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# The Fibre Fineness of South African Merino Wool.

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## INTRODUCTION.

MERINO Wool is characterized by fibre fineness. In a survey of the world's wool, published by the Empire Marketing Board (1932), the report differentiates three main types: Merino, Crossbred and Carpet, the basic distinction depending on fibre fineness. It was also shown that Merino wool has the largest range of quality numbers with limits from 60's to 100's, that Crossbreds range from 36's to 58's and Carpet from 22's to 34's.

Several workers have used fibre fineness for classifying the different quality numbers of Merino wool. (Duerden, 1929; Winson, 1931; Plail, 1930; Dantzer and Roehrich, 1931; Barker and Winson, 1931, *et alia*).

Different authors have used different systems for expressing fibre fineness. Some have adopted fibre thickness or fibre width, others have used the weight-length method.

Fibre fineness and quality numbers of South African Merino wool form the subject of the present study. The method of measurement and the standards for classification are those established by Duerden (1929), who included the range from 60's to 100's as well as a 120's and a 150's, since some Merino wools are finer than 100's quality number.

The micro-camera projection method for measuring fineness which has been adopted has definite advantages over other methods such as the Gravimetric (Roberts, 1927) or the Diffraction Method (Duerden, 1929), in that it demonstrates the fibre variability within the sample, an important wool factor (Barker, 1931) and is a quick and ready method for routine analysis. In addition to fibre fineness an analysis is given of fibre variability, crimping and the coefficients of correlation.

## MATERIAL.

South African Merino wool is produced under very varying conditions, and a representative selection needs to be based on a large number of samples so that this is taken into account. In the present study the collection consists of one thousand wool samples obtained from woolmen at the coastal ports and from South African wool farmers. The material is in the form of small and large wool samples and many represent an average selection from bales and clips. There are included wools grown under droughty conditions and in seasons of plenty; Karroo grown and Grassveld grown, and wools from all the four provinces of the Union of South Africa.

In a recent publication (Bosman and Botha, 1933), the authors describe an analysis of stud ram wool from leading Merino stud breeders in South Africa. It was shown that ram wool requires different standards of classification from the general commercial clips. The proportion of wool of this type in the Union's wool has been estimated by sheep officers as one to two per cent., and this is baled separately according to the standards of the National Wool Grower's Association. Ram wool is not included in the present study which only takes into account the general South African commercial clips.

## METHODS.

Individual samples were analysed for fibre fineness by the Camera method (Duerden, 1929). Fibre fineness is expressed as the mean fibre thickness or fibre width.

In order to obtain a representative mean thickness of the sample, a system of random sampling was used. This takes into account the variability of wool.

Each sample was divided into smaller lots and a random selection of staples taken from each, so that ultimately these consisted of 100 to 500 staples from the original sample, the number depending on the size of the sample. A wool strand was taken from each staple and all the strands were rolled together. These were further cut into small clippings at about eight to ten places along the staple length so as to average up any variability along the length of the staple (Duerden and Bosman, 1927).

The small clippings were mixed in ether until a mixture of uniform dispersion was obtained. The fibres were dried and mounted in Euparal for the measurement of 250 on a Zeiss Hegener Micro camera. As was shown by Duerden (1929), test measurements of different slides of the same sample prepared in the above manner revealed great consistency and the method is a reliable one for obtaining mean fibre thickness.

Experiments have also shown that the mean fibre fineness expressed as fibre width of a large number of fibres does not differ materially from results obtained by using the cross-sectional area method, or the gravimetric method.

The determination of fibre fineness by the Camera method has given the frequencies of fibre thickness. It was thus possible to obtain the standard deviation and the coefficient of variability of each of the thousand samples.

## EXPERIMENTAL RESULTS.

### 1. Fibre Thickness and Distribution.

One quarter of a million fibres were measured for the study which is based on a random selection of South African Merino wool. The grouping of the fibre measurements according to class intervals of $2 \cdot 5\mu$ is shown in Table 1, where the frequencies and percentage frequencies are given in the second and third columns.

