On average the ratio of adult ewes to lambs was almost equal in a flock despite high percentage of mortality reported in the lambs. This data suggested high lambing efficiency as evidence from reproductive performance of flocks (Table 2). 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 ration was comparable with Indian Shahabadi sheep (Chandran *et al*. 2013), however, lower than Pakistani sheep breeds, Balkhi, Hashtnagri and Michni (Ibrahim *et al*. 2011).

Husbandry practices

Sheep were raised under the sedentary shepherding system i.e. flocks are reared at the same place throughout the year. Majority of Hazaragie sheep farmers were small, marginal or landless laborers and sheep rearing was their main occupation. Some farmers also maintained cattle and goats along with sheep. Animal husbandry practices in the region were based on a low input, low output system.

Grazing and feeding practices: During summer (1 month of fall 3 months of summer and 2 months of spring), Hazaragie flocks entirely depend upon grazing (Khan and Iqbal 2001). At this time the flocks were allowed to graze up to 6.4 ± 0.2 km for 11.0 ± 0.1 h/ day. Flocks usually grazed on the hilly locations, where pasture condition was ranked middle for 93.9% of the land; however, a fraction of the land (2.0%) on high elevation had good pasture. The quality of pasture was reportedly good in 3 month of summer, but poor in spring and fall.

Hazarajat is the coldest area in Afghanistan, and during winter (1 month of spring, 3 months of winter and 2 month of fall) the sheep were fed in house usually on the hay of Hepsophyle, alfa alfa and grass. Previous studies reported the use of roughages, straw, tree leaves and also concentrates during winter (Khan and Iqbal 2001). Similar feeding practice is employed for Pakistani sheep breeds raised under sedentary system (Ibrahim *et al*. 2011). However, in contrast some of the Indian sheep breeds exclusively depend upon grazing throughout the year (Devendran *et al*. 2010, Chandran *et al*. 2013).

Shearing practices: Shearing was done twice a year during spring and fall similar to reported earlier by Khan and Iqbal (2001). Similar shearing practices are reported for Indian (Devendran *et al*. 2010, Yadav *et al*. 2011) and Pakistani (Ibrahim *et al*. 2011) sheep populations, however other Indian sheep breeds are sheared 3 times a year (Arora *et al*. 2007, Chandran *et al*. 2013).

Breeding practices: Both the restricted and continuous breeding programs were followed in Hazaragie sheep similar to Pakistani sheep breeds (Ibrahim *et al*. 2011). 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 Hazaragie flocks was similar to the uncontrolled and random mating practice followed by some Indian shepherds in their flocks (Devendran *et al*. 2010, Chandran *et al*. 2013).

The Hazaragie shepherds were satisfied with their sheep hence used only pure Hazaragie ram for breeding except very few — 68.7% shepherds used breeding ram their own flock, however, 31.3% of them used elite rams. Age of ram at first breeding raised in (11 months) was similar to Indian (Raja *et al*. 2012,Chandran *et al*. 2013) and Pakistani sheep breeds (Ibrahim *et al*. 2011), however, their breeding life was much longer than that reported for Hazaragie sheep.

Health management and disease prevalence: About half (49.5%) of the flocks received regular vaccination against common diseases, however, none of them were dewormed. Veterinary treatment to diseased animals was very limited due to lack of veterinary hospitals and lack of awareness. Pneumonia was the main reason for higher mortality rate in lambs during winter. On average 28.3 ± 1.8% lambs and 12.8 ± 0.9% adults died per flock during the last year. Mortality rates in lambs and adults were in accordance with 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).

Reproductive performance under different breeding program: Different reproduction parameters recorded from the flocks were compared in flocks following different breeding programs (Table 2). Different breeding strategies

Table 2. Reproductive performance of Hazaragie sheep in flocks following different breeding strategy

Trait	Overall	Breeding strategy		Sig.
		Restricted	Continuous	
Age at first lambing (month)	11.5±0.1	11.9±0.04	11.0±0.2	***
Gestation length (month)	5.0±0.0	5.0±0.0	5.0±0.0	NS
Lambing efficiency (%)	98.3±0.8	99.5±0.5	97.0±1.6	NS
Lambing twice/yr (%)	42.0±4.4	-	84.8±1.7	***
Litter size	1.09±0.01	1.06±0.01	1.11±0.01	*
Twining rate	8.4±0.9	5.9±1.1	10.9±1.5	**
Triplets rate	0.5±0.2	0.3±0.2	0.8±0.4	NS
Age of ram (month)	16.8±0.6	17.8±0.9	15.8±0.8	NS
Serving period of ram (month)	6.0±0.5	6.7±0.8	5.3±0.6	NS

NS,Nonsignificant; *,P<0.05; **,P<0.01; ***,P<0.001.

in the flocks not only affected lambing twice/year, but also age at first lambing, litter size and twinning rate. Hazaragie ewes at continuously bred flocks conceived earlier for the first time because of the uncontrolled breeding and presence of ram always in these flocks. Age at first lambing reported for Hazaragie sheep was much smaller than Indian (Yadav *et al*. 2011, Raja *et al*. 2012) and Pakistani sheep breeds (Ibrahim *et al*. 2011).

