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SOHAIL AHMAD

MUHAMMAD SAJJAD KHAN

M. FATAH ULLAH KHAN

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Factors affecting wool characteristics of Kari sheep in Pakistan

Sohail AHMAD[1], Muhammad Sajjad KHAN[1,*], Muhammad Fatah Ullah KHAN[2]

[1]Department of Animal Breeding and Genetics, University of Agriculture, Faisalabad 38040, PAKISTAN

[2]Pakistan Agricultural Research Council, Islamabad, PAKISTAN

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Abstract: The present study attempted to generate some basic information on wool production and quality in the Kari breed. Thirty flocks, 10 each in the 3 Union Councils (UCs), were registered for on-farm performance recording in the Lotkho Tehsil, north of Chitral city. Two animals per flock were selected for collecting fleece samples from 3 yearly shearings. The actual greasy wool yield per sheep was 937 g. Wool yield per shearing averaged 366 ± 9.6 g. Location and flock differences were found significant ($P < 0.01$). The same was also true for the clean fleece yield with an overall average of 300 ± 8.2 g per shearing. The fibre diameter averaged 23 ± 0.2 µm, and flock differences were significant ($P < 0.01$). The staple length varied among flocks ($P < 0.01$), locations, and shearing season ($P < 0.05$). Male Kari had more medulated fibres than female Kari (6.9 ± 0.37% vs. 5.5 ± 0.37%). The greasy and clean fleece yields were quite repeatable traits (repeatability > 0.5). The repeatability estimates of fibre diameter and staple length were 0.38 and 0.20, respectively. Sheep of 3-4 years of age had maximum fleece yield, while there was a declining trend thereafter. As the area is not approachable during winter season, research and developments efforts can be effective if nuclei could be established in the Lotkho area.

Key words: Wool quality, wool yield, repeatability, sheep

Introduction

In the extreme north-west of Pakistan, in the rugged mountainous region of the Hidukush and Karakuram ranges, lies the Chitral. Northern and western borders of the district touch Afghanistan. The district consists of 35 narrow and deep valleys. Of the total land area, 62% is rangeland with sparse vegetation, 24% are glaciers and snow, 4% are forest, while 3% is left for agriculture (1). About 50% of the rangeland area is available for grazing to domestic and wild animals on flanks and upper peaks of mountains (2).

Attempts to document the animal genetic resource of the area in the past have been lacking. A survey on 'Patti' production (3) identified Kari as an indispensable sheep breed for Patti production, contributing to the socioeconomic status of the local people. In fact, Patti is a handmade woollen cloth, 30-35 cm in width and 18 m in length, made from wool. The natural coloured wool of white, brown, and black is used for this purpose. Walnut husk is also used to colour the white wool to other shades of brown. The typical headgear and warm waistcoats worn in the area and in other parts of the country are made from it.

* E-mail: drsajjad2@yahoo.com

The Kari population is quite limited (probably less than 15,000), but demand is quite high, especially during social and cultural festivals. Mutton consumption in winter season also increases up to 22% at the household level. Nevertheless, Patti production remains the major objective for keeping Kari flocks. This serves as a source of continuous income for the poor farming families. The only report on wool production from the Kari breed is a limited sampling study containing information on wool quality (4).

The objective of the study was to generate basic information on wool production, its quality for future breeding, and the development of the Kari sheep breed.

Materials and methods

Location and the climate: The study area comprised 3 union councils (UCs), named Garam-Chashma, Karimabad and Shoghoor, in the Lotkho Tehsil to the north of Chitral City. Garam-Chashma is the largest of 3 UCs and comprises several valleys including Begusht, Overk, Munnor, Murdan, and Goboor. It shares its border with Afghanistan to the north and west. Altitude of the area varies form 2000 m at Izh, to about 5000 m at the southern peaks. Karimabad comprises the Karimabad and Parsan valleys. Shoghoor lies 45 km to the north-east of Chitral City. Arakri is the only valley constituting the Shoghoor UC. The valley ranges in elevation from 2440 m at Mizhigram, to 7700 m at Tirichmir peak, with several peaks over 6000 m. People live in scattered settlements in these valleys and maximize the utilization of the available cultivable land mass (5).