TABLE 1.—FIBRE DISTRIBUTION OF SOUTH AFRICAN MERINO WOOL.

| Fibre Thickness in $\mu$. | Frequency. | Per cent. Frequency. |
|---|---|---|
| 7·5 | 330 | ·13 |
| 10·0 | 5,013 | ·20 |
| 12·5 | 23,869 | 9·48 |
| 15·0 | 40,737 | 16·18 (83 per cent.) |
| 17·5 | 62,082 | 24·66 |
| 20·0 | 51,882 | 20·61 |
| 22·5 | 29,325 | 11·65 |
| 25·0 | 19,524 | 7·76 |
| 27·5 | 8,350 | 3·32 |
| 30·0 | 4,943 | 1·96 |
| 32·5 | 2,963 | 1·18 |
| 35·0 | 1,228 | ·49 |
| 37·5 | 853 | ·34 (16 per cent.) |
| 40·0 | 245 | ·10 |
| 42·5 | 178 | ·07 |
| 45·0 | 84 | ·03 |
| 47·5 | 82 | ·03 |
| 50·0 | 62 | ·02 |
| | Total 251,750 | |

It is of interest to note that the finest fibres measure 7·5$\mu$ and the coarsest 50$\mu$. Eighty-three per cent. of the fibres range from 7·5$\mu$ to 22·5$\mu$ and the remaining sixteen per cent. have their limits between 25$\mu$ and 50$\mu$. The latter limits are coarser than a 60's quality number and not strictly classified as Merino.

The mean fibre thickness of all the fibres is 19·11$\mu$ or a 66's quality number. The standard deviation is 4·868$\mu$ and the coefficient of variability 25·5 per cent. The frequencies of the table are represented graphically in Figure 1.

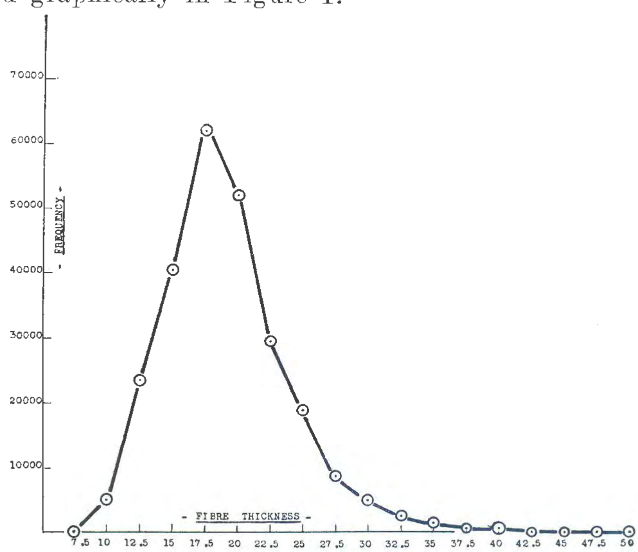


Fig. 1. Frequency distribution of a quarter million South African Merino wool fibres arranged in classes according to fibre thickness.

The mode at $17 \cdot 5\mu$ shows a frequency of 24·6 per cent.

### Quality Numbers of Individual Samples.

The frequencies and percentage frequencies of the quality numbers are summarized in Table 2.

Table 2.—Quality Numbers of South African Merino Wool.

| Quality Number. | Frequency. | Per cent. Frequency. |
|---|---|---|
| 150's | 57 | 5·7 (92 per cent.) |
| 120's | 58 | 5·7 |
| 100's | 49 | 4·9 |
| 90's | 96 | 9·5 |
| 80's | 133 | 13·2 |
| 70's | 166 | 16·5 |
| 66's | 159 | 15·8 |
| 64's | 127 | 12·6 |
| 60's | 79 | 7·8 |
| 58's | 50 | 5·0 (8 per cent.) |
| 56's | 26 | 2·6 |
| 54's | 7 | 0·7 |
| | Total 1,007 | |

