2

THE ROLE OF OBJECTIVE MEASUREMENTS IN WOOL RESEARCH AND MARKETING[1,2]

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Abstract

A high proportion of U.S. wool is sold with most of the important price determining characteristics (yield, diameter, length and strength) subjectively assessed by the wool buyer. From a theoretical standpoint, it is possible to objectively measure most of these important characteristics. The entire U.S. industry (sheep producers, warehousemen, wool buyers, and textile manufacturers) should benefit from the increased application of objective measurements in developing selection, nutrition and management programs for flocks as well as when wool is tested prior to sale. Australia, New Zealand and South Africa utilize objective measurement technology in producing and marketing their wools. To increase and subsequently maintain momentum for presale objective measurements of grease wool in the U.S., it will be necessary to gain consensus between all segments of the industry including producers, warehousemen, wool co-operative managers, commercial fiber testing businesses, wool buyers, and wool processors. Ultimately the application of this technology as a production and marketing tool will be achieved only when the industry is willing to take advantage of it.

Introduction

An objective measurement is an assessment made without distortion by personal feelings or prejudice. Therefore, it is a measurement that can only be accomplished through the use of an instrument. Everyday examples include metering of gasoline, weighing of meat and produce at the supermarket and measurement of length with a ruler or tape measure. In contrast, visual or subjective methods are based on training and experience and were used in the development of this country's first official standards for grades of raw, greasy wool in 1923. The basis for these standards was (and still is) fineness or average fiber diameter. It was not until 1935 that the American Society for Testing Materials (ASTM) issued a tentative objective method of test for fineness of wool. Core testing of greasy wool for yield commenced on a significant scale in 1938 when the U.S. Customs Department first started coring wool for assessment of tariff duties. By 1960, most of the major test methods required to establish the quality and value of grease wool were in place. The U.S. led the world in establishing standard methods for core sampling, yield determination, diameter, staple length, and crimp. In time, such prestigious groups as the International Standards Organization, the International Wool Textile Organization (IWTO) and national organizations in Europe, Africa and Australia were to base standard methods on the U.S. prototypes. Scientists such as E.M. Pohle, W. von Bergen, D.D. Johnston, H.R. Keller, W.A. Mueller, H.D. Ray and H.C. Reals were publishing such authoritative works as, "Value-determining physical properties and characteristics of domestic wools" (Pohle, et al., 1958), and "Physical measurements and their application in describing wool" (Johnston, et al., 1958). Their conclusions concerning production, marketing and manufacturing of wool are as applicable today as they were in the 50's.

So far as the worsted processing industry is concerned, fiber, staple and fleece characteristics have the significance illustrated in Table 1 (Specialist Working Group, 1978).

Table 1. Significance of Wool Characteristics

MAJOR	1.	Yield (including quantity and type of vegetable matter)
		Average fiber diameter
		Average staple length
		Staple strength and position of break
		Color/colored fibers
SECONDARY	2.	Variability of fiber diameter
		Variability of staple length
		Cots (felted fibers)
		Crimp (resistance to compression)
MINOR	3.	Weathered tips
		Age/breed/type
		Style/character/handle

A high proportion of U.S. wool is sold with most of these parameters subjectively assessed by the wool buyer. It is often necessary for the textile mill to reinforce the buyers' estimates with objective measurements prior to processing. In contrast, many pounds of wool are now sold in the U.S. after being sampled and tested for yield and fiber diameter. From a theoretical standpoint, it is

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possible to objectively measure most of the listed characteristics. Cots and the minor category being the exceptions at this time.

Objective Measurement. Objective methods that are available today for establishing the quality and value of grease wool are reviewed as follows.

Coring. Portable, electric coring tools having two-inch or half-inch diameter tubes are probably the most commonly used in the U.S. today. Typically, two-inch coring tools are used to sample bags or bales of wool at the warehouse and mill. At the commercial testing lab, the two inch cores are normally subsampled using a coring machine fitted with half inch tubes. The half-inch core samples are then used in yield and diameter determinations. From an economic viewpoint, it is difficult to justify core testing of small clips to enhance saleability. Nevertheless, information gained from this exercise is invaluable for quality control and maintenance of sound breeding programs.

Many overseas storage complexes and wool textile mills throughout the world are using specially designed coring machines for sampling wool bales. The role of correct sampling procedures cannot be overstated since this is the key to obtaining meaningful objective measurements.