Despite the younger ewes used for breeding, the lambing efficiency of Hazaragie ewes was higher than that reported for Pakistani sheep populations. Flocks following continuous breeding programs also received 2 lambings/ewe/year with much higher efficiency than Pakistani sheep breeds (Ibrahim *et al*. 2011). This character in principle depends on the management practices, under good management Hazaragie reproduce well in both seasons of the year. Litter size and twinning rate were also higher in flocks following continuous breeding strategy, probably because of high number of lambing they obtained per year.

Fleece and milk production: Mutton and wool were the main economic traits and wool is of considerable importance as the breed is reported to produce carpet quality wool (Mason 1996). The fleece of Hazaragie sheep compared to other sheep breeds in Afghanistan is soft, but the color is mostly black and brown and percentage of white is extremely 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 (56%) wasted, but the remaining raw fleece was sold in local market on a price of 49.8 ± 0.9 AFN/kg.

Mean lactation length was 138.2 ± 1.1 days with mean milk yield 0.7 ± 0.02 litre/ewe/day. However, milk yield was higher during summer and an ewe produced on average 1.0 ± 1.1 litre milk/day. The lactation length was almost similar to Pakistan Michni sheep, however, was longer than other Pakistani (Ibrahim *et al.* 2011) and Indian (Raja *et al*. 2012) sheep. Milk production was higher than Pakistani and Indian sheep.

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 (Table 3). Sheep are also preferred for sacrifice in religious occasions. Average selling price was highest for rams followed by ewes and lowest for lambs (Table 3). The prices reported were in accordance with the prices reported for lambs by Thomson *et al*. (2005). However, the prices goes up before religious occasion, due to increase in demand.

Morphology of Hazaragie sheep: Rams used for breeding were mostly in the age group of 1 to 2 years; however, ewes up to 4-year-old were also found in the flocks.

Body color and fiber cover: Hazaragie sheep are predominantly black, however, white, red, brown and mixture of these colors are also found. Per cent distribution of color on different body parts in male and female Hazaragie sheep is given in Table 4.

Most of the body parts of Hazaragie sheep are completely covered with fleece, which is probably an adaptation to the cold environment of the area. Head and face regions are devoid of fleece, however, other body parts including loin, back, belly and limbs were covered with fleece in all of the animals. Fat-tail of Hazaragie sheep is covered with fleece in 43.2% animals. In contrast sheep populations found in other warmer countries such as Pakistan and India are usually covered with fleece only on loin and back (Ibrahim *et al.* 2010, Raja *et al.* 2012)

Appearance of different body parts: Similar to most of the domesticated sheep breeds Hazaragie sheep are generally polled. The animals possess flat forehead with a straight nose in most of the cases (95.5%), however, specimens having slightly convex nose are also observed in low frequency (4.5%). Teeth are right on pad in all of the individuals; however, congenital defect such as ear buds could be seen in 4.5% individuals. A fraction (4.5%) of the sampled individuals had erect ears, but most of them had pendulous ears (68.2%). Shining eyes were observed in most of the individuals (93.2%).

Majority of the individuals possessed broad fat-tails without lobes (84.1%) with a tail switch. The tail switch appeared to emerge from the distal part of the tail, goes

Table 3. Number of animals consumed and average price of lamb, ewe and ram of Hazaragie sheep

	Consumed at home	Sold	Average price (AFN)
Lamb	3.5±0.1	7.5±0.5	2464.5±87.7
Ewe	0.9±0.2	1.2±0.2	3360.5±1.0
Ram	0.1±0.03	0.7±0.1	4681.6±2.6

Table 4. Color of different body parts in Hazaragie sheep (%)

