The Journal of Animal and Plant Sciences, 23(1 Suppl.): 2013, Page: 20-25
ISSN: 1018-7081

INFLUENCE OF GENETIC AND NON-GENETIC FACTORS ON QUANTITY AND QUALITY OF WOOL FROM SHEEP REARED AT RAWALAKOT AZAD JAMMU AND KASHMIR

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ABSTRACT

The data on body weight and greasy wool yield was collected from 35 animals during July, 2007 to July, 2009. The animals were weighed in the first week of each month and shorn annually in March. The least squares means for annual greasy fleece yield, staple length, fiber diameter, medullation, clean yield percent, clean wool yield and wool bulk were 2.28±0.20 kg, 7.66±0.44cm, 26.23±0.60 percent, 69.67±2.34 percent, 1.59±0.14 kg cm3/gm, respectively. The analysis of variance revealed that the years of shearing and breed were the significant ($P<0.05$) sources of variation for greasy fleece yield, however, sex showed non significant difference. The least squares means for greasy fleece yield was 2.29±0.10 kg 2.84±0.91 and 2.34±0.09,kg during 2007, 2008 and 2009, respectively. However, least squares means for Crossbred, Poonchi and Rambuillet genotype was 2.19±0.08, 1.92±0.12 and 2.36±0.091kg, respectively. The differences due to year of shearing was significant ($P<0.05$), however, sex and breed were non significant for staple length. Least squares means for staple length was 8.75±0.58, 7.75±0.53 and 9.46±0.53 cm during the study period (2007-09). However, it was 8.88±0.05, 7.89±0.67 and 9.00±0.48 cm, for Crossbred, Poonchi and Rambuillet genotypes, respectively. Males produced more staple length (9.01±0.78 cm) when compared with female lambs (8.09±0.29 cm). Least squares means for fiber diameter and medullation were 27.47±0.09, 26.77±0.65, 27.06±0.65 micron and 6.40±1.28, 5.77±1.17, 5.89±1.17 percent during 2007 to 2009, and for Crossbred, Poonchi and Rambuillet sheep were 26.36±0.83, 27.93±0.58 and 20.02±0.65 cm and 3.08±1.49, 8.89±1.05 and 6.09±1.17 percent respectively. Analysis of variance for clean yield percent and wool bulk gave non significant difference for all factors studied. Clean yield percent was almost similar during the rearing period but it was higher (71. 08±2.12 %) in Poonchi and female (70.47±1.08%) sheep. Least squares means for wool bulk were similar but it was high in Poonchi (26.46±0.49 cm^3/gm) and female animals (26.18±0.25 cm^3/gm). There was an overall improvement in greasy wool yield in crossbred lambs compared to local Poonchi sheep. Crossing of local sheep with exotic Rambouillet results in the overall improvement in wool quality. However, it was recommended that the estimated environmental effects are important and needs more extensive study for improvement and planning in sheep breeding in future.

Key words: Sheep, Rawalakot, Non-Genetic Factors, Fleece yield, Staple length.

INTRODUCTION

Small ruminants are important domestic animals in arid and semi-arid hilly regions of the country. They are continuous to be backward, since they are raised by poor, landless or small or marginal farmers on natural vegetation and stubbles supplemented by tree browsing and lopping. The productivity of these species in rural areas is relatively lower subjected to nutritional and physical environmental conditions under which they are reared. They are primarily raised in a traditional manner in mixed farming by the livestock farmers. The reasons to their lower productivity are inadequate grazing resources, harsh season, disease stress particularly parasites and serious lack of organized efforts for their genetic improvement. It is necessary to exploit their potential by using objective selection. It has definitely shown that the desirable traits in sheep i.e. more lambs per ewe per gestation and more wool of good quality per animal can be improved through selective breeding. Genetic improvement based on objective selection methods tap the potential of this specie in a given environment. For suitable pastoral livelihood, small ruminant production on rangelands requires special attention and control on flock feeding and feed distribution. The aim of this study was to evaluate the wool production potential of local (Poonchi), exotic (Rambouillet) and their crossbred reared in AJK.

