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QUALITY AND CHARACTER OF PAKISTANI WOOLS

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Five different series of Pakistani wools, of both carpet and medium type, were examined for a number of fibre characteristics. The relationship between crimp and diameter was investigated with a view to examining its use for quality assessment. The relationships among the various other parameters and especialy the dependence of character on other characteristics were also investigated.

Pakistani wools are known at home and abroad for their suitability for carpet manufacture. These wools, however, differ widely in their origin as they come from as many as 22 breeds of sheep. A survey of the fineness of the wools[1] has revealed that some of them are as fine as 50's, whilst same individual fleeces approach 60's. A substantial portion of these wools gets mixed up with coarse carpet types and is not utilized for its proper end use. This is partly because of the fact that no system for quality assessment of these wools by eye and hand methods, analogous to well-known systems used for fine wools such as Merino, seems to have evolved. Some of the reasons for this situation could well be the low crimping commonly associated with these wools and their general classification as carpet wool with little or no emphasis on fineness within the type.

An additional factor has been introduced to this situation in the past 10–12 years. Attempts have been made at crossbreeding some of the breeds producing medium quality wools with imported fine woolled breeds such as Rambouillet. As a result, some quantities of medium and fine quality wool are now being produced.

The practice of visual assessment based largely on observation of staple crimp frequency is not very accurate as there are sufficient individual exceptions to the relationship between diameter and staple crimp to make it unsatisfactory to place full reliance on the frequency.[2,3,4] The desirability of more objective techniques has, therefore, been long expressed. The visual assessment would, however, continue to be of significant assistance till such time that alternative objective techniques of almost equal convenience become established. Further, in situations such as above where mainly the matter of distinguishing medium quality wools from coarser carpet types is involved, the method could be of sufficient effectiveness.

Most characteristics of wool associated with visual appraisal such as colour and length, are directly observable and offer little or no difficulty in the assessment. The estimation of quality or fineness is perhaps the most critical aspect, partly because of its importance and partly because of the difficulty of its accurate assessment by the method. Another such critical characteristic is the 'style' or 'character' of wool which affects the price and even if a direct premium is not paid for a wool of good character, its general attractiveness is likely to influence the buyers' evaluation. The causal factors for character are not fully known even in the case of Merino wool, despite such attempts as those by Sidey,[5] Lang and Skertchly[6] and Lockhart.[7] Pakistani wools, especially of the carpet type, constitute a special system where some fibre characteristics are at marked variance with those of Merino wool and, therefore, offer an opportunity for investigation of their inter-relationships in comparison to the known facts.

In addition to the above, there are other considerations necessitating an investigation of the said relationships. Shah and Whiteley[8] have shown that, in terms of their substance as reflected through their mechanical properties, carpet wools do not significantly differ from fine wools and reasons for their particular end use should, therefore, lie largely in their external parameters.

The objectives of the present study were thus to examine the external parameters of carpet wools, with special emphasis on quality crimp relationship, analysis of 'character' and other interrelationships among the various parameters.

The term medium quality wool has been frequently used in this study to denote indigenous wools finer than 44's to distinguish them from the coarse carpet types.

Materials and Methods

Wool Samples.—The indigenous wools differ widely in origin and characteristics. The situation is further complicated by irregular crossbreeding between the various breeds as well as the variations in environment and nutrition in the different parts of the country.

To overcome this situation, two series of samples have been recently procured in these Laboratories for investigation of their various characteristics. In the first, between breed 'Miscellaneous' series, samples obtained from widely differing sources, have been included to examine the extent of the wide variation as it exists. In order to minimize these extreme variations, a small flock of a typical carpet breed, Hashtnagri, was maintained at Peshawar for a period of more than one year, and samples from the right midside were obtained in spring. The samples in all the other series were also from the midside with the exception of the miscellaneous series, where samples were picked up from commercial lots and shorn-off fleeces. In these samples, however, skirtings were not included.

