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**Relationship of Initial Wool Fineness,
Medullation, and Variability
To Quality of the Mature Fleece**

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College of Agriculture

**About
This
Research**

The research reported in this bulletin was conducted at the U.S. Sheep Experiment Station, Dubois, an agency of the Animal Science Research Division, ARS, USDA, in cooperation with the University of Idaho Agricultural Experiment Station. Lowell O. Wilson is research fiber technologist, ARS, USDA, headquartered at this station.

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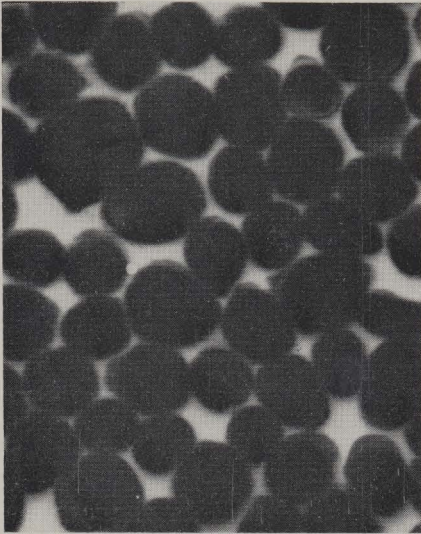
Summary

Two groups of Columbia ewes were studied to compare weanling and yearling wool traits with future wool production, and to compare wool traits and processing characteristics between groups. The wool on one group of weanling ewes graded 56's or coarser and contained coarse hair-like fibers. The wool on the other group of weanling ewes graded 56's or finer and was of a uniform quality.

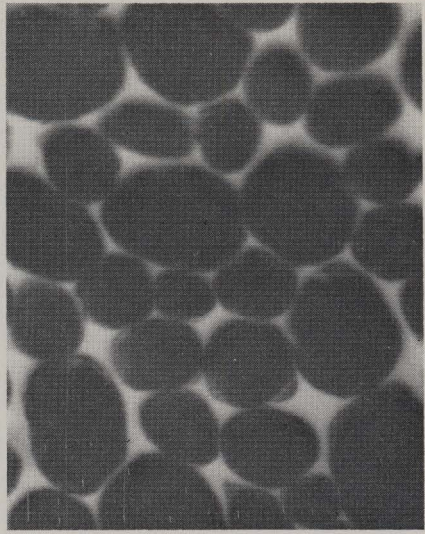
Quantity and quality of fleece production by the coarse wool ewes were measured each year over a 4-year period. Yearling and mature wool production was compared for wool traits and processing characteristics. The fleeces from the coarse wool ewes were coarser, heavier, and more variable than fleeces from the finer wool ewes. Individual fleeces from the coarse wool ewes were borderline or would not meet quality standards for the Columbia breed. The ewes from the finer wool group produced fleeces that conformed with the wool requirements of the Columbia breed.

Fiber diameter increased each year. The number of crimps per inch decreased from the first to the fourth fleece. Staple length showed very little change. The coarse wool had fewer crimps per inch, more medullated fibers, and longer staple length than the finer wool.

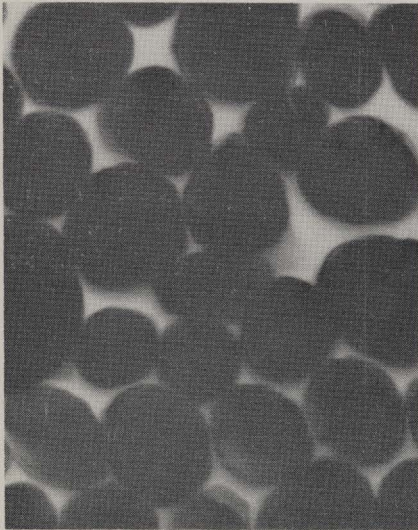
Grease wool, clean wool, and top weight increased each year for the first three years and decreased slightly the fourth year. The coarse wool had higher percent clean wool, card sliver, and top yields, and higher top to noil ratio than the finer wool.