Flock registration and data recording: Thirty flocks, 10 each in the 3 UCs, were registered for on-farm and on-field sheep performance recording. Owners having at least 10 adult ewes were registered. The data collectors, one at each of the UCs, were trained in using the electronic (hanging) weighing scale for collecting wool samples. A typical ram, either selected from the farmer's own flock or from other registered flocks, was donated to the farmer at the time of registration to perform as the solitary sire in their respective flock until the end of the study. Two animals, including the sire and an ewe, were randomly selected from each flock and used for collecting wool samples for all 3 shearings in a calendar year. Registered shepherds were given periodic on-farm training for using pre-labelled zip-lock polythene bags for fleece samples clipped from the selected sheep. Farmers were facilitated for vaccination and deforming, and were provided with urea molasses blocks during the study period (2004-2006). After recording the weight, the samples were coded and analyzed at the National Agricultural Research Centre (NARC), in Islamabad for fibre characteristics including yield (%), fibre diameter (μm), standard deviation of fibre diameter (μm), staple length (cm), medulation (%), and bulk (cm^3/g). Monitoring for recording fleece yield at Garam-Chashma UC was not consistent, and data were incomplete for all 3 shearings. Therefore, for greasy fleece yield on all age classes, data from the other 2 UCs were used.

Statistical analysis: Data on annual greasy fleece yield from animals of different age classes (n = 258) in the Karimabad and Shogoor UCs were analysed by using the following model:

$$Y_{ijklm} = \mu + L_i + F_{ij} + X_k + A_l + e_{ijklm} \qquad \text{[Model 1]}$$

where

- Y_{ijklm} = Annual greasy fleece yield recorded on individual sheep
- μ = Population mean
- L_i = Effect of location (i = 2)
- F_{ij} = Effect of the flock within location (j = 19)
- X_k = Effect of sex (k = 2)
- A_l = Effect of age (l = 6)
- e_{ijklm} = Random error associated with individual observation

The fleece yield and quality parameters (greasy fleece yield per shearing (g), clean fleece yield per shearing (g), yield (%), fibre diameter (μm), standard deviation of fibre diameter (μm) staple length (cm), medulation (%) and bulk (cm^3/g)) information recorded for one adult male and one female from all the registered flocks in the 3 UCs, was collected for all 3 shearings during the year under the study ($3 \times 10 \times 2 \times 3 = 180$). A general linear model was used to analyze various traits. The statistical model was as under:

$$Y_{ijklm} = \mu + L_i + F_{ij} + S_{ijk} + X_l + e_{ijklm} \quad \text{[Model 2]}$$

where

Y_{ijklm} = Measurement on a particular trait

μ = Population mean

L_i = Effect of location (i = 3)

F_{ij} = Effect of the flock within the respective location (j = 30)

S_{ijk} = Effect of shearing within flock and nested within respective location (k = 3)

X_l = Effect of sex (l = 2)

e_{ijklm} = Random error associated with individual observation

The repeatability of wool quality parameters was estimated from a simpler model, estimating among and within sheep variance components.

Results

Farmers belonging to Lotkho clipped their sheep 3 times in a calendar year: winter, spring/summer, and autumn with almost equal intervals (Table 1). In autumn, flocks were clipped within a short period between September 10th and October 20th, on their return from high pastures. Winter shearing was more inconsistent, and was extended over a longer period (i.e. from December to early March), when the sheep were housed inside. Spring shearing was generally done in June or July before letting the sheep pasture up the hills before mid July. A survey indicated that most farmers (79.5%) shore their sheep themselves, while 19.5% hired labour or other farmers helped them in lieu of other farm chores. This was especially true for the winter harvest (Table 2). However, the pattern of hiring was not the same across 3 localities under study. All the Shogoor farmers performed shearing by themselves. Shearing was mainly a man's job (Table 3), as 94.4% of the shearing was done by men. Women, however, had a greater share in manufacturing Patti. A few households (3.7%) also indicated that the job of shearing was shared by both men and women. The actual wool yield (greasy wool) per sheep was 937 g (Table 4) of which 2.4% was wasted, on average, in carding. The maximum wastage was 18.9% as observed for third shearing in a flock.