In addition to the above, three series of samples were available from the Government Sheep Farm in the Azad Kashmir, where crossbreeding between the local breed Kail and the imported Rambouillet is in progress. Samples of Kail, a medium quality wool and those of F_1 and F_2 progenies were available. These samples are of interest in connection with studies on changes in wool parameters when breeds of two different wool types such as above are crossed.

Thus the following 5 series of samples were included in the study:

1. Between breed 'Miscellaneous' series	= 20 samples
2. Hashtnagri series	= 30 samples
3. Kail series	= 34 samples
4. F_1 series	= 45 samples
5. F_2 series	= 16 samples
Total	145 samples

In addition, 6 samples of the parent Rambouillet sheep were also available.

Character and Form.—In view of the difficulties associated with the assessment of character,[6] care has to be exercised both in its definition and the method of assessment. For the purpose of this study Lockhart's definition[7] has been adopted according to which character means distinctness of crimp of the base end of the staple. Lockhart has, however, not given any details of the procedure of assessment and in this respect Lang and Skertchly's method[6] (iii) viz. repeated assessment by the same assessor was adopted. The senior author, trained under Australian conditions graded the samples thrice and average grade for each sample was determined. Five grades analogous to Lockhart's grades[6] were employed, grade 5 containing those samples with the most distinct crimping and grade one those with the most indistinct. A similar scale was used for staple form, after Lockhart, where grade 5 contains the largest staples of locks.

It may be pointed out that in terms of character the medium quality indigenous wools as well as the carpet wools are no match for fine wools such as Merino. The grading constituted, therefore, an assessment of samples relative to one another within the series.

Staple and Fibre Crimp.—For staple crimp, 10 staples were selected at random from each of the samples. With the staple straightened but not stretched, the number of crimps throughout the length of the staple was counted. The length of the straightened staple was also measured by placing it along side a foot rule, and the average number of crimps per inch determined.

Preliminary experiments revealed a wide range of fibre crimp frequency within the series so that the following method was adopted which could pick up between sample differences of about 0.5 in the frequency per in. Out of the 10 staples measured, one with staple crimp frequency approximating to the average for the sample was selected and 20 fibres were drawn from it at random for measurement of fibre crimp. In the case of the coarse carpet wools viz. Hashtnagri series and most of the miscellaneous samples, however, measurements were recorded for 40 fibres in view of the greater variation arising from medullation.

Diameter and its Coefficient of Variation.—The original samples employed for estimation of character and form were small samples of about ½ oz each so that the above 10 staples constituted about a third of the sample. These randomly selected staples thus formed a sub-sample which was employed for the purpose of the remaining determinations. Out of this, 3 or 4 staples were drawn at random and degreased in ether followed by washing with alcohol and water. Each was halved and one half selected at random. The division was made lengthwise and not by pulling the fibres by their ends. (The other half was spared for future work to be undertaken at these Laboratories). After reduction of fibre snippets

to 0.2 mm or under by a pair of scissors and conditioning at about 70°F and 65% R.H., 400–600 measurements were recorded at a magnification of ×500.

Statistical Analysis.—The relationships between the various parameters were examined by evaluating coefficients of correlation. Further, to separate some of the confounded effects, multiple regressions were carried out by employing linear regression models. These models cannot be considered to be the most pertinent ones but were considered to be of sufficient assistance in revealing important information for the purposes of this study.

For convenience, the staple crimp frequency per inch, fibre crimp frequency per inch and coefficient of variation of fibre diameter have been denoted by S.C., F.C. and C.V., respectively.

Results and Discussion

Characteristics.—Table 1 gives the mean and standard deviations of the various characteristics in respect of all the five series. Mean values for the Rambouillet samples have also been given for comparison, but in view of the small number of the samples, these series were not subjected to the statistical analysis. The change in the magnitude of the various characteristics from Hashtnagri and Miscellaneous series through F_2 to Rambouillet can be perused. The carpet wools are characterised by a high diameter, a high C.V. and a conspicuously low S.C.