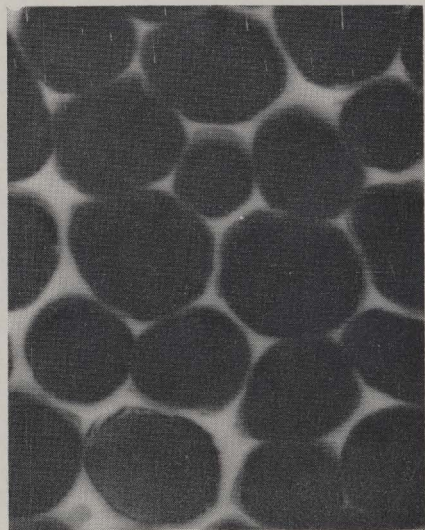
Fine



1/2 Blood



1/4 Blood



3/8 Blood

Fig. 1. Cross-sections of the four major grades of apparel wool, magnified 500 times. Grade characteristics are:

Blood grade	Spinning count	Micron range
Fine	70/64's	19.2 - 22.0
1/2 Blood	62/60's	22.1 - 24.9
3/8 Blood	58/56's	25.0 - 27.8
1/4 Blood	54/50's	27.9 - 30.9

Relationship of Initial Wool Fineness, Medullation, and Variability To Quality of the Mature Fleece

Lowell O. Wilson

Some Columbia weanling (120 days) lambs have coarse hair-like and/or medullated fibers in their fleeces while others are free of such fibers. All true wool fibers have not been completely developed at this early age nor have the lamb hairs and medullated fibers present in the birth coat been entirely eliminated (Dry, 1933; Pohle et al., 1945; Grandstaff et al., 1947).

Lambs that have coarse hair-like fibers usually have wool of very long staple length. This gives them the appearance of superiority in body weight, type, and condition which increases the likelihood they will be selected as replacements in a breeding flock. The yearling fleeces from this type lamb are usually coarser and/or more variable than recommended by the Columbia Breed Association.

Lambert et al. (1938), Pohle (1942), and others have studied relationships between weanling and yearling fleece characteristics in range sheep. Terrill and Kyle (1953) and Kyle and Terrill (1953) showed significant repeatabilities for side grade, britch grade, and staple length for Columbia sheep at weanling and yearling ages. They showed significant correlations among yearling traits for fleece diameter and grease fleece weight, variability of diameter, diameter grade, fleece grade, side grade, britch grade, and staple length.

This study was conducted (a) to determine if Columbia lambs with coarse hair-like and/or medullated fibers in their fleeces at weanling age would meet the standards of the Columbia Sheep Breed Association (1966) by yearling age; (b) to determine any change in wool traits that might occur from one fleece to the next as the sheep grew older; and (c) to determine relationships of quality traits and processing characteristics of this type of wool.

Materials and Methods

Two groups of Columbia ewes were studied over a four-year period. One group of 24 weanling ewe lambs had coarse hair-like fleeces which visually graded 56's or coarser. This study group is referred to as coarse wool ewes. A second group of 24 Columbia ewes from the same age group with uniform 58's or finer yearling fleeces was selected later and is referred to as the finer wool group. The first four fleeces produced by the coarse wool ewes were measured in the grease, processed to top, and analyzed to determine relationships among wool traits of this type of wool. Changes in wool traits from one year to the next were determined. Similar measurements were made on the first and fourth fleeces produced by the finer wool ewes. Processing characteristics were observed for both the coarse and finer wool groups.

Laboratory methods for measuring quality traits were those given in the ASTM Standards on Textile Materials (1961) and those developed by Pohle (1941) and Pohle et al. (1947, 1951). The number of crimps per inch was determined by matching the crest of each crimp to a screw pitch gauge at a level of one third of the staple length from the base. The standard deviations reported for fineness and length are the means of standard deviations of fiber measurements obtained for each sample measured rather than the standard deviation among samples. Therefore, the variability referred to is that within a sample rather than that between samples.

