28. Effect of Fibre Properties on Processing Performance: Greasy Wool to Top

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Learning objectives

On completion of these two lectures you should be able to:

- an understanding of how and why greasy wool fibre properties affect topmaking
- an understanding of how and why top properties affect yarn properties and spinning performance
- an appreciation of the key drivers of specifications for tops and greasy fibres
- an understanding of, and reasons for, the relative importance of fibre properties in early stage processing

Key terms and concepts

Diameter and length distributions, diameter profile, crimp and curvature, TEAM regression fits, yarn properties, spinning performance, topmaking prediction, spinning prediction, relative importance of fibre properties

Introduction to the topic

This topic describes the effect of fibre properties on performance in early stage worsted processing. In the first lecture the effects of greasy wool properties on performance in topmaking are examined. In the second lecture the effects of the measured top properties on yarn properties and spinning performance are examined, with some reference back to greasy wool properties. The spinner's requirements drive the specification of top properties and ultimately what wool is purchased and, together with supply and demand, the price relativities. The potential performance in spinning and the yarn properties are determined or limited by the fibre properties and so it is possible to predict expected performance and establish a firm basis for the relative importance of fibre properties.

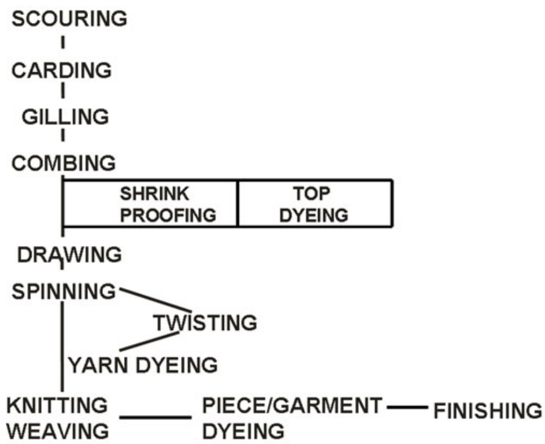
28.1 The topmaker's demands

The topmaker purchases, or is supplied with, consignments of greasy wool to produce a requested amount of top to a given specification. Except for very fine wool the topmaker prefers that consignments exceed 10 tonnes and will charge more if commission processing smaller consignments. About 15 tonnes of top can be packed into a 6 metre shipping container and it is convenient to deal in whole containers of either greasy wool or top. Given that the average sale lot is 4 to 5 bales of 200kg there will be typically 20 or more sale lots in a consignment. Part of the art of the topmaker is to purchase the set of sale lots of the lowest total price that can be processed to just meet the specification in terms of quantity and properties. If the top does not meet specifications, particularly in terms of diameter, length and cleanliness, then it may be rejected by the customer. Most contracts conform to the terms set out in the IWTO (International Wool Textile Organisation) Blue Book with the measurement methods and standards set out in the IWTO Red Book. The topmaker does not want to produce top that significantly exceeds specifications because this generally means that too high a price was paid for the wool, but will build in a margin of error to protect against failure to meet specifications or the risk of a subsequent claim if contamination is found in the top, yarn or (most seriously) the fabric. "Contamination" can include pesticides, dark fibre, plastics, metal objects, unscourable brands, pack material, twine etc. The topmaker's key demands of the fibre relate to the wool performing as expected, no surprises, and having the measured attributes.

28.2 Overview of processing route – greasy wool to top

The worsted processing route is illustrated in Figure 28.1. The sequence of operations in worsted processing essentially involves getting rid of contaminants (grease, suint, dirt and vegetable matter) which necessarily entangles the fibres and destroys their fairly parallel alignment, then to remove the entanglement and get the wool back into a uniform array of disentangled, straightened, parallel and blended fibres. Scouring can be seen as a flow of dirty wool in one direction getting progressively cleaner and clean water travelling in the opposite direction getting progressively dirtier. The motion required in opening, transporting, dunking, agitating and squeezing the wool necessarily leads to entanglement. In addition there will be entanglement associated with burrs and other VM and occasionally there will be some cotting and entanglement of the wool prior to shearing. The wool can also be damaged in scouring if strong alkalis and high temperatures (notably in the drier) are used. The damage can both weaken and yellow the fibres.