The general improvement due to crossbreeding is apparant from a comparison of the last four series. The diameter and C.V. improve right at the F_1 stage and there is a significant increase in both S.E. and F.C. The improvement from the F_1 to F_2 stage is slight in these characteristics but a noticeable change was observed in the character of the two types. Both the parent Rambouillet and Kail breeds are generally associated with a good character, despite the wide difference in the crimps frequency. The F_1 samples were, however, found to be generally poor in character, and very few samples were found to have a distinct staple crimp. It seems that at this stage the crimp patterns of both the parent breeds disturbed each other and the result was a general irregularity or lack of crimp. The phenomenon seems to be analogous to that of super imposition of two wave trains of different frequencies resulting in a general non-uniformity associated with beats. At the F_2 stage, however, the character improved noticeably as the wave system of the Rambouillet became dominant. The observation also gives support to the biological origin of crimp, the environmental factors appearing to be of secondary importance.

Character.—Table 2 gives the coefficients for correlation between character and other parameters for all the five series.

Staple form is negatively correlated with character, the relationship being significant in four of the cases. In some cases the form is almost synonymous with character. It appears, in agreement with Lockhart,[7] that the former cannot be regarded as the causal basis for the latter and both would seem to largely arise from similar causes.

The most consistent dependence is on C.V., which approaches significance in four out of the five series. This confirms the earlier findings.[7]

The coefficient is positive for the relationship with S.C. in the case of indigenous wools which is in contradistinction to that in fine wools. Lockhart[7] has shown that, other things being equal, a wool of low S.C. will be high in character. This does not seem to hold in the case of carpet wools where a general deterioration in character is revealed as the S.C. falls. That the positive relationship may be a result of the fact that some of the independent variables are confounded, was resolved by carrying out multiple regressions in the case of the typical carpet series, Hashtnagri, and the medium series Kail. Tables 3 and 4 give the correlation matrices for the two series, respectively, whilst the standardised partial regression coefficients have been given in Table 5.

TABLE 1.—MEANS AND STANDARD DEVIATIONS OF FLEECE CHARACTERISTICS.

Characteristic	Hashtnagri		Miscellaneous		Kail		F_1		F_2		Rambouillet
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean
Character	2.70	0.92	3.15	1.05	2.74	1.31	2.51	1.04	2.88	0.71	4.00
Staple form	3.43	1.29	2.85	0.93	3.29	2.31	3.02	1.37	3.06	1.26	2.81
Fibre diameter (u)	34.5	4.9	35.3	5.1	26.1	4.8	23.6	1.9	22.9	2.5	20.8
C.V. fibre diameter	38.3	7.8	33.3	9.4	24.6	4.4	20.5	5.3	19.9	3.7	13.7
Staple crimp (per inch)	0.55	0.22	1.20	1.05	4.52	1.97	9.07	3.79	8.31	1.20	13.32
Fibre crimp (per inch)	5.00	0.31	7.01	2.79	6.37	1.65	12.73	2.98	13.62	2.43	17.21

TABLE 2.—CORRELATION BETWEEN CHARACTER AND OTHER CHARACTERISTICS.

Characteristic	Hashtnagri	Miscellaneous	Kail	F_1	F_2
Staple form	−0.627**	−0.465*	−0.465*	−0.585**	−0.186
Fibre diameter	−0.238	−0.494*	+0.112	−0.003	−0.393
C.V. fibre diameter	−0.350	−0.530*	−0.363*	−0.438**	−0.746**
Staple crimp	0.329	0.381	0.600*	0.675**	−0.198
Fibre crimp	0.047	0.334	0.311	0.256	0.009

*Significant at the 5% level; **Significant at the 1% level.

TABLE 3.—CORRELATION MATRIX FOR THE CHARACTERISTICS OF HASHTNAGRI WOOL.