The wool samples from the mid-side and thigh (below belly line) areas of the coarse wool ewes were measured for crimps per inch and staple length. The same side and thigh samples were individually scoured, blended by hand carding, and measured for fineness, variability, and medullation. Visual side and thigh wool grade and measured staple length (side area) were recorded at weanling age on both coarse and finer wool ewes. Other measurements and processing characteristics obtained on the four successive fleeces from the coarse wool ewes were compared with similar measurements where available on the first and fourth fleeces from the finer wool ewes.

More detailed estimates of fineness, number of crimps per inch, and staple length were obtained from multi-area sampling. One measure of fineness representing the entire fleece was obtained from a blended sample of three locks from each fleece — one each from the shoulder, back, and hip areas as described by Pohle and Schott (1943). A second estimate of fineness was obtained from an average of 10 locks from predetermined areas of each fleece. Number of crimps per inch and staple length were the average measurements of the 3 and 10 locks. These measurements were used for comparison of grease wool traits with similar top traits. Grease fleece weight, body weight, and visual fleece grade were recorded each year.

After the sample locks were taken each year, the 24 fleeces from the coarse wool ewes were randomly divided into 3 sublots containing 8

fleeces each for ease of processing. The fleeces produced by the finer wool ewes at 4 years of age were similarly divided into 3 sublots. Sublots of grease wool were scoured at the University of Wyoming Laboratory. The scoured wool was carded and French combed into top at the Philadelphia College of Textiles and Science. The card sliver was dry combed on the Prince Smith French Comb. The settings on this comb were: nippers 0.0248 mm; drawing off rollers 24 mm. The moisture level was approximately 12 to 15%. Top samples were analyzed to determine fiber length, fineness, and variability. Noils were measured for fineness (ASTM Standards, D-2130-1961). Weights of clean wool, card sliver, top, noil, and waste were obtained.

Results and Discussion

Wool Traits

Side and thigh wool from the coarse wool ewes at yearling age were finer than the wool at weanling age by 1.5 and 1.6 microns, respectively. Side wool from the coarse wool weanling lamb contained 2.1% medullated fibers, but they had disappeared by yearling age. Thigh wool from the coarse wool weanling lamb contained 28.8% medullated fibers. This decreased to 6.8% at yearling age and to a level of 2.1 to 2.6% in subsequent fleeces. No medullated fleeces were observed in the fleeces from the finer wool ewes (USDA, 1961).

The means of fleece measurements from first year fleeces and fourth year fleeces of the coarse and finer wool ewes are shown in Table 1. The mean fiber diameter increased by 1.9 microns in the coarse wool ewes from the first to the fourth year fleeces and by 1.7 microns in the finer wool ewes.

Table 1. Means of fleece measurement.

Trait	Unit	Coarse wool ewes		Finer wool ewes	
		1st fleece	4th fleece	1st fleece	4th fleece
Three locks					
Shoulder, back, hip					
Fineness	micron	29.5	31.4	24.3	26.0
SD (Standard deviation).....	micron	6.4	7.5	4.7	5.3
Crimp	per inch	7.2	6.1	10.2	9.3
Staple length	inch	4.1	4.2	3.4	3.5
Single Measurements					
Side fineness	micron	29.1	30.9	24.0	25.9
Side SD	micron	6.2	7.3	4.4	5.0
Thigh fineness.....	micron	32.1	33.7	26.3	27.6
Thigh SD.....	micron	7.4	8.4	5.5	6.0
Grease fleece wt.....	lb.	10.4	12.9	9.2	11.5
Shearing grade	code ^a	8.0	8.3	4.3	4.9

^a62's = 3, 60's = 4, 58's = 5, 56's = 6, 54's = 7, 50's = 8, 48's = 9.