Figure 28.1 Steps involved in worsted processing.
Source: CSIRO Textile and Fibre Technology (2005).



The subsequent carding, gilling and combing can be seen as the steps needed to remove the entanglements and unscourable contamination (VM). Losses and breakage are primarily determined by the amount of entanglement and contamination and the difficulty of removing it without breaking fibres. This has been confirmed by demonstrating that almost no breakage is suffered by top fed back through carding. The worsted card primarily removes vegetable matter by opening and spreading the fibre on rollers covered with metal teeth to grip the fibres and then hitting the VM that sits proud of the fibres by high speed bladed cylinders (burr beaters). The card attempts to break up entanglements by tooth and claw; that is, holding the wool with one set of teeth or pins while working it with another set. Removing entanglements this way necessarily pulls part of the entanglement tight, giving rise to neps, and breaks some of the fibres. Lubricants which minimise friction between teeth and fibre reduce the amount of breakage and these synthetic products have been shown to be more effective than wool grease. Thus it is not desirable to have scouring leave much residual grease which will also carry dirt and eventually clog or stick to processing machinery.

Fibres gripped by pins or teeth are necessarily hooked and the web that comes off a card is an array of disoriented, lightly entangled fibres. The gilling steps are designed to remove the hooks and to align fibres for presentation to the comb. It is standard to use 3 gilling steps. More steps tend to increase the number of neps (pull them tighter) while slightly reducing the losses in combing. Negligible breakage occurs in gilling (unless the machines are over-loaded) and only a small amount of VM drops out. The comb is an intermittent process that brushes/combs the leading ends of a beard of fibres then grips and pulls the most forward fibres through a fine comb so that their trailing ends are pulled between pins. The successive beards of fibres are then overlapped like tiles to reconstruct the sliver which is given two more gillings to consolidate it and remove the introduced layering. Combing is highly effective at removing non-fibrous contaminants, short fibres and entanglements (neps). The waste from combing primarily consists of the entanglements, short fibre and the VM left by the card together with the wool that is gripped by the VM. Combing will break some of the hooked, disoriented and entangled fibres but increases the mean length by removing short fibres.

Only a small amount of wool (5 to 12%) is lost as noil and from the card, so that diameter and the spread in diameter are little affected by topmaking. It is observed that the wool in noil is slightly finer, on average, than the parent top (typically 1µm) which would mean that the mean diameter of the top would increase by about 0.1µm if 10% of such noil was removed. The mean length of the top will be determined by the length of the input wool modified by the amount of breakage in processing and the amount of short fibre removed in combing. The amount of breakage depends on the degree of entanglement (which increases with reducing diameter) and factors such as the strength of fibres, their length and likelihood of being gripped at both ends, the loading of fibres in the working zones, the amount entangled with VM, and the processing lubricants. Experiments in which the same wool has been processed on different scouring systems in different mills then carded and combed on the same machinery (Christoe 2002) has shown that differences due to the scour alone can easily lead to differences of 6mm or more in the mean length of the top. Card loading, lubricants and comb settings can have even bigger effects (Robinson 1996).

The topmaker will normally measure the top properties of the first part of the consignment and then has a small amount of flexibility to change processing conditions to more closely meet specifications. However, any decrease in loadings or increased removal of short fibre comes at the expense of a drop in production.

28.3 Prediction formulae, models and regression fits

Essentially all Australian wool destined for the worsted system is measured for diameter and yield and most is measured for staple length, staple strength and position of break. There are standard procedures for taking samples and for making the measurements and the average errors are known. Most wool is sold through the auction system and a representative sample made up from grab samples is displayed and available for inspection prior to auction. All display samples will be given an AWEX type according to a set of subjective attributes. This and other information, which includes diameter distribution and curvature plus the amount of wool, wool growing area, brand etc., is made available in the auction catalogue.