Body part		Color			
		Black	White	Red	Brown
Forehead	Overall	34.1	50.0	9.1	6.8
	Ram	50.0	33.3	16.7	-
	Ewe	31.6	52.6	7.9	7.9
Face	Overall	47.7	31.8	9.1	11.4
	Ram	50.0	16.7	16.7	16.7
	Ewe	47.4	34.2	7.9	10.5
Ear	Overall	70.5	6.8	15.9	6.8
	Ram	66.7	-	33.3	-
	Ewe	71.1	7.9	13.2	7.9
Neck	Overall	63.8	15.9	4.5	15.9
	Ram	66.7	-	16.7	16.7
	Ewe	63.2	18.4	2.6	15.8
Loin	Overall	65.9	13.6	4.5	15.9
	Ram	66.7	-	16.7	16.7
	Ewe	65.8	15.8	2.6	15.8
Back	Overall	63.6	15.9	4.5	15.9
	Ram	50.0	16.7	16.7	16.7
	Ewe	65.8	15.8	2.6	15.8
Belly	Overall	65.9	13.6	4.5	15.9
	Ram	66.7	-	16.7	16.7
	Ewe	65.8	15.8	15.8	15.8
Limbs	Overall	69.5	13.6	4.5	15.9
	Ram	66.7	-	16.7	16.7
	Ewe	65.8	15.8	2.6	15.8

upwards and then curves downward. Some of the individuals (15.9%) also carried bi-lobed fat-tails with a tail switch. The appearance of fat-tail and the presence or absence of a tail switch is sometimes considered as a characteristic morphological feature of a particular sheep breed (Pourlis 2011). Hooves are tightly in contact with foot in all of the animals.

Head and neck measurements: Mean measurement values (cm) for head and neck parameters in different age and sex categories of sheep are presented in Table 5. Hazaragie was a small-size sheep breed having smaller size of head compare to Pakistani sheep populations (Ibrahim *et al*. 2010). Head length ($P<0.05$) and girth below eyes ($P<0.01$) was significantly different in different age group animals. The breed possessed long pendulous ears which were similar in size in different animals, however, the distance between ears significantly varied ($P<0.001$) among different sex and age group animals. Other head and neck parameters remained similar among different animals.

Body size and weight: Hazaragie is a lighter weight breed compared to other sheep breeds of Afghanistan (Karakul: 40–45, Arabi: 45–50 and Turki: 50–55 kg) (Khan and Iqbal 2001), and India (Munjal: 44, Muzaffarnagri: 40 kg) (Yadav *et al*. 2012, Table 6). Afghan Baluchi and Kandhari sheep have reported average weight of 35 kg which is similar to Hazaragie. However, the breed was heavier than Gadik (28–35 kg), which is the smallest sheep breed of Afghanistan (Khan and Iqbal 2001). Although, mean body weight is similar among different age and sex categories of Hazaragie

Table 5. Mean measurments (cm) for head and neck traits in Hazaragie sheep

Head and neck traits			Overall Age (years)			
			1	2	3	4
Head length	Overall	16.8±0.3	15.4±0.6	16.4±0.4	17.4±0.4	17.9±0.6
	Ram	15.5±0.7	15.5±1.0	15.5±1.5	-	-
	Ewe	17.1±0.3	15.4±0.8	16.7±0.3	17.4±0.4	17.9±0.6
Ear length	Overall	12.0±0.6	12.8±0.9	12.0±1.0	11.2±1.0	12.8±1.0
	Ram	13.9±0.3	13.5±0.1	14.5±0.5	-	-
	Ewe	11.8±0.7	15.4±0.9	11.5±1.2	11.9±1.9	11.8±0.7
Neck length	Overall	30.8±0.8	28.6±0.9	30.0±0.8	31.7±0.9	29.9±1.0
	Ram	27.7±1.0	27.0±0.1	28.0±0.9	-	-
	Ewe	30.7±0.7	26.1±0.8	30.0±0.9	31.1±0.9	29.9±0.1
Neck girth	Overall	30.6±0.5	30.3±0.7	30.0±1.0	29.6±0.9	32.5±1.6
	Ram	31.6±1.0	31.5±1.8	32.5±0.5	-	-
	Ewe	30.6±0.6	29.6±0.4	29.4±1.2	29.6±0.8	32.5±0.8
Head girth above eyes	Overall	15.4±0.4	14.3±0.7	15.0±0.5	15.5±0.7	15.7±0.8
	Ram	15.4±1.0	15.0±1.4	16.0±2.0	-	-
	Ewe	15.1±0.4	13.6±0.7	14.9±0.4	15.5±0.6	15.6±0.8
Head girth below eyes	Overall	24.6±0.2	23.6±0.4	23.9±0.4	25.5±0.9	25.7±0.7
	Ram	23.9±0.7	24.0±0.7	23.5±0.5	-	-
	Ewe	24.7±0.2	23.0±0.8	23.9±0.4	25.5±0.9	25.7±0.7
Distance from ear to ear	Overall	13.1±0.4	13.2±0.7	14.0±0.7	13.3±0.5	15.8±0.9
	Ram	15.5±0.8	14.5±0.7	17.5±0.5	-	-
	Ewe	13.8±0.3	12.2±1.0	13.4±0.5	13.4±0.5	15.8±0.9