MATERIALS AND METHODS

Animals were kept in a closed shed of 45 feet long, 15 feet wide and 8 feet high with ventilators and windows at two sides for cross ventilation. Good lush green grazing was available to animals starting from March depending on the climate and increasing as day length increases up to the end of August. Animals were opened for grazing in the surveillance of shepherd at 8 am in the morning and brought back when sun sets in at about 6 pm at the evening. The animals were opened fro grazing in morning at 9 am to 5 pm in the evening during winter. They were remained closed in the shed if the climate was rainy or there was snowfall. They were offered hay and supplementary feed twice in a day. The fresh water and salt licks were also available in the shed for 24 hours. The data contained relatively more number of spring (summer) born lambs and few number of lambs born in autumn (early winter).

The data contained relatively more number of spring (summer) born lambs and few number of lambs born in autumn (early winter). The ewes were mated in the evening and morning during the breeding seasons under the surveillance of the supervisory staff for record keeping. Furthermore, ewes were also grouped and kept in separate pens with the specific rams at night for accuracy of recording. The ewes were culled for failure to produce milk and/or lamb and poor body condition. The replacements were made from the on farm born young female animals.

The productive and reproductive performance for mature animals including body weight at 30 days interval, greasy fleece weight and dates at mating/lambing were recorded. About 200 gm wool samples taken randomly from back and both sides of neck and belly region were dispatched to NARC wool laboratory, Islamabad for the analysis of staple length, medullation, fiber diameter, clean yield percent and wool bulk using standard procedure described for Optimal Fiber Diameter Analyzer.

Each fleece sample was weighed on an electronic scale and then manually carded and placed in a couring bag. The standard laboratory scouring unit consisted of four bowls, each with a capacity of 72 liters. The bowls were fitted thermostatic heaters. The composition and temperature of scouring liquors in the four bowls are given in Table 1.Starting from bowl one, the sample was retained in each bowl for 25 – 30 minutes and was passed through manual wringer while transferring to the next bowl. When scouring was completed the samples were placed in a dryer for three minutes. The samples were then dried off in the forced air draft oven for 12 hours and oven dry weights were recorded. The percentage clean wool yield was calculated using the following formula: Yield %age = $W2/W1^{*}116$

Where, W1, is the weight of the greasy fleece sample (gm), W2, is the weight of the oven dried scoured sample (gm) and the factor 116 takes into account moisture regain of the 16 percent.

Measurement of Wool Bulk: An instrument called bulkometer, made by Wool Research Organization of New Zealand (WRONZ) was used for the measuring the bulk of the wool samples. A sample of 10 gm of the scoured wool was weight for the purpose and was placed into the cylinder of the bulkometer. The sample was then subjected to a maximum pressure and allowed to stand for 30 seconds. The pressure is exerted by lowering the piston and adding the load, to a maximum of cm^3/gm. The load i.e. piston and added load, was then removed from the sample and the latter was allowed to recover for 30 seconds. The sample was again subjected to the maximum pressure for 30 seconds and the height h_{30} in mm was measured. The load was then removed and after 30 seconds the mass head was taken off the piston. The loaded piston was lowered to give a pressure of 10 cm^3/gm.

Statistical Analysis: Data on various wool characteristics was subjected to the analysis of variance for the effect of year of shearing, breed and sex of the animals. The statistical software MINITAB version 11.12 for windows 32 bit was used for the analysis of wool data by using general linear model (GLM).

RESULTS AND DISCUSSION

Greasy wool yield: The annual greasy fleece yield data revealed that the years of shearing and breed were the significant ($P<0.05$) sources of variation, however, sex showed non significant difference (Table 2). The overall average annual greasy fleece yield in the present sheep flock was 2.28±0.02 kg with coefficient variation of 8.65 percent. Least squares mean for greasy fleece yield are given in Table 3.