There has been much research into the effect of fibre properties on topmaking performance and properties. One approach (Turpie & Gee 1980) has been to perform trials using a wide range of wools and then to extract the effects using regression analysis. This approach can show up effects that were not expected from a simple theory but is fraught with danger (Lamb 1988) due to correlations between properties and with unmeasured variables. It is important to remember that a correlation found by a regression analysis does not imply a causal relationship. A better approach is to examine the processing of wools that are closely matched for all but one property. The main danger here is that the result, e.g. the effect of strength, will only apply to similar wools, e.g. of similar length and diameter. This is usually answered by repeating the trial for other sets of wools, e.g. over a range of diameter. It is also important to ensure that the models used to fit the data are based on sound theory.

The TEAM formulae are an attempt to achieve a robust set of prediction formulae for length, length distribution and romaine (noil) that apply to consignments of merino wool. They were initially developed to enable the processor to take advantages of the ATLAS measurements of staple length (SL) and strength (SS) and have been highly successful at enabling the sale of wool by sample (i.e. by measurement and display sample) and in improving the understanding and reliability of processing of Australian wool. The TEAM formulae are simple linear regression fits that take into account that the length in the top will be related to the length of the greasy wool minus the amount of breakage (which increases for longer, finer, weaker, thin-in-the middle and more heavily VM contaminated wool). They were developed for consignments, not sale lots or special batches of fleeces, processed in a wide range of commercial mills and so reflect average properties processed under average conditions. The formulae allow for mills to add a constant (correction factor) to each formula to take into account that some mills, e.g. by introducing less entanglement or by using different loadings, perform better than others.

The TEAM2 formulae are presented in Table 28.1. The regression variables are staple length (SL), staple strength (SS), fibre diameter (D), vegetable matter (VM), corrected percentage of mid-staple breaks (M*) and a mill correction factor (Mill).

Table 28.1 Co-efficients of regression variables fitted to TEAM2 formulas for Hauteur (H), Coefficient of Hauteur (CV_H) and Romaine (R). Source: Lamb, 2006.

	SL	SS	D	VM	M*	Mill
H	0.52	0.47	0.95	-0.45	-0.19	-3.5
CV_H	0.12	-0.41	-0.35		0.20	49.3
R	-0.11	-0.14	-0.35	0.94		27.7

An investigation of sale lots processed in one mill (Lamb 2000) found:

H = 0.34SL + 0.15SS + 1.61D - 0.66VM - 0.14M* - 1.37CV_D - 0.081Curv. + constant

Table 28.2 illustrates TEAM3 formulae determined by Lindsay et al. (2003) and CSIRO Textile and Fibre Technology (2005). In addition to the variables listed in Table 28.2, the TEAM3 formula includes coefficient of variation of fibre diameter (CV_D) and staple length (CV_{SL}) and Curv is the curvature of the greasy wool in ˚/mm as measured by the Laserscan

Table 28.2 Co-efficients of regression variables fitted to TEAM3 Hauteur formulae's as determined by two different studies. Note: a = Lindsay et al. (2003), b = CSIRO Textile and Fibre Technology (2005). Source: Lamb, 2006.

Study	SL	SS	D	VM	M*	Curv.	CV_D	CV_{SL}
a	0.47	0.34	1.23	-0.14	-0.19	-0.06	-1.15	
b	0.43	0.35	1.38	-0.45	-0.15		-0.59	-0.32

Topmakers have considerable experience on how different wools process and some have developed their own prediction formula according to the type or diameter of the wool being processed. The inspection of the display sample can be seen as insurance against problems wools (tippiness, cotted, rotten, mildewed, discoloured, contaminated, difficult-to-remove VM types, second cuts etc.) and to take into account visual clues, e.g. crimp frequency, crimp definition and dust penetration, that are believed to influence processing. However, the evidence is that the processing performance of most wool lots can be reasonably predicted with the major discrepancies being related to variations in diameter along fibres due to varying nutrition, stress and feed requirements and to the accuracy of the measurements of greasy fibre length and strength.