	Character	Staple form	Fibre diameter	C.V. Fibre diameter	Staple crimp	Fibre crimp
Character	1	−0.627**	−0.238	−0.350	0.329	0.047
Staple form		1	0.204	0.341	−0.009	−0.092
Fibre diameter			1	0.626**	−0.438*	−0.110
C. V fibre				1	−0.313	−0.282
Staple crimp					1	0.301
Fibre crimp						1

*Significant at the 5% level; ** Significant at the 1% level.

TABLE 4.—CORRELATION MATRIX FOR THE CHARACTERISTICS OF KAIL WOOL.

	Character	Staple form	Fibre diameter	C.V. fibre diameter	Staple crimp	Fibre crimp
Character	1	−0.363*	0.112	−0.363*	0.600**	0.311
Staple form		1	0.007	0.226	−0.408*	−0.211
Fibre diameter			1	0.556**	−0.172	−0.200
C.V. fibre diameter				1	−0.360*	−0.409
Staple crimp					1	0.575**
Fibre crimp						1

*Significant at the 5% level; ** Significant at the 1% level.

TABLE 5.—STANDARD PARTIAL REGRESSION COEFFICIENTS OF THE VARIOUS CHARACTERISTICS WITH CHARACTER AS THE DEPENDENT VARIATE.

Characteristic	Hashtnagri	Kail
Fibre diameter	−0.549	0.014
C.V. fibre diameter	−0.405	0.366
Staple crimp	+0.289	−0.652
Fibre crimp	+0.245	−0.181

These analyses also confirm the positive dependence of character on S.C. in the two series. The fact, that For F_2 which approaches fine wool in characteristics, the coefficient is negative, though non-significant, (Table 2) gives support to the observation that the relationships have different signs in the cases of carpet and fine wools.

The correlation coefficients (Table 2) and the partial regression coefficient (Table 5) reveal the significant and consistent dependence of character on C.V. The dependence on diameter, S.C. and F.C. is also revealed in varying degrees for the different series. The multiple regressions on these four characteristics (Table 5) account for some 50% of the variance in character in the case of the two series. This contrasts with about 55% accounted for by C.V., diameter, S.C. and fibre density in the case of Merino.[7] The effect of the last parameter is unfortunately not included in the present study as it concentrated largely on fibre parameters of the samples as available. It is, nevertheless, obvious that in all the studies conducted so far, a substantial portion of the variance remains unresolved and perhaps cannot be accounted for in terms of unresolved and perhaps cannot be accounted for in terms of commonly

known fibre characteristics. Character, therefore, appears to be at least partially of superfluous nature and its only economic significance appears to be that, other things being equal, a wool of good character is likely to be finer and more uniform in diameter.

Quality.—The correlation between diameter and S.C. has been given in Table 6 for all the five series. In the case of the carpet wools diameter is significantly related to staple crimp, but the relationship is not significant in the case of the medium wools and even the sign is reversed in the case of F_1. The reason may well lie in the fact that the range of diameter in the medium wools was small, making the relationship less obvious. In the case of the carpet series the diameter ranged from 27 to 44 microns and a significant relationship resulted due largely to the extreme values and despite the high variation for intermediate cases.

With regard to the use of crimp-diameter relationship for quality assessment, the series have been compared in Table 7. In view of the disagreement over quality-diameter data,[9] the A.S.T.M's[10] diameter ranges for the various qualities have been adopted. The approximate S.C. values for the three series Hashtnagri, Miscellaneous and F_2 have been taken from linear regressions of crimp on diameter for the respective cases. Lang's[11] values for Australian wool have also been included for comparison.

The table reveals a sharp contrast in frequency in the carpet and Australian wools: for the same quality number and diameter range, the carpet wool is associated with a conspicuously low frequency. In the case of 56's, for instance, Australian wool is associated with 6.5 S.C., but Hashtnagri with 0.9 only. This is in general agreement with the important findings of Lang[5] and Roberts and Dunlop[12] that the crimp-diameter relationship varies from strain to strain even within Merino wool. In fact, the relationships for all the four series included in the table are different from one another.