The average annual greasy wool yield as obtained in the present data set was in line with various workers (FAO, 1982; Naqvi and Rai, 1990; Qureshi, *et al*. 2002 and 2010) they reported that annual greasy wool yield was ranging from 0.65 to 2.65±0.03 in various breeds of sheep. Greasy wool yield for Gaddi, Karanah, Gurez, Kashmir Merino, Poonchi, Chang Thangi and Bakarwal sheep breeds in hilly areas of occupied Kashmir ranged from 0.78±0.02 to 2.8±0.08 kg (FAO, 1982) was similar as obtained in the present study. Furthermore, lower values of annual greasy wool yield were also reported (1.96±0.14, 1.20±0.09 and 0.88±0.09 kg) for Chokla and (1.26±0.06, 0.87±0.04 and 0.65±0.05 kg) for Avivasta Indian breeds of sheep (Naqvi and Rai, 1990; Devendran, *et al*. 2008; Gowane, *et al*. 2009) . Moreover, very high least squares means for greasy fleece was also reported from various genotypes of sheep (Dorset, Whiteface, Romanov, Texel, Motadale, Finnsheep, Composite III and their crosses) ranged from 3.04 to 3.84 kg (Lupton *et al*. 2004).

Least squares means for greasy fleece yield was 2.29±0.02, 2.84±0.15 and 2.34±0.02 kg during 2007 through 2009, respectively. The average annual greasy fleece yield was 2.19±0.01 kg for Crossbred, 1.19±0.037

kg for Poonchi and 2.36±0.01 kg for Rambouillet genotypes. The annual greasy fleece yield was 2.15±0.04 kg and 2.17±0.015 kg in male and female lambs, respectively.

The significant effect of year of shearing on greasy fleece yield as obtained in the present study was similar to the early reports in the literature (Qureshi, 2002 and 2010 Devendran, *et al*. 2008). However, Devendran, *et al*. (2008) also reported non significant effect due to sex which is in line with the present study. Moreover, variability of wool yield under the influence of some genetic and non genetic factors was also confirmed by various workers (Iliev, 2006; Slavova, 2002; Panayotov, 2002, 2008; Lupton *et al*. 2004 and Neser *et al*. 2004).

The yearly variation in annual greasy wool yield over different years indicated management and feed availability. Naqvi and Rai (1990) studied the effect of nutritional stress, quality and conversion of feed in to wool on Chokla and Avivasta genotypes. Chokla animals produced 54.9, 36 9 and 35.5 % more wool with 114.2, 84.2 and 72.6 % greater efficiency in conversion of feed to wool in comparison to Avivasta animals. Efficiency of feed conversion to wool increased with decreasing level of feed intake in both the breeds.

Staple length (cm): There was significant ($P<0.05$) difference due to year of shearing, however, breed and sex of the lamb showed non significant difference for the staple length (Table 2). The least squares means for staple length was 7.66±0.04 cm which ranged from as lowest as 5.65 cm to as high as 9.66 cm with coefficient variation of 5.69 percent. Least squares means and standard deviation for staple length in each category of factors influencing the trait is given in Table 3.

The differences due to year of shearing was significant, however, least squares means for staple length during the study period were 8.75 ± 0.58 cm, 7.75±0.53 and 9.46±0.53 cm, respectively. Least squares means for staple length for Rambouillet, Crossbred and Poonchi lambs was 9.00±0.48, 8.88±0.05 and 7.89±0.67 cm, respectively. The annual staple length for wool from males was higher (9.09±0.78 cm) than females (8.09±0.29 cm).