28.4 Effect of greasy properties on top properties and topmaking performance

The key fibre properties of top are mean diameter (D), mean fibre length (H), the spread in lengths (CV_H) and/or the short-fibre content, the diameter distribution and the fibre strength. The mean fibre length by number (hauteur, H) is typically measured by an instrument called the Almeter (Figure 28.2). A beard of fibres with their ends aligned is prepared from the top then the mass distribution is measured from base to tip of the beard. A decrease in mass is interpreted as fibres finishing and in this way a distribution of fibre lengths is built up. The length distribution can also be determined by hand drawing out of fibres according to their length or by pulling out and measuring the length of individual fibres; an extremely laborious procedure. The spread in properties is normally presented in terms of a percentage co-efficient of variation (100 times the standard deviation divided by the mean) and hence we have CV_D (the co-efficient of variation of diameter) and CV_H (the co-efficient of variation of hauteur). The spread in greasy fibre lengths is relatively small prior to fibre breakage so CV_H is seen to increase with increasing breakage and hence with decreasing H. The strength of the top can be measured by gripping a small section of fibres between closely spaced jaws (typically 3.2mm apart), measuring the force to break and then weighing the fibre that was gripped by the jaws.

Figure 28.2 An Almeter measures mean fibre length and distribution. Source: CSIRO Textile and Fibre Technology (2005).

Losses in topmaking are usually presented in terms of romaine (comb noil as a percentage of top plus noil), tear (ratio of top to noil) or yield in terms of mass of top as a percentage of the mass of greasy wool. Performance is considered in terms of H relative to the expected length, total losses and the rate of production. It also covers meeting all specifications including upper limits to faults/contamination such as VM and neps. The various greasy wool properties will now be considered in terms of their impact on top properties and topmaking performance.

Yield

In general, the yield is just taken into account in terms of calculating the amount of top that will result after removing all grease, dirt, suint and VM. However, low yields mean that there is more dirt or grease which may require more severe scouring resulting in additional entanglement, or that there is more VM which results in additional wool loss and fibre breakage. Lower yields are also associated with drier, dustier environments and so imply that the sheep were exposed to harsher or more variable nutritional conditions.

Diameter (D)

A recent project (TEAM-3 Steering Committee 2004), undertaken by AWTA, observed that the mean diameter of the resultant tops were 0.20μm coarser than the mean diameter determined from the greasy wool measurements while a 0.09μm difference was observed in TEAM2. The small difference is not necessarily just due to the removal of finer noil but can also reflect subtle differences in measurement procedures and biases in sampling. It is standard purchasing practise to buy greasy wool that averages about 0.2 to 0.3μm finer than the specification in order to be reasonably confident of meeting specifications. It also needs to be appreciated that the 90% confidence limit on the diameter measurement of a single sale lot is about 0.3μm so that 1 in 10 results can be expected to be in error by more than this amount and the error in predicting diameter of consignments is only reduced because it is formed by averaging over a number of sale lots.

The finer the fibre diameter the more easily fibres entangle and felt. Finer fibres are weaker (per fibre) and, on average, have higher bulk. Hence breakage and CV_H should be expected to increase and hauteur to decrease with decreasing diameter, and this is observed (see TEAM2 formulae above). Finer fibres also mean that there are more fibres by number per tooth or pin in processing and it seems that fibres are more easily individualised at low fibre loadings. It is typical to lower loadings for finer wool and to adjust scouring conditions. So production in terms of weight of top per unit time tends to decrease as diameter decreases.

Fibre diameter increases in the presence of moisture and the moisture content depends on how the wool has been treated so the diameter can only be compared when test conditions have been controlled. Most dyeings have negligible impact on fibre diameter as measured by the Laserscan.