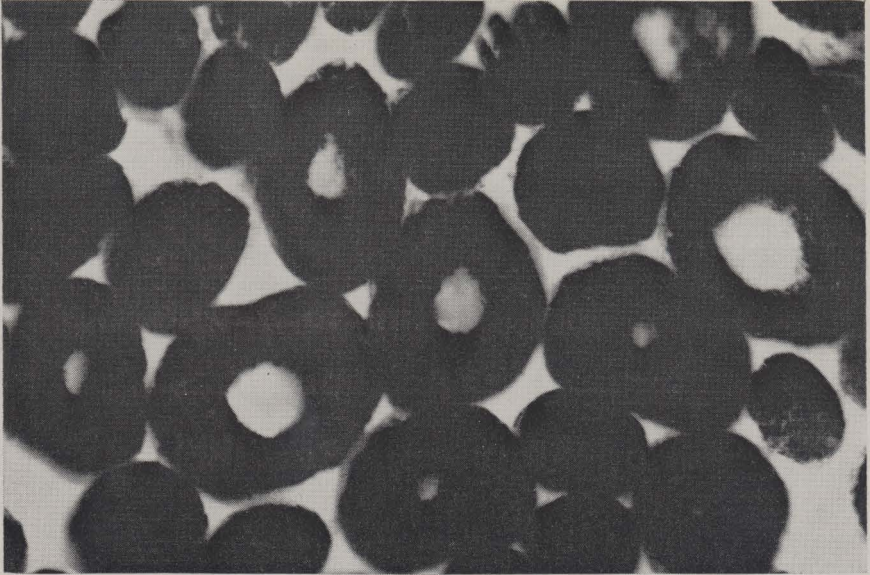


Fig. 2. Cross section (500X) of wool showing medullated fibers. The presence of medullated fibers in apparel wool is detrimental to quality from the standpoint of the manufacturer. Medullated fibers are hair-like, void of crimp, lustrous, and usually coarser than the wool fiber. The spinning properties are lowered and dyeing effect is a lighter shade than true wool fiber. This cross section shows variable fibers with a spinning count of 48's and average fiber diameter of 32.3 microns with 20% of the fibers medullated.

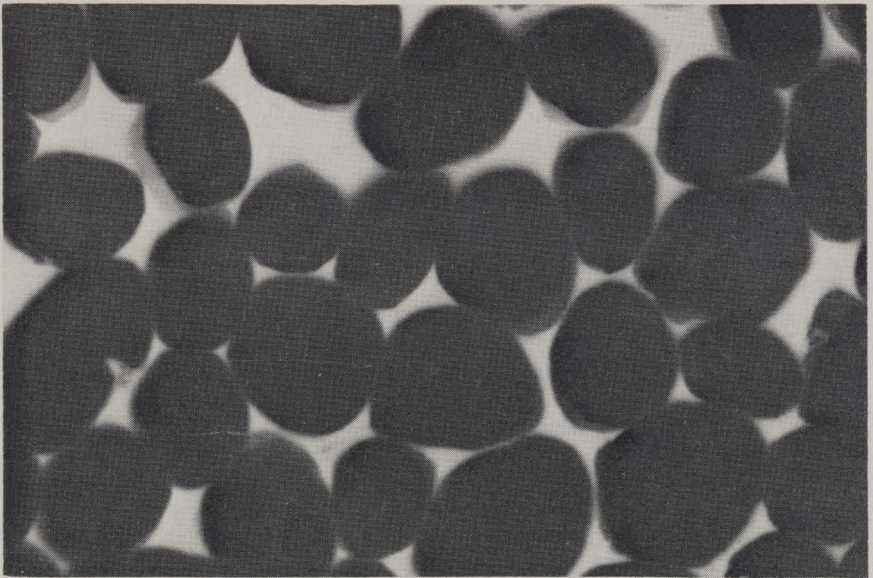


Fig. 3. Cross section (500X) of wool showing the various shapes and sizes of fairly uniform fibers with a spinning count grade of 46's and average fiber diameter of 34.2 microns.