Yield. This standard has changed little since its introduction. Basically, the method involved scouring wool core samples in hot, soapy water followed by determinations of residual grease, inorganic ash and vegetable content on the dried, scoured wool. Subsequently, "Wool Base" (or pure, oven-dry wool) is converted to a value known as "Clean Wool Fiber Present" by dividing with a factor of 0.86. This is the factor required to adjust the wool base to a moisture content of 12%, an alcohol-extractives content of 1.5% and a mineral matter content of 0.5%. Although this latter is standard procedure in the U.S., such is not the case elsewhere. This and other U.S.-specific practices will be the subject of further comment later in this report.

Numerous attempts to speed up or circumvent this tedious method using modern technology have been described in the literature. One technique with some promise is near infrared reflectance spectroscopy. (Connell, 1983). To date, a suitable replacement has not been established.

Diameter. A microprojection technique for determining average diameter has been the international industry standard for many years. In the ASTM method, short longitudinal sections are projected onto a screen using standard magnification of 500X. The widths of the projected images are measured using a standard wedge card. This method allows for calculation of both an average and a measure of variability of diameter, that is, the standard deviation of diameter. Using the wedge card technique, a good technician can measure 200 fibers in about 20 minutes. In order to obtain ± 0.2 m confidence limits of the mean at the 95% probability level when measuring 64's wool, it is necessary to measure 2401 fibers. For 50's wool, this number increases up to 6146. Consequently, obtaining data in this way is an expensive and relatively slow proposition.

Several U.S. institutions are experimenting with instruments, for example, the sonic digitizing device, that could replace the wedge card and allow for more rapid measurement. At this time, none of the innovative techniques have been accepted into standard methods.

Ultrasound and image analysis techniques have been used to measure the diameter of wool with varying degrees of success. ASTM D3510 describes a technique that utilizes a PiMc Particle Measurement Computer System. Unfortunately, this instrument is now obsolete and the method will be discontinued. Nevertheless, several research groups including the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia are further developing image analysis techniques. The technology shows distinct promise for enhancing the speed with which fiber diameter can be measured and is predicted to be commercially available in the (relative) short term.

For many purposes, a knowledge of the variability of diameter is not required. In such cases, air flow instruments have made a tremendous contribution. Three versions that have been used in the U.S. include the Micronaire, Port-Ar and WIRA instruments. These instruments require sample sizes of 4.8, 12.5 and 2.5 g, respectively, of scoured, well-blended, conditioned wool. The actual measurement of average diameter takes less than a minute. Sample preparation takes longer.

For many years, there has been a need for an instrument capable of rapid and accurate measurement of fiber diameter and distribution. This need has been met to a large extent by the introduction of the CSIRO Fiber Fineness Distribution Analyzer and its commercial counterpart, the Peyer Texlab FDA200 System. These instruments undoubtedly represent the most innovative concept for determining animal fiber fineness parameters since the introduction of projection microscopy for this purpose. The electro-optical technique is capable of measuring 2000 fibers, calculating a mean, standard deviation and coefficient of variation and printing this information together with a histogram all in the space of three minutes. Probably because of the high price ($47,500) only three of these instruments are present in the U.S. One is in the Texas Agricultural Experiment Station Wool and Mohair Research Lab in San Angelo, another is at the Burlington plant in Clarksville, VA, and the third is in the sales office of Peyer Corporation in Spartanburg, NC. Approximately 30 of these instruments are operating throughout the world.

For various technical reasons, this instrument has not yet been accepted for use in any standard method. Acceptance for an IWTO standard is anticipated eventually.

This instrument is expected to make a major contribution, particularly in those research and quality control applications where a knowledge of diameter distribution is necessary e.g., selective breeding studies with sheep.

Length. The length of wool fibers determines primarily which system may be used to spin the fibers into yarn, i.e., the worsted, woolen and short-staple (or cotton) systems.

A highly significant linear relationship exists between the staple length of sound wools and mean fiber length in top. Fiber length in top has a major influence on spinning speeds, yarn count and yarn quality. Thus, mean staple length is another important parameter to measure. The technique recommended by ASTM is simple, accurate and slow and requires only a rule for measurement and a pencil for recording.

By 1964, researchers with the U.S. Department of Agriculture had managed to speed up the process using a semi-automatic "Staple Length Recorder," a device in which each staple was fed through a slot onto a moving belt and past a light beam (Roy, et al., 1964). When this beam was interrupted by a staple, electronic pulses in units of 1/10 inch of staple length were counted. The device was not fast but it contained the basic ideas found in present designs, none of which have yet managed to qualify for entry into an ASTM standard.