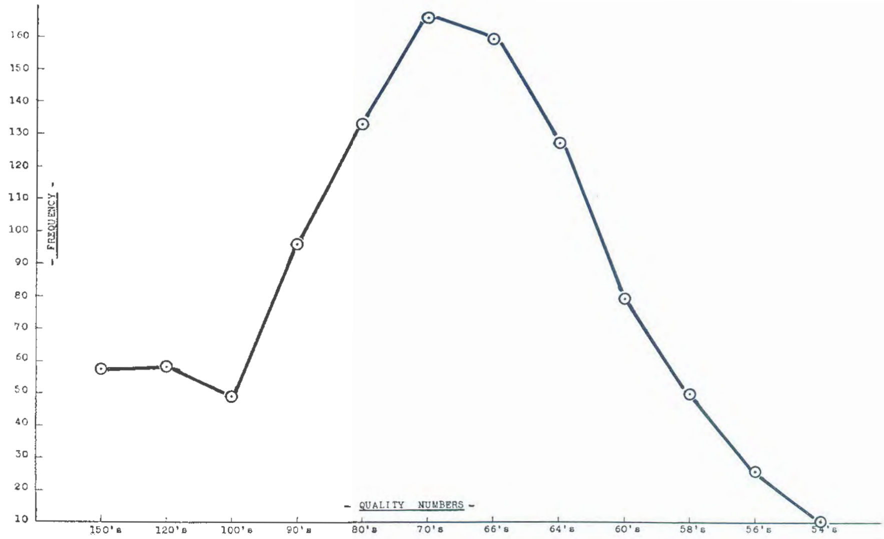


Fig. 2.—Frequency distribution of one thousand Merino wool samples arranged in classes according to quality numbers.

The percentage frequencies show that 92 per cent. of the samples fall strictly within Merino quality numbers. Eight per cent. is coarser and is classed as cross-bred. It may be noted that 25·8 per cent. range from 90's to 150's. These include wools grown under droughty conditions and a portion of the samples are tender. Many have sufficient tensile strength to be passed as " sound ". It is, therefore, demonstrated that the South African Merino clip includes a small proportion of superfine wools that conform to a fineness of 90's to 150's.

When classification is based on the fineness types adopted by the National Wool Growers' Association and classed as " Strong ", " Medium ", and " Fine " Merino then approximately eight per cent. are strong of 60's quality number, twenty-eight per cent. are medium with a 64's to 66's, and fifty-five per cent. are fine, and consist of 70's quality number and finer. Eight per cent. are cross-bred.

The frequencies in Table 2 are shown graphically in Figure 2.

## Variability.

Uniformity is an important wool attribute to the textile manufacturer. Several authors have made reference to its value. (Roberts, 1930; Barker, 1929, *et alia.*) Barker (1931) asserts that " it is not only the average fineness of a sample and its frequency distribution, but also its coefficient of variation within the sample, that is of supreme importance ".

The fibre variability of the South African Merino samples, expressed as coefficient of variability, is summarized in Table 3. The coefficient of variability arranged in class intervals that differ by two per cent. is given in the first column of the table. The frequency and percentage frequency are shown in the second and third columns.

Table 3.—Coefficient of Variability.

| Coefficient of Variability (per cent.) | Frequency. | Per cent. Frequency. | |
|---|---|---|---|
| 10–12 | 5 | ·5 | 10·8 |
| 12–14 | 20 | 2·0 | |
| 14–16 | 84 | 8·3 | |
| 16–18 | 179 | 17·8 | 79·0 |
| 18–20 | 289 | 28·7 | |
| 20–22 | 195 | 19·4 | |
| 22–24 | 132 | 13·1 | |
| 24–26 | 70 | 6·9 | 10·4 |
| 26–28 | 21 | 2·1 | |
| 28–30 | 7 | ·7 | |
| 30–32 | 7 | ·7 | |
| Total | 1,007 | | |

As regards coefficient of variability it is shown that the samples have a range from 10 to 32 per cent. Approximately 79 per cent. range from sixteen to twenty-four per cent. coefficient of variability. Eleven per cent. are more uniform with ten to sixteen per cent. coefficient of variability. Ten per cent. are more variable with values from 24 to 32 per cent. coefficient of variability.

The frequencies of the coefficients of variability are given graphically in Figure 3.

## Correlations: Fibre Fineness and Crimps.

In wool buying and selling practice, crimping is often used as an aid to estimate fibre fineness or quality number. It is held that fibre fineness is associated with size of crimps or number of crimps per inch.