Diameter Distribution (CV_D)

The average CV_D observed for Australian wools for both commercial tops and sale lots is $CV_D\% = \mu m/2 + 10.5$ (Naylor 1996). The similar mean values for tops and sale lots is because it is unusual to mix sale lots with significantly different values (>±1µm) of mean diameter. For wools of 20 to 24 µm, about 95% of sale lots have CV_D between 19 and 26%. It is therefore difficult for a topmaker to put a consignment with low CV_D together. A survey of the diameter distribution of 100 commercial tops from four different top makers gave an observed range of CV_D values in tops that was much smaller than in sale lots, only about ±1.5, in units of %, about the mean value for that fibre diameter.

The CV_D value of a sale lot arises from the CV_D values of individual fleeces and the range of fleeces in the lot. The range of mean fleece diameters present in a flock is probably larger than the range in diameter of sale lots blended in a consignment, so that binning of fleeces according to on-farm diameter measurement will slightly reduce the average CV_D, but most of the variation is already present in a single fleece. The variation within a fleece is the result of diameter differences between fibres (genetic) and the variation in diameter along fibres (nutrition, environment and genetics).

A small effect on topmaking due to a wider range of diameter between fibres is expected because fibre strength is proportional to D^2 and entanglement is likely to be dependent on a higher power of D. There should then be terms in D^2, or similar, in the TEAM formulae but so far a linear dependence on D has been sufficient and it has not been found necessary to introduce such terms. The effect of variation in along-fibre diameter is to reduce the breaking strength of fibres which might be expected to lead to more breakage in processing. Both TEAM3 and an earlier study of sale lots (Lamb 2000b) observed a similar and significant dependence of hauteur on CV_D. The inclusion of a CV_D term also greatly reduced the significance and size of the staple strength (SS) term presumably because the two are related measures of fibre strength. The size of the CV_D term is significant in the sense that an increase of 5 units (%) is associated with a decrease in H of 5 to 7mm but it has not been observed to have a marked effect on noil.

Staple length

The ATLAS instrument optically measures the length of a sample of staples taken from a grab sample. The fibres within a staple are not straight and also have a range of lengths. On average the mean length of fibres within a staple has been measured to be 1.17 times the length of the staple but this ratio has been observed to vary between 1.0 and 1.35. It is likely that this variation is a significant cause of errors in prediction and belly wools, for example, in which the staples appear to get shortened by agitation on the sheep measure differently.

If there was no fibre breakage the hauteur would average 1.17 times the staple length (SL). In reality the hauteur has a dependence of about 0.5 * SL. The necessary conclusion from this is that longer staples suffer relatively more fibre breakage in processing although longer staples still give longer tops. The suggested reason is that it is relatively more likely that long fibres will be gripped strongly in two places during carding and get broken. Noil, however, which includes both entanglements and short fibre is observed (TEAM2) to decrease as SL increases. So, for topmaking performance, there is no reason to penalise longer SL.

Staple length distribution (CV_{SL})

This is a measure of the range of staple lengths found in the grab sample and then calculated for the whole consignment. It could reflect that sale lots with markedly different mean staple lengths were blended or that there was a big variation in staple length between sheep or within sheep which may even partly reflect the quality of shearing and of skirting. Given that the coefficient of variation of fibre length within a staple is likely to be larger than the variation of staple lengths but is not considered and that a non-linear term in SL has not been found necessary then it is inappropriate to consider a term in CV_{SL} as has been done in the TEAM3 analysis. The small correlation between H and CV_{SL} is more likely to reflect some artefact such as a correlation between the blending practices and topmaking performance of better and poorer mills!