Strength. Wool fiber strength is a major factor in the strength of yarns. It also has an important effect on the percentage of noils formed and mean fiber length in top-making. This is particularly true if there is a weakness in the staple due to nutritional or health factors. The position of the weakness along the staple is also important. ASTM methods of tensile testing grease wool do not indicate position of break.

Current state of the art in staple length/strength/position of break instruments is the CSIRO ATLAS (Automatic Tester for Length and Strength). Several of these $100,000-plus instruments are currently being used in the Australian Wool Testing Authority labs providing mainly presale data for potential wool buyers. In addition, researchers from the South African Wool and Textile Research Institute (SAWTRI) have developed a length/strength tester which provides information on the profile, length and strength of raw wool staples both at the maximum practical gauge length and also at a short gauge (Cizek and Turpie, 1985).

Color/colored fibers. Although no ASTM standard exists, it has been demonstrated that clean color is a measurable characteristic of wool. In Australia, a test method is currently being considered by the Australian Standards Association. New Zealand already has a published standard.

It is generally appreciated that measurement of dark fibers in grease wool will not be attainable because of the sampling problem (Foulds, 1985). In contrast, development in metrology means we might be able to standardize and automate testing for detection of dark fibers in top.

Variabilities of fiber diameter and staple length. When required, variabilities of fiber diameter and staple length can be obtained concurrently with determinations of the means.

Crimp. Again, no current ASTM standard exists for determination of this characteristic. Visual appraisal of staple crimp frequency and definition still forms an important part of buying strategy. Image analysis techniques have been developed to provide this information objectively (Higgerson and Whitely, 1985). Alternatively, an indication of crimp level can be obtained by a measure of fiber compressibility or bulk.

That concludes a brief review of currently available objective measurements. A few self-addressed questions will now be answered.

Questions and Answers

Q. In what type of programs and experiments are objective measurements used in sheep and wool research?

A. At the Texas Agricultural Experiment Station in San Angelo, objective measurements are being used extensively in the following projects:

* TAES Ram Performance Test
* TAES Angora Goat Performance Test
* Selection experiments with sheep and goats
* Effects of various chemical applications on vegetable contamination in mohair and wool
* Kemp studies with U.S. mohair
* Phenotype x environment interactions
* Nutrition experiments with sheep and angora goats
* Effects of shearing method and skirting technique on the quantity, quality and value of wool from finewool sheep
* Effects of clip preparation and marketing on the quality and value of U.S. mohair.

In addition, the Texas Agricultural Experiment Station has a continuing program to evaluate new instruments with potential for rapid, accurate, objective evaluation of wool and mohair.

Q. Who gains when wool is tested prior to sale?

A. In all probability, the textile manufacturer has most to gain, followed by the producer, wool buyer and warehouseman. Benefits of presale objective measurements on grease wool may be summarized as follows for each segment of the industry.

General

* Potential to provide a common language in business transactions in the U.S. and worldwide
* Improved definition of wool quality characteristics

- More specific determination of the value of wool lots
- More accurate feed-back of wool manufacturers' requirements to producers and wool buyers
- Potential for improved wool packaging, storing and transporting
- More precise matching of wools

Textile manufacturer

- More efficient design of blends (least cost solutions)
- More accurate prediction of processing performances
- More efficient processing; increased productivity; improved quality control
- More accurate prediction of top, yarn and fabric properties

Producer

- Greater equity in wool prices (particularly growers of uncharacteristically fine or high yielding wools)
- More accurate assessments of the effects on wool growth from seasonal, nutritional and health factors
- Improved strategies for shearing, lambing and other management and breeding practices (especially when used in conjunction with the National Sheep Improvement Program)
- Potential for improved, more standardized preparation of wool for marketing; increased profits
- Opportunity for new markets

Warehouseman, cooperative manager, wool buyer

- Potential for increased efficiency and cost reduction in marketing
- Reduced risk when buying and selling; less necessity for hedging

Q. How have instrument measurements impacted marketing of wool in the U.S. in the last 30 years?

A. Barely at all. In fact, today there is probably less wool tested prior to sale than there was in the late 50's and 60's.

Q. Why?

A. There are many reasons. First, failure by producers and warehouse personnel to realize the full potential of using objective measurements for the indicated purposes. Secondly, resistance, in some areas, by wool buyers. And thirdly, failure by the textile industry to provide adequate financial incentives to perform these tests prior to sale.