Similar least squares means for staple length were found in the literature from various genotypes of sheep (Dorset, Whiteface, Romanov, Texel, Motadale, Finnsheep, Composite III and their crosses) that ranged from 7.38±0.67 to 9.33±1.05 cm (Lupton *et al*. 2004). Earlier studies from Pakistan also reported average staple length in various breeds was ranged from 8.02 cm to 10.0 cm. The average staple length reported in the literature was 4.0 to 6.5 cm which is lower than the average staple length of present data however, it ranged from 2.35 to 10.0 cm (Wahid, 1982; Siddiqi, 1982; Shah, 1982; Ishaq, 1982) in various breeds of sheep in Pakistan which is falling in the range of the present values. Khan *et al*., (1996) reported that staple length for Rambouillet, Salt Range, Lohi, Sipli, Buchi and Balochi sheep were 5.6±1.2, 5.6±2.0, 7.5±1.5, 7.4±1.8, 7.1±1.3 and 6.8±2.5 cm, respectively lower than the present values.

Naqvi and Rai (1990) studied conversion of feed in to wool for Indian Chokla and Avivasta sheep breed. The mean values for staple length in Avivasta sheep were 3.66±0.56, 3.16±0.24, 2.35±0.24 cm on three feeding treatments, respectively. However, the mean values in Chokla were 6.73±0.71, 4.93±0.19, 3.80±0.40 cm staple length on the same feeding treatments. The differences in the staple length may be attributable both genetic and non genetic factors (Iliev, 2006; Slavova, 2002; Panayotov, 2002, Slavov, 2007, and Neser, *et al*. 2004). Fiber length is another parameter which along with fiber diameter, determines the value and use of the wool. As for instance, the worsted yarn manufacturing employs fine wools having length within a specified range. Wools with shorter or longer length are put to many other uses, of course, with due consideration to the fiber diameter. Staple length provides reasonably good estimate of the fiber length and is easier and time saving to measure. This parameter also influences the spinning performance and the yarn yield. The staple length and yield may be reduced due to growth period and when crimps/cm of fiber increased due to the effect to lower level of nutrition (Snyman *et al*., 1995)

Fiber diameter (Fineness): The analysis of variance revealed that the influence of year of shearing, breed and sex of the lamb were non significant sources of variation (Table 2) for fiber diameter. Least squares means for fiber diameter was 26.23±0.06 micron and it was ranged from 24.21 to 28.25 micron with coefficient variation of 2.27 percent. Least squares means for fiber diameter in each category of factors influencing the trait are given in Table 3.

The average fiber diameter was 27.47±0.02, 26.77±0.11 and 27.06±0.11 micron during 2007, 2008 and 2009, respectively. It was 26.93±0.30 and 27.27±0.04 micron in males and female lambs, respectively. The least squares means for fiber diameter in Crossbred (Poochi x Rambuillet), Poonchi and Rambuillet lambs were 26.36±0.19, 27.93±0.09 and 20.02±0.10 micron, respectively.

Similar values for fiber diameter reported by Lupton, *et al*. (2004) for Dorset x Whiteface (26.1 micron), Finnsheep x Compsite III (26.6 micron), Romanoeve x Composite III (26.3 micron), Texel x Composite III (26.9 micron) crossbreds. The average fiber diameter was ranged from 20 to 29 micron in Rambouillet, Hissardale, Baghdale, Corriedale, Kaghani, Chitrali, Bikaneri and Kail sheep, respectively (Cheema et. al. 1957-80; Ishaq, 1982) which was in agreement with the present study. The fiber diameter obtained in the present study was falling in the range (21.30±5.53 to

32.78±15.41 micron) reported by various workers (Wahid, 1982; Shah, 1982; Siddique, 1982) for various sheep breeds in Pakistan. Moreover they also reported higher average values of fiber diameter (33.4 to 51.0 micron) in some other breeds.

Khan *et al*., (1996) found that the wool from Rambouillet was finest with an average fiber diameter of 18.25±3.80 micron of the native breeds, Balochi sheep wool have the lowest average fiber diameter 26.00 ±12.00 micron, whereas the Salt Range sheep was the coarsest with an average fiber diameter of 35.20±16.90 micron. They further reported that fiber diameter fell in a range of 28.81±15.21 micron for Harnai to 31.68±22.28 micron for Bibrik. The values obtained in this study for fiber diameter (22.08±4.45 to 32.83±18.50 micron) are within the range reported.