Staple Strength

The ATLAS measurement of staple strength (SS) determines the force required to break a staple at its weakest point, which is usually the point of minimum cross-sectional area. The peak force at break is normalised by the average linear density, determined from the weight of the staple corrected for the measured length and yield. Staple strength thus has units of tenacity (N/ktex) but the mean linear density rather than the minimum is used. The peak force results from the combined behaviour of a large number of individual fibres. Any variation in thickness along the fibre reduces the total load that can be supported and variation between fibres in thickness and length means that they can extend at different times and rates and so not share the load equally or not break at the same time, which reduces the peak force. Thus staple strength is a measure of the average strength of the weakest places in single fibres modified by their collective behaviour and normalised by the average linear density.

A recent review of SS (Lamb 2004) concluded that the effects of SS are non-linear, being more marked at low SS, and the size of the effects attributed to SS in the TEAM formula are over-estimated due to correlations with other fibre properties and a flaw in the Almeter measurement of hauteur when there is marked variation in diameter along fibres. It was hypothesised that breakage in processing would be more likely to relate to single fibre strength than to staple strength but the measurement of single fibre strength is extremely laborious. In two recent trials using lots assembled from measured fleeces well matched in all properties except SS (25 N/ktex) a difference of only 2 to 3mm in H was observed when TEAM2 would predict 11mm.

Most wools have fairly similar intrinsic tenacity but lower SS can also arise from trace element deficiencies, microbial damage and weathering.

Mid-breaks and along-fibre diameter profile

It has long been argued and observed that staples with higher levels of mid-breaks, as measured by ATLAS, will break more in processing and so give higher CV_H and shorter H. The position of break by itself does not influence H because the mean length of the two broken parts is independent of the position of break (except to the extent that a short component is removed in combing). It is postulated that a weak place near the middle of the fibre is more likely to be broken because it is more likely that the weak place will be between two places being gripped during carding.

Studies using the Laserscan or OFDA instruments to measure along-fibre diameter profiles of staples have found that thick-in-the-middle profiles give a longer H, lower CV_H and less short fibre than expected while thin-in-the-middle profiles have the opposite effect (Oldham & Peterson 2000). For southern Australia such profiles correspond to Autumn and Spring-shorn wool respectively. Recent analyses have discovered that most of the apparent effect can be explained as an artefact of the flaw in the way the Almeter determines H and CV_H. When the fibres get thinner the Almeter sees a drop in signal and interprets this as fibres stopping. The correlation between M*, SS and along-fibre diameter profile means that that the effect of these parameters on actual length needs to be re-examined (although they influence the existing Almeter values used in specifications).

Vegetable matter

The AWTA measurement reported in the sale catalogue divides vegetable matter (VM) into burr, seed/shive and hardheads. These three different vegetable matter types a shown in Figure 28.3.

Figure 28.3 Three different types of vegetable matter types (burr, seed/shive and hardheads) reported on sale catalogues. Source: CSIRO Textile and Fibre Technology (2005).

In addition the AWEX-ID description carries some information about the major type of VM present. Burrs are relatively more easily removed in carding and combing until broken open. The most difficult to remove plant contaminants are the shive types such as barley grass because they have components that are fibrous (long and thin) and surfaces that grip fibres. Hardheads can jam in card wire but do not easily get through to the top. However, they present problems for carbonising in the woollen system. A certain percentage of each type of VM will get through to the top depending on the quality of equipment, settings and maintenance so the level and type of VM are of potential concern to the topmaker. Removal of VM also leads to loss of fibre attached to the VM and higher VM levels are, on average, associated with shorter hauteur and more fibre breakage. The TEAM2 formula implies that nearly 1% of combing noil results from each 1% increase in VM in the greasy wool even though >90% of the VM by mass will be removed at the card prior to combing.

Crimp and curvature

Historically, wools of high crimp frequency have been more highly valued and there is still a premium for higher crimp frequency in otherwise similar sound, superfine wools. This premium originally related to the fact that higher crimp frequency is associated with finer diameter. This is no longer true for different fleeces within one mob of fine-woolled sheep (Hansford & Humphries 1997) but there remains a marked correlation between mean diameter and crimp frequency for sale lots and, more so, for consignments.