The annual greasy fleece yield averaged 956 ± 32.2 g (Table 5) and flock differences were apparent ($P < 0.01$). Age classes also differed for this parameter. Sheep of 3-4 years of age had a maximum yield,

Table 1. Interval between successive shearing in a calendar year at Lotkho, Chitral.

	Shearing I	Shearing II	Shearing III
N	392	324	323
Mean	119.0	121.2	124.3
Std	12.28	9.85	10.32
Min	101	106	99
Max	145	135	148

Table 2. Shearing (%) of Kari sheep (n = 54) in the 3 Union Councils.

	Garam-Chashama	Karimabad	Shoghoor	Overall
Barter or hire	25.7	14.9	0	19.5
Own shearing	74.3	84.1	100	80.5
Total	100	100	100	100

Table 3. Household involvement of men and women in the wool harvest (%).

	n	Men	Women	Both
Shearing	54	94.4	1.9	3.7
Woollen Patti	54	74.1	25.9	-

Table 4. Wool production and wastage from different clippings during a calendar year.

Shearing	n	Actual Yield (g)	Wool wasted		
			Quantity (g)	Average %	Maximum %
1st	446	282.7	9.0	3.2	7.1
2nd	456	336.6	10.1	3.0	9.5
3rd	379	317.6	3.0	1.0	18.9
Overall	1281	937	22.1	2.4	

Table 5. Least squares means for annual greasy fleece yield.

Source of variation	n	Mean ± SE
Location NS		
Karimabad	172	939 ± 34.2
Shoghoor	87	973 ± 48.3
Sex NS		
Male	75	998 ± 48.0
Female	184	914 ± 34.1
Flock **	259	
Age-class (years)**		
1	34	776 ± 64.6
2	54	918 ± 52.8
3	62	1064 ± 52.6
4	70	1066 ± 45.4
5	29	980 ± 74.0
6	10	933 ± 119.1
Overall	259	956 ± 32.2

NS = Non-significant; ** = P < 0.01

followed by a declining trend thereafter. As expected, the youngest class (< 1.5 years) had the lowest annual greasy fleece yield (776 ± 64.6 g).

Table 6 presents a variation in the sources for wool quality parameters. Wool yield per shearing averaged 365.9 ± 9.56 g, and location and flock differences were important (P < 0.01). Sex differences were not important. The same was true for clean fleece yield, which had an overall average of 300 ± 8.21 g. The difference between Karimabad and Garam-Chashma UCs was the magnitude of 65 g per animal per shearing. The fibre diameter averaged 23.2 ± 0.17 μm, and flock differences were statistically important (P < 0.01). None of these factors were, however, important for standard deviation of fibre diameter and the bulk. The staple length not only varied among flocks (P < 0.01), but location and shearing season differences were also important (P < 0.05). The difference between Shogoor and Garam-Chashma UCs was 0.7 cm in staple length. Males had more medulated fibres than females (6.9 ± 0.37% vs. 5.5 ± 0.37%).

The repeatability estimates for various wool quality parameters (Table 6) indicated that greasy and clean fleece yield were quite repeatable traits (repeatability > 0.5). The repeatability estimates of fibre diameter and staple length were 0.384 and 0.201, respectively. The medulation (0.121), bulk (0.066) and standard deviation of fibre diameter (0.004) had very low repeatability.

Table 6. Least squares means (± standard error) and repeatability estimates of wool quality traits.

	GGY (g/shear)	CFY (g/shear)	SL (cm)	FD (μm)	SD-FD (μm)	Medulation (%)	Bulk (cm^3/g)
Location	**	**	*	NS	NS	NS	NS
GChashma	328.5 ±1 7.86	265.4 ± 15.50	3.7 ± 0.16	23.1 ± 0.29	8.5 ± 0.03	5.4 ± 0.46	16.7 ± 0.23
Karimabad	403.8 ± 14.42	330.3 ± 12.51	4.0 ± 0.16	23.3 ± 0.29	9.3 ± 0.03	6.7 ± 0.46	17.1 ± 0.23
Shogoor	371.0 ± 14.42	306.9 ± 12.51	4.4 ± 0.16	23.2 ± 0.29	9.2 ± 0.03	6.5 ± 0.46	16.7 ± 0.23
Sex	NS	NS	NS	NS	NS	*	NS
Male	369.5 ± 12.59	301.2 ± 10.93	4.1 ± 0.13	23.1 ± 0.24	8.9 ± 0.26	5.5 ± 0.37	16.8 ± 0.18
Female	366.1 ± 12.46	300.6 ± 10.81	3.9 ± 0.13	23.3 ± 0.24	9.1 ± 0.26	6.9 ± 0.37	16.9 ± 0.18
Flock	**	**	**	**	NS	NS	NS
Shearing	NS	NS	*	NS	NS	NS	NS
Overall mean	365.9 ± 9.56	300.2 ± 8.21	4.0 ± 0.10	23.2 ± 0.17	9.0 ± 0.19	6.2 ± 0.25	16.8 ± 0.13
Repeatability	0.515	0.506	0.201	0.384	0.004	0.121	0.066