Variability of fineness was higher in the thigh wool than in the side wool for both the coarse and finer wool ewes. The staple length of both the first and fourth fleece from the coarse wool ewes was 0.7 inch longer than the comparable staple lengths of the finer wool ewes. The fourth fleece had 0.1 inch longer staple than the first fleece for both the coarse and finer wool ewes. The grease fleece weight increased 2.5 and 2.3 pounds from the first year to fourth year fleeces in the coarse and finer wool ewes, respectively.

It was not possible to separate age of ewe and year effect in these data. However, average clean fleece weight and body weight by wool grade were similar for all ewes maintained at this station during these four years. Clean wool yields in Table 2 also indicate that yearly environmental influences were relatively unimportant.

Processing Grease Wool to Top and Noil

The processing data of sublots from each group of fleeces were so nearly alike each year that the results were combined for this report (USDA, 1961). Processing results of the combined sublots are shown in Table 2. Grease wool, clean wool, card sliver, and top increased in weight each year for the first three years and decreased in weight the fourth year. Percent clean wool, card sliver, and top each year showed very little change among the four years.

The proportion of noil to top and noil from the fourth fleece was 2% less for the coarse wool than for the finer wool. Coarse wool had a top-to-noil ratio of 15:1 compared to an 11:1 ratio for the finer wool. The noil was 16.1% (5.1 microns) and 11.6% (3.1 microns) finer than the top

Table 2. Processing results of combined sublots.

Item	Unit	Coarse wool ewes				Finer wool ewes
		1st fleece	2nd fleece	3rd fleece	4th fleece	4th fleece
Grease wt shearing	lb.	250.2	271.4	315.5	309.0	275.9
Clean wt (standard)	lb.	140.2	152.4	175.9	172.6	137.2
Yield of clean wool	%	56.0	56.2	55.8	55.9	49.7
Card weight ^a	lb.	135.1	148.5	166.5	165.7	128.8
Card/clean weight	%	96.4	97.4	94.7	96.0	93.9
Top weight ^a	lb.	122.2	137.5	159.2	156.3	120.6
Top/grease wool	%	48.8	50.7	50.5	50.6	43.7
Top/clean wool	%	87.2	90.2	90.5	90.6	87.9
Noil weight ^a	lb.	10.8	7.6	10.3	10.6	11.1
Noil/grease wool	%	4.3	2.8	3.3	3.4	4.0
Noil/clean wool	%	7.7	5.0	5.9	6.1	8.1
Noil/top and noil	%	8.1	5.2	6.1	6.4	8.4
Top to Noil	ratio	11:1	18:1	16:1	15:1	11:1
Waste	lb.	3.6	9.2	11.5	7.7	6.9
Loss or gain	lb.	-3.6	1.9	5.1	2.0	1.4

^a15% regain.

Table 3. Measurements of top and noil.

	Suter length			Cross section			Micronaire
	Avg length (inch)	SD (inch)	Coef var. (inch)	Avg diam (micron)	SD (micron)	Coef var. (%)	Avg diam (micron)
Coarse wool ewes							
1st Fleece	2.9	1.19	41.0	29.2	6.7	22.9	27.9
2nd Fleece	3.6	1.49	41.4	29.4	7.5	25.5	28.8
3rd Fleece	3.6	1.54	42.8	31.2	7.5	24.0	30.8
4th Fleece	3.7	1.45	39.2	31.7	7.5	23.7	30.9
Finer wool ewes							
4th Fleece	3.3	1.28	38.8	26.7	6.0	22.5	26.5
Coarse wool ewes				Noil^a			
1st Fleece				25.0	6.2	24.8	25.4
2nd Fleece				25.3	6.3	24.9	25.1
3rd Fleece				26.7	5.9	22.1	26.6
4th Fleece				26.6	6.3	23.7	26.1
Finer wool ewes							
4th Fleece				23.6	5.5	23.3	24.0

^aNoil is not measured for length.