Table 6. Mean measurements (cm) for body size and weight in Hazaragie sheep

Body size		Overall	Age (years)			
			1	2	3	4
Body length	Overall	45.8±0.6	42.0±0.9	46.0±1.0	47.8±0.9	46.8±1.4
	Ram	43.4±1.2	42.5±1	45.0±2	-	-
	Ewe	46.5±0.6	41.6±0.9	46.4±1	47.8±0.9	46.8±1.4
Body width at belly	Overall	30.5±0.8	27.4±1.0	30.9±2.5	30.7±1	32.8±1.5
	Ram	33.4±4.3	28.3±1.7	43.5±10.5	-	-
	Ewe	29.9±0.8	26.6±1.6	28.1±0.7	30.7±1.1	32.8±1.9
Body depth at heart	Overall	19.2±0.9	16.8±1.7	19.0±1.3	17.9±1.2	17.9±1.2
	Ram	19.0±0.7	18.5±0.7	20.0±2	-	-
	Ewe	19.3±1.0	15.4±2	18.9±1.9	21.7±2	17.9±1.2
Body depth at belly	Overall	23.8±0.7	22.2±1	24.8±1.5	23.8±1	22.9±2.8
	Ram	21.9±2.8	21.8±2	23.8±1	-	-
	Ewe	23.7±0.8	22.0±7	23.8±1	22.9±2.8	22.9±2.8
Height at withers	Overall	65.7±0.6	63.0±1.0	65.9±1	66.9±1	66.3±1
	Ram	65.9±1.8	64.0±1.9	69.5±2.5	-	-
	Ewe	65.7±0.6	62.2±1.0	65.0±09	66.9±1	66.3±1
Height at rump	Overall	65.1±0.7	65.8±2.3	65.5±1	66.3±0.9	66.8±1
	Ram	67.7±3.3	67.0±4.9	69.0±1	-	-
	Ewe	65.8±0.6	64.8±2.0	64.7±1	66.3±0.9	66.4±1
Body girth at heart	Overall	78.8±0.9	73.8±1.4	78.7±1.3	80.8±1.5	82.7±1.8
	Ram	75.9±1.9	75.3±2.8	77.0±2	-	-
	Ewe	79.6±0.9	72.6±1.0	78.6±1.5	80.8±1.4	82.7±1.8
Body girth at belly	Overall	94.6±1.4	88.8±1.6	94.6±2.4	96.4±2.4	97.7±4
	Ram	92.7±2.0	91.3±2.9	95.5±0.5	-	-
	Ewe	94.9±1.6	86.8±1.4	94.1±2.8	96.4±2.4	97.7±4
Rump length	Overall	16.7±0.7	16.1±0.8	17.0±0.6	15.9±0.6	18.3±1
	Ram	15.4±0.5	15.5±0.7	15.0±1	-	-
	Ewe	16.9±0.5	16.6±0.7	17.5±0.7	15.9±0.7	18.5±1
Body weight (kg)	Overall	35.0±1.2	30.2±1.3	34.8±1.7	36.4±2.3	38.4±3.0
	Ram	34.3±1.7	32.8±2.0	37.5±2.5	-	-
	Ewe	35.2±1.3	28.2±1.1	34.2±2.0	36.4±2.3	38.4±3.0

sheep, body length (P<0.05) and width (P<0.001) vary significantly with the age of the animals. Furthermore, rams are significantly (P<0.001) wider than ewes. Mean body length is shorter than Indian (Yadav *et al*. 2012, Raja *et al*. 2012) and Pakistani (Ibrahim *et al*. 2010) sheep breeds.

Body height at withers and girth at heart varied (P<0.05) in different age group animals, however, height at rump and girth at belly were similar. Rams were relatively higher at rump than at withers. Average body height recorded in Hazaragie sheep was less than Indian (Yadav *et al*. 2012, Raja *et al*. 2012) and Pakistani (Ibrahim *et al*. 2010) sheep breeds. However, wither height in Hazaragie was more than Zambian fat-tailed sheep (Pares-Casanova *et al*. 2013). Other body measurements were similar among different age and sex categories of the breed.