However, optimal fiber diameter analyzer was used for the present research for AJK sheep breeds for the first time. Some early results were higher than the present values whereas others values were lower. The differences may be attributed to the source of animals as well as wide period between the studies and methods of measurement used. There appears to a large within sample variation in fiber diameter for wools from native breeds. This may be, for the most part, due to the presence of large proportions of heterotypic and medullated fibers including kemp in the coarser wools, whereas these types of fiber are almost absent in the fine wools. However, in order to obtain more reliable breed comparison for fiber diameter, it would have been worthwhile to employ a large number of wool samples from each breed studied. The staple length and fiber diameter reduced wile crimps/cm of fiber increased due to the effect of lower level of nutrition.

Medullation: The records on 104 animals for medullation percent were subjected to analysis of variance, revealed that the differences was found significant ($P<0.05$) due to breed and sex of the lamb, however, year of shearing was found non significant source of variation (Table 2). Least squares means for medullation percent was 6.02±0.12 and it ranged from 3.09 to 8.10 percent with 20.11 percent coefficient variation. Least squares mean values for medullation percent for each category of factors influencing the trait are shown in Table 3.

The least squares means for medullation percent varied among 6.40±0.24, 5.77±0.19 and 5.89±0.19 percent during the year 2007, 2008 and 2009, respectively. Least squares mean value for medullation percent were 3.08±0.35, 8.89±0.16 and 6.09±0.18 percent for Crossbred (Poonchi x Rambouillet), Poonchi and Rambouillet lambs, respectively. However, it was 4.01±0.55 and 8.02±0.06 percent in males and females, respectively.

The mean value of medullation as obtained in the present flock was in accordance to the range reported by Naqvi and Rai (1990) and Siddiqi (1982) they reported that modulation ranged from 6.4 to 8.0 percent in Rakhshani, Michni and Latti/ Salt Range sheep in Pakistan. Naqvi and Rai (1990) reported modulation was 6.72, 6.36 in Avivasta sheep in India. The percentage of medullation in the current study varies considerably (2.60 to 26.20 percent) and falls within the results obtained by various other workers who reported that the medullation percentage was ranged from 2.0 to 26.0 percent for various breeds of sheep in Pakistan (Shah, 1982; Siddiqi, 1982; Ishaq, 1982; Naqvi and Rai, 1990).

Clean yield percent: The data about clean yield when subjected to analysis of variance revealed that the differences due to year of shearing, breed and sex were found non significant. The analysis of variance for the clean yield percent is given in Table 2. Lerast squares means for clean yield percent was 69.67±0.23, the range being 67.07 to 71.71 with a coefficient variation of 3.12 percent. Least squares means for the Crossbred (Poonchi x Rambouillet), Poonchi and Rambuillet were 68.14±0.60, 71.08±0.37 and 69.78±0.52 percent, respectively. The clean yield percent was high in female lambs (70.47±0.13 percent) than the male lambs (68.86±1.50 percent). Least squares means with deviation for the clean wool yield for various non genetic factors are given in Table 3.

Similar findings regarding clean yield percent were reported from some breeds of sheep from Pakistan (Khan *et al*., 1996; Siddiqi, 1982) they reported that clean wool yield was 69.5±4.6 percent in Rambouillet sheep maintained in Pakistan, whereas range reported was 58.0 to 69.5 percent. Siddiqi (1982) reported that clean wool fiber content percentage in various breeds from Pakistan range from 46.9 in Kooka to 91.5 percent in Latti. However, other workers reported higher clean wool yield for some other breeds of sheep (Khan *et al*., 1996; Naeem, 1987) they reported that clean wool yield ranged from 73.5±6.8 to 79.7 percent for Kaghani, Gilgit sheep and wool samples collected from woolen mills in Punjab and NWFP. Moreover, lower values for clean wool yield for salt range, Lohi, Sipli and Buchi were 65.5±8.5, 60.8±10.5, 64.50 ±10.4 and 38.8±9.8 percent, respectively. Lupton, *et al*. (2004) reported clean yield percent in Dorset, Whiteface, Finnsheep, Romanove, Texel, Montadale and their crosses was ranged from 61.3 to 66.4 percent which was lower than the present values.