Table 4. Correlations and regressions of fleece traits with age on the coarse wool ewes.

Trait	r	b
Three locks		
Shoulder, back, hip		
Fineness .....	.51**	.70**
SD (standard deviation) .....	.38**	.28**
Crimp per inch	-.20*	-.10*
Staple length	-.15	-.02
Single Measurements		
Side fineness .....	.43**	.62**
Side SD .....	.34**	.26**
Thigh fineness .....	.32**	.51**
Thigh SD .....	.19*	.18*
Gr. fleece weight .....	.54**	.42**
Shear grade code ^a .....	.01	.05

*Significant at the 0.05 level.

**Significant at the 0.01 level.

^aSee footnote table 1.

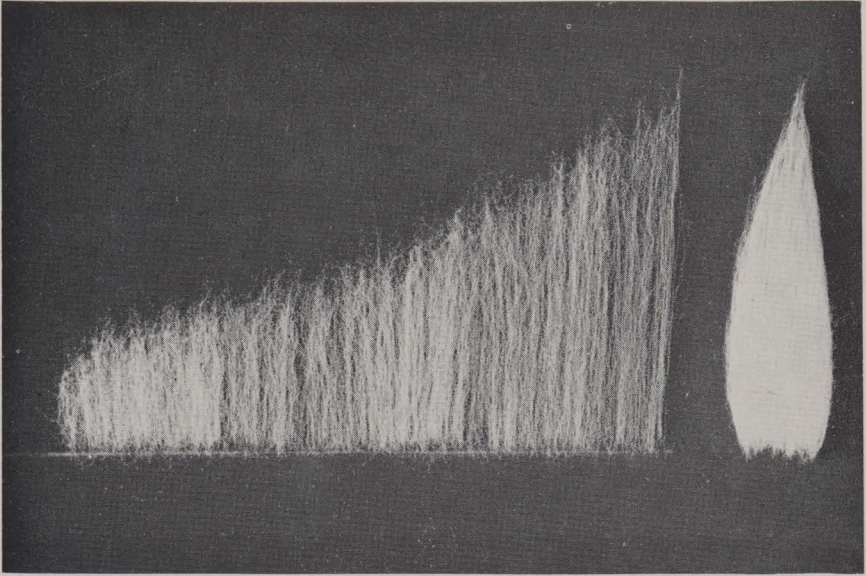


Fig. 4. The length of wool fibers is an important quality factor in wool processing. Fiber length is highly variable among different breeds of sheep and even on the same animal. A stapling machine (Suter Stapler) is capable of segregating fibers into quarter-inch length groups for calculating average fiber length of wool top.

from the coarse and finer wool, respectively. Top from the coarse and finer wool was 0.3 and 0.7 microns coarser than the grease wool from which it was combed. Fiber length of top was shorter for both the coarse and finer wool than the staple length of the respective grease wools. Top was measured for fineness by cross section and micronaire methods. Top length from the Suter apparatus and fineness results from the cross section method and micronaire instrument are reported in Table 3.

Correlation and regression coefficients for various fleece measurements on the coarse wool ewes are shown in Table 4. Significant correlations were shown for all fleece traits studied on age except staple length and shearing grade code. Fiber fineness and variability of fineness of the coarse wool ewes increased with age by 0.7 and 0.3 microns ($P \leq .01$) per year, respectively. Grease fleece weight for the coarse wool ewes increased with age 0.8 pound ($P \leq .01$) per year.

Wool Standards for Columbia Sheep

At yearling age, 18 of the 24 coarse wool ewes failed to meet wool requirements of the Standard of Excellence for registration by the Columbia Sheep Breeders Association of America (1966). Standard of Excellence requirements that these ewes failed to meet are: "More than two grades of wool on same sheep or medullated fibers," and "Wool coarser than 50-54's except on lower thigh which may be 48's if body fleece is 50-54's." All 24 finer wool ewes met these wool requirements.

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