Tail and limbs measurements: The breed possess a broad fat tail, short in length with a tail switch. On average tail was relatively but not significantly broader in rams and longer in ewes (Table 7). Tail length of the Hazaragie sheep was shorter than Indian Munjal and Muzaffarnagri sheep (Yadav *et al*. 2011, 2012), and Pakistani Hashtnagri and Michni sheep, however, was similar to Balkhi sheep (Ibrahim *et al*. 2010). The diameter of tail switch was more at base and getting narrowed towards the tip (Table 7). All other tail and limbs measurements recorded were similar among different sheep categories except shank circumference, that varied significantly (P<0.05) among different age group animals.

Measurements of male and female reproductive organs: Average values for male and female reproductive organs for

Table 7. Mean measurements (cm) for tail and limbs in Hazaragie sheep

Tail, and limbs traits			Overall Age (years)			
			1	2	3	4
Tail height from the ground	Overall	29.9±0.5	28.6±1	29.5±0.9	30.7±1	29.1±1
	Ram	28.5±1	28.7±1.7	28.0±0.0	-	-
	Ewe	30.0±0.6	28.6±2	29.9±1	30.7±1	29.1±1
Tail length	overall	23.5±0.4	21.9±0.6	23.5±0.1	23.5±0.8	25.3±0.8
	Ram	22.0±0.6	21.8±0.9	22.5±0.5	-	-
	Ewe	23.7±0.5	22.0±1	23.8±1	23.5±0.8	25.3±0.8
Tail circumference	Overall	30.8±0.7	29.9±1.8	29.9±1.4	32.0±0.7	27.3±1.6
	Ram	31.8±1.7	31.5±2.6	32.5±1.5	-	-
	Ewe	26.9±0.7	28.6±2.6	29.3±1.7	32.0±0.7	27.3±1.6
Tail switch diameter at base	Overall	1.0±0.1	1.3±0.3	0.7±0.3	1.0±0.2	1.8±0.9
	Ram	0.8±0.4	1.1±0.4	-	-	-
	Ewe	1.2±0.1	1.4±0.4	0.7±0.3	1.0±0.2	1.8±0.2
Tail switch diameter at mid	Overall	0.6±0.08	0.6±0.1	0.3±0.1	0.6±0.1	1.0±0.2
	Ram	0.4±0.2	0.6±0.2	-	-	-
	Ewe	0.6±0.08	0.6±0.1	0.4±0.2	0.6±0.1	1.0±0.2
Tail switch diameter at tip	Overall	0.3±0.04	0.4±0.07	0.2±0.07	0.4±0.05	0.6±0.1
	Ram	0.3±0.1	0.3±0.1	-	-	-
	Ewe	0.4±0.04	0.4±0.01	0.2±0.08	0.3±0.05	0.6±0.1
Sole to elbow	Overall	31.1±1.0	29.8±1.7	34.6±2.9	30.9±1.6	33.1±1.4
	Ram	33.9±1.9	32.8±2.6	36.0±2	-	-
	Ewe	31.7±1.1	27.4±0.9	34.4±3.5	30.9±1.7	33.3±1.4
Forelimb circumference	Overall	13.1±0.2	14.1±0.4	13.6±0.7	13.9±0.2	14.4±0.4
	Ram	14.7±0.4	15.0±0.4	14.0±1.0	-	-
	Ewe	13.9±0.2	13.4±0.4	13.6±0.8	13.9±0.2	14.4±0.4
Shank circumference	Overall	12.6±0.2	11.8±0.5	12.7±0.7	12.3±0.6	13.5±0.9
	Ram	13.0±0.5	12.8±0.8	13.5±0.5	-	-
	Ewe	12.6±0.2	11.0±0.6	12.0±0.7	12.3±0.6	13.5±0.9
Thigh circumference	Overall	16.1±0.6	15.8±0.6	15.6±0.7	16.8±0.7	16.5±0.5
	Ram	16.6±0.7	15.8±0.7	17.0±1	-	-
	Ewe	16.1±0.3	15.8±0.8	15.2±0.8	16.8±0.7	16.5±0.5

Table 8. Mean measurements (cm) of reproductive organs in Hazaragie ewes and rams

Size of reproductive organs	Overall	Age (years)			
		1	2	3	4
Teat length (ewes)	2.6±0.08	2.2±0.2	2.4±0.2	2.8±0.1	2.8±0.1
Teat to teat distance (ewes)	8.3±0.5	6.8±0.5	8.1±1.3	9.0±0.6	8.3±1.5
Scrotum diameter (rams)	4.7±0.5	4.8±0.6	4.7±1.3	-	-
Testes length (rams)	12.7±1.2	11.5±1.3	15.0±2	-	

Hazaragie ewes and rams are presented in Table 8. The sampled ewes possessed well developed udder with medium sized and well defined teats, 8 cm apart from each other on average. Measurement values for teats and testes did not varied across different age groups of ewes and rams.

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