The greasy wool are expected to differ in their clean yield contents due to variation in grazing location, breed, quality, source and time of shearing and sampling etc. The sample used and method of estimation may also contribute to the differences in the clean wool yield content. The percent clean yield estimation is important for commercial point of view, as this measure is used in determining the price of greasy wool, and is perhaps one of the oldest bases employed for this purpose. It is the weight of clean wool expressed as percentage of the greasy or raw wool after the removal of impurities. Since wool is very hygroscopic fiber, picking up and losing moisture with the change in the atmospheric conditions, it is a standard procedure to take into account a moisture regain of 16 percent by the oven dried scoured wool samples. Hence a factor of 116 is used in the formula for computing the percentage yield.

Wool bulk: The data for wool bulk when subjected to analysis of variance revealed that the year of shearing, breed and sex of lambs had non significant effects on wool bulk (Table 2). The least squares mean for bulk (compressibility) of the wool was 26.08±0.06 cm^3/gm. The range being 24.06 cm^3/gm to 28.10 cm^3/gm with coefficient variation 2.08 percent. The least squares means for the wool bulk were 25.87±0.14**,** 26.46±0.09 and 25.92±0.12 cm^3/gm for Crossbred (Poonchi x Rambuillet), Poonchi and Rambouillet sheep lambs respectively (Table 3). The compressibility for males was 24.99±0.35 cm^3/gm and for female lambs it was high 26.18±0.03 cm^3/gm. Least squares means and standard deviation for the bulk are given in Table 3.

Table 1. Composition and temperature of aqueous scouring liquors (bowl Capacity = 72 liters).

Ingredient	Bowl 1	Bowl 2	Bowl 3	Bowl 4
Chemirite Ni 400 ml	120	80	40	-
Sodium chloride (gm)	150	-	-	-
Water (to make upto litter)	72	72	72	72
Temperature (C^0)	70	70	70	45

Table 2. Analysis of Variance Greasy Fleece Yield, Staple Length, Fiber Diameter, Medullation, Clean Yield and Wool Bulk for Sheep Kept During Study Period (2007 – 09)

Greasy Fleece Yield				Staple Length		Fiber Diameter		Medullation		Clean Yield			Wool Bulk	
Sources of Variation	Degree of Freedom	Mean Squares	F Values	Mean Squares	F Values	Mean Squares	F Values	Mean Squares	F Values	Degree of Freedom	Mean Squares	F Values	Mean Squares	F Values
Year	2	2.7386	15.58**	35.128	5.92**	3.612	0.41	3.09	0.11	1	5.92	0.08	2.049	0.49
Breed	2	1.0865	6.18**	7.812	1.32NS	17.639	1.98	223.53	7.73	2	50.07	0.65	2.844	0.68
Sex	1	0.0027	0.02NS	8.616	1.45NS	0.981	0.11	139.3	4.82	1	13.52	0.17	0.194	0.05
Error	99	0.1758		5.937		8.914		28.91		71	77.4		4.189	
Total	104									74				

* Significant at 5 % level ** Significant at 1 % level NS = Non Significant

Table 3. Least squares means for Greasy Fleece Yield, Staple Length, Fiber Diameter, Medullation, Clean Yield and Wool Bulk With Standard Deviation and Coefficient of Variation for various factors studied during 2007-09.