GFY = Greasy fleece yield, CFY = Clean fleece yield, SL = Staple length, FD = Fibre diameter,
SD-FD = Standard deviation of fibre diameter, NS = Non-significant; * = $P < 0.05$; ** = $P < 0.01$

Discussion

Shearing pattern: The only information on the performance of Kari sheep, before the present study, was a survey report (3) where the general sheep population of the Chitral district was studied in an attempt to evaluate the wool production system in the area. The present study indicated that wool production had a pattern specific to the area. Sheep are generally shorn twice a year in Pakistan, mainly before the start of a harsh summer and comparatively less severe winter (6). This helps the animal to cope with the weather extremes. Even though in Lotkho shearing was weather-bound, it also depended on the quantum of fleece available for the spinner to work with (3). Availability of labour was also important. Although flocks were shorn by male members of the household, women shared in the responsibility as well; in particular, for the winter clipping when most of the men leave for the south before the arrival of winter. According to AKRSP (3), 80% of the men folk of Chitral leave their homes for the lower country during late autumn. The average flock size in the area is 13.4 animals, and therefore, families can shear sheep by themselves. Larger flocks required hiring labour, especially for winter shearing. The present study is consistent with the earlier report on the shearing pattern (3), where shearing was reported as a man's job, but women were doing the winter shearing due to most of the men leaving for the lower country for work.

Flocks at Shoghoor were exclusively sheared by their owners (either the men or the women members of their households), which could be attributed to the cultural norms of the valley. Frequent clippings were perceived not only as an attempt to produce maximum fleece, but also the staple length matched the requirements of the Patti product. One kilogram of wool produced 6 yards of quality Patti, which was enough to make one waistcoat and a cap (Pakol). Raw wool was also sold, but income obtained from selling Patti was 8-10 times higher than that of the raw wool, and was equivalent to more than 10% of the total average off-farm income of a family (3).

Fleece yield: Annual fleece yield recorded in the present study was higher than the 780 g yield reported by AKRSP (3), and this may be due to the feeding of the registered flocks with urea molasses blocks (UMB) during the scarce period of a chilling winter. The UMBs supplied required nutrients (sulphur containing amino acids, Cu, Zn, folic acid, pyridoxine, etc) required for improved wool growth (7). Differences among flocks (Table 5) indicated individual farmer differences in management,

feeding, housing, health care, and to a lesser degree, the genetic makeup. No preferential treatment was extended to any individual, except to freshly lambed ewes, supplemented with some barley or maize grains, apart from UMBs. Age differences in fleece yield were expected because weight of the animals varied with age. Relationship, however, was not linear. Many studies have documented a change in fleece yield due to changing age (8, 9, 10). Kari is the smallest Pakistani sheep breed, yet greasy fleece yield may be similar to the breeds Rakhshani and Pahari (11). The Ethopian Menz, a small-sized breed, have been reported to yield only 0.53 kg of fleece (12), but heavier breeds such as Merino (13), Awassi (10), Polypay, Rambouillet, and Targhee (14,15) produce higher greasy fleece yields. Under limited feed resources the stress of a cold climate, and migration through tough hilly routes over the steep flanks of mountains in summer and autumn, fleece yield were quite remarkable.