Recommendations for objective measurement of U.S. wool were recently summarized in a publication of the National Wool Growers Association in the context of preparation and marketing of wool and purchasing of replacement rams (Jones, 1985).

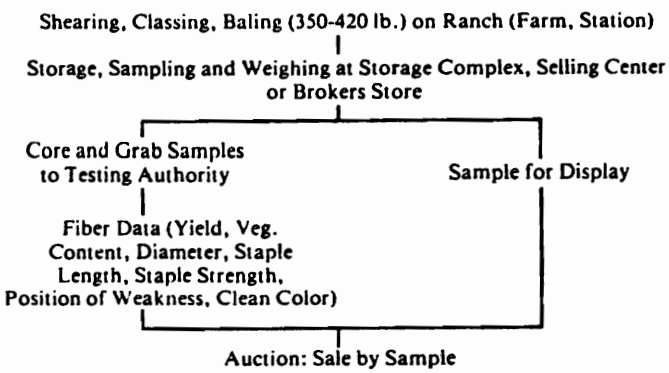
Q. How have objective tests impacted marketing of wool in other places throughout the world?

A. In the last 15 years, sale of wool by sample and objective measurements has increased significantly in Australia, South Africa and New Zealand. Of these systems, the Australian practice is probably the most advanced and may be summarized as follows. Last year, 99% of auction wools were tested presale and sold by sample with the following measurements made on core samples: fiber diameter, yield and vegetable matter. A proportion of these wools was also tested for staple length, strength, position of weakness and clean color. These additional measurements are seen as part of the continuing trend in the international industry towards the ultimate process of selling by description alone. Sale by description implies that there is no recourse to physical inspection of the sample by buyers who will, as a result, determine the value of the wool (and their prices) on the basis of measurements and guaranteed information. It has the potential for major savings in marketing costs (Rottenburg and Andrews, 1985).

These changes in marketing systems have been accelerated by applied research on a very large scale that has and is being conducted cooperatively between research, marketing and industrial processing groups throughout the world. Notable examples are the work with carpet wools in New Zealand (Carnaby, 1983) and fine-wools in South Africa (Turpie and Gee, 1980) and Australia (Andrews and Downes, 1973; TEAM, 1985). Even in a practical sale by description system, there will always be a need for an impartial appraiser. Such a person will be required to assess such things as style, tippiness, cots, stains, skin content and wool type. Nevertheless, all important characteristics would be measured (Mackay, 1980).

One authority (Wham, 1973) has estimated that full use of sale by sample and presale measurement offers reductions in cost of wool preparation, handling, storage, transportation, increased efficiency of purchasing and more precise matching of wools is worth 3 cents (U.S.)/lb of grease wool. Yield and fineness tests on auction lots in accordance with IWTO standards represent an average total cost of about half a cent (U.S.)/lb of raw wool (Mackay, 1980). Traditionally-sold wools in Australia are now discounted by wool buyers to the tune of 1½ - 3 cents (U.S.)/lb clean. The current method used for marketing Australian worsted type wools is summarized in Figure 1.

Figure 1. Sale by Sample — Australian Style



Summary and Conclusion

An Australian type of system is not being advocated for the U.S. market. Nevertheless, it may serve as a basis for further discussion since advantages of even partial adoption can be anticipated. Of course, advantages accruing from the adaption of other marketing related measures may also be envisaged. Specifically, attention is drawn to the following ideas which to some degree are interrelated: improved wool preparation; increased lot sizes; a decreased number of points of sale; and compliance with internationally acceptable (IWTO) standards. It is ironic that ASTM methods served as the basis for some of the IWTO standards. Now, unfortunately, it is the U.S. that is out of step. If we intend to sell even a portion of our wool overseas, it will be preferable to express wool quality using IWTO terminology. On a practical note, in order for further specification of grease wool to be adopted in the U.S. to even a moderate extent, it will be necessary to expand our commercial testing facilities.

Ultimately, the introduction of objective measurements as a marketing tool will be achieved only when the industry is ready to take advantage of it. It will be necessary to generate support by a widespread appreciation of the benefits to be attained. For some time now, the international wool research community and grower associations (Jones, 1985) have expended a great deal of effort in this direction.

To increase and subsequently maintain momentum for presale objective measurements of grease wool in the U.S., it will be necessary to gain a consensus between the following industry segments: producers, warehousemen, wool cooperative managers, commercial fiber testing houses, wool buyers and wool processors. These people should be able to work together to streamline the current wool marketing system with a view to improving efficiency and increasing profits in each sector.

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