Greasy Fleece Yield (kgs)				Staple Length (cm)		Fiber Diameter (micron)		Medullation (%)		Clean Yield (%)			Wool Bulk (cm^3/gm)	
Factors	No	Mean	Coeffi-cient of Variation	Mean	Coeffi-cient of Variation	Mean	Coeffi-cient of Variation	Mean	Coeffi-cient of Variation	No	Mean	Coeffi-cient of Variation	Mean	Coeff-icient of Variation
Overall	105	2.28± 0.197	8.65	7.66± 0.435	5.69	26.23± 0.595	2.267	6.02± 1.210	20.106	76	69.67± 2.335	3.351	26.08± 0.543	2.082
2007	29	2.29± 0.100	4.35	8.75± 0.578	6.61	27.47± 0.091	0.332	6.40± 1.277	19.959					
2008	38	2.84± 0.914	32.18	7.75± 0.531	6.85	26.77± 0.651	2.430	5.77± 1.172	20.306	37	69.39± 2.168	3.124	26.25± 0.504	1.921
2009	38	2.34± 0.091	3.91	9.46± 0.531	5.61	27.06± 0.651	2.404	5.89± 1.172	19.902	39	69.94± 2.168	3.099	25.92± 0.504	1.946
Crossbred	18	2.19± 0.082	3.75	8.88± 0.054	0.61	26.36± 0.825	3.129	3.08± 1.485	48.299	18	68.14± 2.553	3.747	25.87± 0.594	2.296
Poonchi	42	1.92± 0.116	6.03	7.89± 0.673	8.53	27.93± 0.584	2.092	8.89± 1.052	11.836	32	71.08± 2.117	2.978	26.46± 0.493	1.861
Rambouillet	45	2.36± 0.091	3.87	9.00± 0.477	5.30	20.02± 0.650	3.249	6.09± 1.171	19.229	26	69.78± 2.578	3.694	25.92± 0.600	2.313
Male	10	2.17±0 .048	2.240	9.09± 0.783	8.62	26.93± 0.960	3.563	4.01± 1.728	43.056	6	68.86± 3.678	5.341	25.99± 0.856	3.292
Female	95	2.15± 0.135	6.28	8.09± 0.292	3.61	27.27± 0.345	1.266	8.02± 0.622	7.750	70	70.47± 1.081	1.534	26.18± 0.251	0.960

A study from Pakistan made by Khan *et al*., (1996) showed lower value for the bulk of wool as compared to values obtained in the present study. They reported that average bulk values of 18.2±2.4, 23.0±2.0, 26.8±2.5, 27.0±2.2, 27.5±2.1 and 24.8±2.4 cm^3/gm for Rambouillet, Salt Range, Lohi, Sipli, Buchi and Balochi sheep in Pakistan, respectively. However, the range reported was in compliance with the present study conducted at Rawalakot, Azad Jammu and Kashmir.

The difference in bulk among the wools largely depends on the type and level of crimps possessed by the fiber. High crimped finer wools having less bulk, as seen in case of Rambouillet and Crossbred in the present work. The fine wool would not be expected to impart the desired bulky effect to the carpet and has little use in carpet manufacturing. The wool from Poonchi exhibited this property of bulkiness to the extent that makes it suitable for carpet manufacturing, that's why, called carpet wool. However, a proportion of fine fiber is often blended to give special effects to the finished carpet (Snyman *et al*, 1995).

Conclusion: The crossbreeding among native Poonchi and exotic Rambouillet will result in the improvement of wool quality as well as the quantity. Reports on wool qualities important for carpet manufacturing i.e. wool bulk for different sheep breeds in AJK and Pakistan is scanty. The present findings seem to be the first on wool characteristic of sheep breeds from Azad Jammu and Kashmir.

Recommendations: The estimated environmental effects are important and needs further study on a large volume of data. The base for this purpose has been established to study the magnitude of genetic and non genetic factors in sheep breeding / production and improvement in future. There is dire need of establishing nucleus flocks of local sheep breeds in AJK for further improvement and conservation.

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