Curvature, as measured by Laserscan or OFDA, has been shown to have a close relationship to crimp frequency, with low crimp frequency corresponding to low curvature. Curvature is the rate of change in direction (in degrees) a fibre bends per mm along its length http://www.awta.com.au/Publications/Newsletter/
Newsletters.htm under Opinion in May 2000 newsletter).

It should be directly proportional to crimp frequency if the depth of crimp (amplitude) is the same for wools of the same crimp frequency. Unfortunately, curvature is not a fixed property and is gradually reduced by processing as the fibres are straightened. The curvature of top is not a very stable property but is typically about 70% of that of the greasy wool. However, a curvature value fairly similar to that of the greasy wool can be recovered by wet relaxation of the top, if it has not been dyed. The relationship, if any, between depth of crimp and curvature for constant crimp frequency has not been determined. Hence, there may be some crimp attributes that are not covered by a measurement of curvature. It has been observed that crimp frequency and curvature vary with the rate of growth of fibres so that the same sheep on a higher plane of nutrition will grow longer wool of lower curvature. There is also a marked correlation between fleece weight and curvature so that a selection on heavier fleece weight is a selection on lower crimp frequency (Purvis & Swan 1998). A measurement of resistance to compression is available, which is closely related to bulk, but it is also approximately proportional to the product of diameter and curvature.

Trials examining extremes of curvature in which the other fibre properties, including SL and along-fibre diameter profile, have been well-matched have found a small improvement in hauteur and noil with decreasing curvature. The effect on hauteur is small as evidenced by the regression fits above where a decrease of 12 to 16º/mm is associated with a 1mm increase in H. It is therefore not surprising that the effect was not statistically significant in the TEAM3 analysis where the diameter and curvature of consignments was strongly correlated. For noil it is consistently observed that an increase in curvature is associated with an increase in wastes (typically 0.5% for 10º/mm). This is a little surprising given that higher crimp tends to reduce felting in water but may arise from the increase in bulk and likely stronger interaction with pins and teeth in processing. It is interesting that breeding for increased fleece weight at constant fibre diameter will lead to wool that fetches a lower price (Curtis & Stanton 2000) but which performs slightly better in topmaking.

It has been claimed that wools of high crimp definition, a visual assessment of the clarity and uniformity of the crimp, give rise to longer hauteur. One trial (Stevens & Crowe 1994) claimed enormous effects for both crimp frequency and crimp definition. In the light of subsequent trials which have not seen large effects the results must be treated with considerable caution. Potential explanations for the suspect results include that the crimp frequency, crimp definition and fibre attributes do not seem to have been re-measured after the selection for extremes (which will introduce a bias in SL, for example), and that CV_D and along-fibre diameter profiles may have been different but were not measured.

Style and AWEX-ID

Style characteristics are visual assessments of staple properties including density, character (crimp definition), length regularity, tip type, visual colour and dust penetration. The AWEX-ID (Australian Wool Exchange Ltd 2002) is a descriptor of these properties and other non-measured characteristics of greasy wool made by trained appraisers. The AWEX-ID Style does not necessarily imply any expected processing capabilities and there is little evidence that any of these attributes have a significant effect on processing beyond that attributed to the measured property (e.g. high dust penetration being associated with lower yield). The AWEX-ID can also distinguish weaners and fellmongered wool, fleeces and bellies, and VM type, and has qualifiers for unscourable colour, cotted wool etc., so can help prevent surprises if the buyer has not had a chance to visually inspect the wool. The AWEX-ID can label wool finer than 18.5μm as Australian Superfine (AS) or Merino (M) but it can only be labelled AS if it has high crimp frequency (traditional superfine appearance).