The proportion of usable fleece yield as a percentage of greasy fleece was quite high. Sheep were generally washed on the morning on the day of shearing and lain on a clean grassy floor. Alocal scissor was the most widely used as shearing aid, and uneven clumps were generally visible. The fleece after shearing was usually placed in a basket made of smooth wire-like grasses, named "Shorbelu". The same basket was also used for keeping wool yarn, and knitting instruments. The normal content of grease/wax and suint in Pakistani breeds fluctuates between 39% and 74 % as reported for Bucchi and Kaghani breeds, respectively (16). For most of the breeds, clean fleece yield percentage ranges between 64% to 76% as reported by many workers (9,17,18). Presumably, this could be due to the practice of washing sheep before shearing, and keeping the shearing floor as clean as possible. Among other reasons, the lack of bushy vegetations, hard twigs, and thorny seeds in Lotkho pastures (5) might have helped low burr and foreign vegetable contents of the fleece.

Many workers have reported an age effect on wool yield (8,9). Location (9,19), shearing season (18), sex (8,20), and flock (13,21,22) have also been reported to be important factors.

Staple length: Staple length is one of the consistent criteria of the first 4 official wool grades in Pakistan. Its minimum requirement is 5 cm or 2 in. Fibres below the 5 cm staple, irrespective of its diameter, are graded as inferior (23). Wool from Kari with 4 cm staple length, on average, may be graded inferior. However, it can be used for making yarn for weaving Patti. Breeds differ in their potential to produce wool fibres of a certain staple. Tabbaa et al. (10) reported that 11 ± 0.7 cm to 15 ± 0.3 cm staple lengths for Awassi sheep, the longest among the sheep breeds. According to Al-Azzawi (24), staple length for most of the breeds from Arab countries ranged from 13 to 20 cm. Wool harvested from US Rambouillet ranged from 7.2 ± 2.9 cm to 12.78 ± 0.34 cm (9,14,15). However, the staple length from Merino and other breeds in South Africa was shorter than the USA and Australia for the same breeds. Staples from neck and brisket are generally longer than that from the back and sides, while staples from the belly and legs are shorter (23). Breed difference is important, but shearing frequency seemed to be the main reason for shorter staples.

Fibre diameter: Fibre diameter (FD) reflects the fineness and comfort to the quality of the final product, and may account for most of the value of wool (25). Pakistani breeds are generally coarse wool breeds and FD is ≥ 30 μm. Baluchi, Michni, and Rakhshani breeds are medium quality wool producers in Pakistan with an average FD of 31 μm (11). Merino and its synthetic breeds produced fibre with the lowest FD (16.01 μm to 25.5 μm) as reported by different workers (18,26). Kari stands comparable to most Merino breeds. Findings of the current study were consistent with the earlier report (3), which reported the average FD of 24.48 μm for sheep in the Chitral district. The variability in FD in the present study among flocks may be due to the sampling procedure, where sampling was done at random (whole fleece) rather than from the mid-side region of the body. Shearing season (9) and flock differences in FD have been documented (18,21,26). Sex difference (8,22,27) may or may not (28) be important.

Medulation: Only 6.2% of medulated fibres found in Kari sheep are less than that of other sheep breeds of Pakistan, where average medulation is above 8% (11). Awassi and Arabi breeds from Jordan and Iraq

also have medulation above 8% as reported by Tabbaa et al. (10) and Ashmawi and El–Azzawy (29). Breeds like Merino have been reported to have very low (< 1%) medulated fibres as reported by Bunge et al. (30). In breeds like Barbados and St. Croix, the medulation rate of 5.4% and 6.0%, respectively, have been reported.

Bulk Density: Bulk density is a measure of resistance to the compression of the wool. It is largely a function of fibre diameter and single fibre crimp frequency. However, wool with a high resistance to compression leads to higher losses in scouring (25). Bulk density for Kari was higher than Rambouillet and Ramghani breeds (16,19), but lower than other native breeds of Pakistan (16). Location and flock had been identified as the environmental factors affecting this trait in sheep (19,22).

Conclusions

The Kari sheep, integral part of socio-economic setup of upper Chitral, is an important genetic resource with respect to wool quality. Although small in size, clean wool obtained from the breed may be comparable with other sheep breeds of Pakistan. The fibre diameter of 23 μm indicated that the breed is the finest indigenous wool breed. The small staple length was suitable for producing the value added products such as Patti, an important cottage industry of the area.

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