Several workers have investigated the relationship between fibre fineness and crimping.

Davenport and Ritzman (1926) found no significant correlation between the two factors.

Duerden (1929), showed an agreement between the two characteristics when the wools were not impoverished and not associated with skin folds. On well grown wools definite standards for crimping and fibre fineness were established.

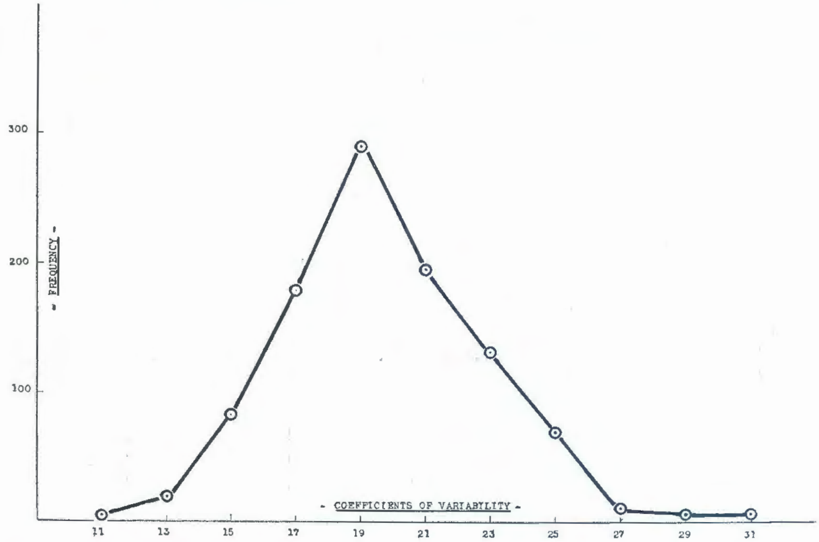


Fig. 3.—Frequency distribution of one thousand Merino wool samples arranged in classes according to co-efficients of variability.

Reimers and Swart (1929; 1931), showed that no definite relationship between average fibre diameter and crimping existed.

Hultz and Paschal (1930) found an insignificant negative correlation between crimp and fibre diameter in wool studies on Rambouillet sheep.

Bosman and Botha (1933) in their work on shoulder samples from Merino stud rams found a negative correlation coefficient between crimping and fibre fineness which was definite though not high.

In the present study the relationship of the characteristics of fibre fineness and crimping are compared. The study is based on samples that include droughty and well grown wools, those from skin folds and on different regions of the body of the sheep. Ram wool is, however, excluded as this type is usually baled separately from the general clips.

The coefficient of correlation between crimps and fibre fineness on 340 samples selected at random from the 1,000 available for study, is given as $-\cdot617 \pm \cdot0226$. This indicates a definite correlation, although not a perfect one. In general fine fibred wools have more crimps per inch than coarse fibred ones.

Although a very general relationship between the two characteristics exists the number of perfect agreements obtained on individual determinations is not high. In the study it is shown that:—

121 samples or 36 per cent. are coarser in fineness than the crimps indicate.

93 samples or 28 per cent. show absolute agreement in both standards.

120 samples or 36 per cent. are finer in fibre thickness than the crimps indicate.

Of the 121 samples that were coarser in fibre thickness than the crimps showed, 60 were coarser by one quality; 39 by two qualities and 22 by more than two qualities.

Of the 120 samples that showed a finer fibre thickness than the crimps indicated, 56 were finer by one quality, 43 by two qualities and 21 by more than two quality numbers.

### Fibre Fineness and Coefficient of Variability.

The coefficient of correlation between fibre fineness and coefficient of variability was $-\cdot0754 \pm \cdot0217$ which shows no significant correlation between the two factors. When coefficient of variability is taken as the measure of uniformity then fine wools have the same degree of variability as coarse wools. This result confirms that obtained by Bosman and Botha on Stud Ram Wool (1933).

## DISCUSSION.

The study demonstrates fundamental characteristics of South African Merino wool, which as a raw material forms the major pastoral product of the Union.