Other greasy wool attributes

There may be other attributes between fleeces that affect processing performance but their effects are small or averaged out within sale lots and consignments. A short square tip is a preferred style attribute but seems to have little effect. Weathered tips will tend to break off during processing and so lead to lower yields and shorter hauteur but a simple and reliable method of quantifying weathering is not available. Sheep coats, which reduce weathering, give longer hauteur and less waste but some of this is due to the lower VM. It has been claimed that some wools have better fibre ellipticity (roundness) but the only well established tendency is for finer diameter wools to be more nearly round. It has been observed that some wools felt more rapidly than others but most of the differences can be explained by differences in diameter and curvature with finer, lower curvature wools felting more readily. It may be that some wools have a less pronounced scale structure, particularly in water, but no one has shown this for otherwise similar wools. Greasy wool brightness and colour are poorly related to scoured colour so it is difficult to select wools which will provide a whiter substrate and so give brighter colours in dyeing. There are now test methods for pesticide levels and for dark fibre. Measuring a small sample cannot guarantee freedom from dark fibre but such tests may become economically attractive when freedom from pesticides (eco-labelling) or dark fibre (pastel shade fabrics) is required.

28.5 Relating price to greasy properties and performance

There are tools such Wooldesk (www.agric.wa.gov.au/wooldesk or http://www.woolcheque.com.au) where auction data from recent years can be examined for variations in price and supply of different specifications. Price is indirectly driven by topmaking performance inasmuch as fibre properties affect the ability to meet the spinner's specifications. D and CV_D of the consignment relate very directly to their values in the top but the required H can be achieved by mixing and appropriately processing a wide choice of wools. Price also depends on the supply and demand for the available wools and a topmaker can have different recipes for the same top dependent on the current premiums and discounts.

Readings

The following readings are available on CD

1. Lamb, P.R., 2002, 'Metrology and processing research: Implications for growers', *Wool Technology and Sheep Breeding,* vol. 50(4), pp. 671.
2. Scrivener, C.J., Vizard, A.L. and Hansford, K.A. 1999. 'The valuation of superfine wools in relation to their topmaking performance', *Wool Technology and Sheep Breeding,* vol. 47(4), pp. 241.
3. Turk, T. 2002, Meeting the Needs of the Processor, *Wool Technology and Sheep Breeding,* vol. 50(4), pp. 622.

Activities — Available on WebCT

Multi-Choice Questions — Submit answers via WebCT

Useful Web Links — Available on WebCT

Assignment Questions — Choose ONE question from ONE of the topics as your assignment. Short answer questions appear on WebCT. Submit your answer via WebCT

Summary

Summary Slides are available on CD

The fibre properties and wastes in topmaking are primarily determined by the greasy wool properties with some small scope for the topmaker to control quality. The diameter and diameter distribution are determined by the wool that is purchased except that a small part is lost in processing. The length is determined by the length of the input fibres degraded by breakage due to entanglement but slightly improved by the removal of short fibre in combing. The breakage and losses are related to the amount of entanglement introduced by scouring and to the fibre length, strength, diameter, position of break and vegetable matter content. Diameter distribution and along-fibre diameter profile also have significant effects while lower curvature is associated with slightly better length and less wastes. The topmaker can achieve longer length or less waste by scouring more gently, by good lubrication and lower card loadings and by settings in combing, but this is generally at the expense of production. The art of the topmaker is to put consignments together from the available sale lots at the lowest total price while meeting the spinner's specifications without problems or surprises in processing. These specifications include not only fibre properties but freedom from contamination and faults of any form.

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Glossary of terms

Bulk	Volume occupied per unit mass of fibre under given load
Commission processing	Processing, e.g. topmaking, of wool owned and selected by another party e.g. spinning mill
Creel	To mount input packages (rovings) on spinning frame
Doff	To remove full bobbins of yarn from all spindles on spinning frame
Dust penetration	The extent to which dust has penetrated down into the staple (it is not the same as dirt content which measures the mass of dirt and may be held near the tip by grease)
Intrinsic tenacity	The inherent strength (peak load per unit of linear density) of the material (fibre)
Re-combing	A second combing, similar to the first, but usually carried out by the spinner after dyeing or for fine diameter wool
Weathering	Damage caused to the outer ends (tips) of the fibres mostly by UV radiation