Table 6.—Correlations Among Some of the Characteristics.

Characteristic	Miscellaneous	Hashtnagri	Kail	F_1	F_2
Staple and fibre crimp	0.866**	0.301	0.575**	0.545**	0.777**
Diameter and its C.V.	0.262	0.626**	0.556**	−0.005	−0.231
Diameter and staple crimp	−0.540*	−0.438*	−0.172	0.292	−0.179
Diameter and fibre crimp	−0.381	−0.110	−0.200	0.166	−0.291

* Significant at the 5% level; **Signficant at the 1% level.

Table 7.—Comparison of Crimp-quality Relationship in the Various wools.

Quality No.	Diameter (U)	Staple crimp per inch			
		Australian Wool	Hashtnagri	Miscellaneous	F_2
70's	19.6–21.0	16.5	—	—	31
64's	21.1–22.5	12.5	—	—	11
62's	22.6–24.0	—	—	—	9
60's	24.1–25.5	10.5	—	—	6
58's	25.6–27.0	8.5	—	2.4	4.5
54's	28.6–30.0	—	0.85	2.2	2.0
50's	30.1–31.7	4.7	0.80	1.8	—
48's	31.8–33.4	3.7	0.70	1.6	—
46's	33.5–35.1	3.0	0.65	1.5	—
44's	35.2–37.0	2.4	0.60	1.3	—
40's	37.1–38.9	2.0	0.55	1.1	—
36's	39.0–41.2	1.5	0.50	0.8	—

It is evident, therefore, that for the purposes of quality assessment the appraiser would have to have a knowledge of the breed type and the particular relationship applicable in the case.

The lower frequency of the F_2 series in comparison with the corresponding Australian qualities would seem to suggest that even the upgraded wools resulting from the crossbreeding would probably be low in crimp.

Other Relationships.—Table 6 gives the relationships between S.C. and F.C., diameter and C.V; diameter and S.C. and diameter and F.C. of these, that between diameter and S.C. has been discussed in the preceding section.

The positive relationship between S.C. and F.C. is highly significant in the case of four out of the five series. That the two frequencies are not equal, numerically, is evident from Table 1, which shows a higher value for F.C. in all the five cases. In fact in the case of Hashtnagri wool, which is associated with an extremely low S.C. of 0.55, the F.C., 5.0, is about 9 times bigger. In such carpet wools, in contradistinction to the low S.C., the individual fibres are associated with an appreciably high F.C. Even among the fully medullated fibres many were found to be regularly crimped, although the amplitude was small. The numerical disagreement between S.C. and F.C. is in general confirmation of the findings of Goldsworthy and Lang.[13]

The relationship between diameter and C.V. is positive in the case of three of the indigenous series and is highly significant in two of them. For F_1 and F_2, however, the relationship is negative, though not significant. It is obvious that with the increase in diameter in carpet wools, medullation increases generally, resulting in a wide variation in fineness from true to fully medullated fibres within the sample and hence a high C.V. This is not the case for fine wools, for which there appears to be small or no relationship.

Diameter and F.C. appear to be negatively related, in general, but the relationship does not approach significance. With increase in diameter, F.C. seems to decrease in true wool fibres but the appearance of a special wavy structure in many coarse medullated fibres upsets the negative relationship.

Conclusions

1. The crimp-diameter relationship as also those between character and other characteristics seem to be specific for wools of different breeds and origin. This should be kept in view in investigation and application of these relationships.

2. The indigenous wools are associated with a conspicuously lower staple crimp frequency than that of the corresponding Australian wools of the same fineness.

3. Other things being equal, a wool of good character is likely to be finer and uniform in diameter.

4. For quality assessment of indigenous wools, on the basis of crimp-diameter relationship, an appraiser would have to be conversant with the breed type and the particular relationship applicable in the case.

5. The low crimping associated with indigenous breeds may also affect, in varying degrees, the wools of their progenies obtained as a result of crossing with finewoolled breeds.

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