Eighty per cent. of South African Merino wool fibres measure from $12\cdot5\mu$ to $22\cdot5\mu$ and this fineness can be regarded as characteristic of the bulk of the South African wool clip.

As regards quality number, eighty per cent. of the samples conform to the Merino quality numbers of 60's to 100's. Eleven per cent. are finer than 100's and are classed as 120's to 150's. The superfine wools are presumed to be the result of droughts and are produced under adverse conditions of feeding. Experimentally it has been shown that lack of nutrition produces this extreme fineness (Maré and Bosman, 1934). Eight per cent. are cross-breds and are coarser than Merino wool.

In the study, fibre fineness is regarded as the basis for classification into the fineness types. The other wool attributes of length, tensile strength, etc., that influence the actual spinning power of wool are regarded as qualifying factors to fineness.

The coefficient of variability of fibre thickness ranges from 10 per cent. to 32 per cent. The bulk or 79 per cent. of the samples conform to a coefficient of variability of 16 per cent. to 24 per cent. There is no significant correlation between coefficient of variability and fibre fineness which demonstrates that coarse wools and fine wools are of equal magnitude as regards variability when coefficient of variability is the measure.

The coefficient of correlation between fibre fineness and crimping is a controversial topic among research workers. Some find an insignificant coefficient of correlation, others find the relationship definite. In general it appears that the workers who established a correlation took into account selected material such as well grown wools away from skin folds or shoulder samples of stud ram wools. The present study shows that where a large number of South African Merino samples are considered which include well grown wools, droughty wools, wools from skin folds, and from different regions of the sheep, a definite coefficient of correlation is established, though not a high one. In general, size or number of crimps per inch indicates coarseness or fineness in the wool fibres. The accuracy with which exact agreement between quality numbers on crimps and quality number on fibre fineness can be established is doubtful and crimping alone is a poor guide for estimating quality number. It is shown that only 28 per cent. of the samples have a perfect agreement between crimping and fibre fineness. Seventy-two per cent. may be out in the agreement of the two standards, some even to the extent of two to three qualities. Accurate estimations for quality number must, therefore, take into account fibre fineness rather than crimps. In the finer qualities of 80's and above an estimate of fibre fineness by hand and eye is often more difficult than in the case of the coarser Merino qualities and instances are recorded where the practical man has had to resort to laboratory analysis for an estimation of the finer Merino qualities.

The method of measurement of fibre fineness by the projection camera has been used by several workers. In the present study it was found preferable to gravimetric methods in that it supplied the analysis of fibre variability within the sample, and is a quick and ready method. Moreover, the mean fibre thickness obtained by the Camera method does not differ very appreciably from the results obtained by the gravimetric method. When a large number of estimations are necessary such as is often required in sheep experiments and routine analyses, the projection method was found preferable and has been used advantageously.

## SUMMARY.

An anlysis of one thousand South African Merino wool samples selected at random and involving the measurement of a quarter of a million fibres is described and fundamental characteristics are demonstrated.

Fibre thickness ranges from $7 \cdot 5\mu$ to $50\mu$. The bulk, or eighty per cent. of the fibres measure from $12 \cdot 5\mu$ to $22 \cdot 5\mu$.

Eighty per cent. of the samples conform to the quality numbers of 60's to 100's. Eleven per cent. are 120's to 150's and it is suggested that these are "hunger fine" and presumably influenced by adverse conditions of nutrition. Eight per cent. are cross-bred and are coarser than Merino quality numbers.

As regards coefficient of variability, South African Merino wool ranges from 10 per cent. to 32 per cent. Seventy-nine per cent. of the samples conform to a variability of sixteen to twenty-four per cent. coefficient of variability.

The coefficient of correlation between fibre finess and coefficient of variability is given as $-\cdot 0754 \pm \cdot 0217$ and indicates an insignificant correlation.

The coefficient of correlation between fibre fineness and crimping is given as $-\cdot 617 \pm \cdot 0226$, which shows a definite correlation, though not a high one.

Twenty-eight per cent. of the samples show a perfect agreement between the quality numbers of fibre fineness and those of crimps.

The woolman who judges fibre fineness on crimps may err in seventy-two per cent. of his judgments by one, two or even three quality numbers.

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