

# Wool Production



Relevant to the following Qualifications and Unit Standards:

<b>Qualifications</b>	<ul style="list-style-type: none"> <li>• Certificate in Sheep Knowledge Level 3</li> <li>• Telford Certificate in Agriculture Level 2</li> <li>• STAR program</li> <li>• Certificate in Agriculture Knowledge Level 2</li> <li>• Stock and Station</li> </ul>			
	<b>Includes (NZQA units)</b>	571	Version 4	Level 3



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## Wool Production in New Zealand

Captain Cook first introduced sheep to New Zealand in the late 1770s but this introduction was unsuccessful and the sheep died out, possibly because of lack of suitable pasture and forage for them. It was 60 years before the first flock of sheep was successfully established. They were Merinos, and this was the predominant breed until the 1880s when farmers began to bring in dual-purpose breeds to meet the demands of the new refrigerated meat export trade. In the North Island, these breeds were initially Lincoln and English Leicester. Later they were replaced by Romney.

Farmers in central and eastern parts of the South Island looked for a breed that would do well in their drier conditions, and they eventually crossed the Merino with the English Leicester, Lincoln or Romney to get the New Zealand Half-bred, and subsequent interbreeding produced the Corriedale breed.

New Zealand's temperate climate means that sheep tend to do well in our extensive farming systems. They can be farmed out of doors all year round living on pasture and pasture products. They can be shorn at any time of year, although there is a peak in shearing activity between November and January.

Although an important part of the sheep industry for over a hundred years, wool returns and production have significantly reduced over the last 25 years (see graph below). Competition from cheaper synthetic fibres, import tariffs, ineffective marketing strategies and conversion to dairy farming have all influenced this downward trend in wool returns and production. Nevertheless, wool still remains an important contributor to the national economy and to sheep farmers.

New Zealand is the third largest producer of wool (on a 'clean' basis) in the world, with around 12% of world production. 'Clean' refers to wool that has been scoured (cleaned). Presently (2014) wool production is around 118,000 clean tonnes<sup>1</sup>, less than 50% since 1990-91). Most of our wool is exported to China and European Union countries, as illustrated in the figure below.

Wool yield per head has changed little over the last 30 years and still remains around 4 kilograms. With the decline in wool prices and relatively higher lamb prices, there has been a bigger emphasis on breeding for meat rather than wool production.

Sheep breeds that produce higher lambing percentages, heavier lambs and that are suited to the New Zealand climate typically produce crossbred or 'strong' wool. Hence, crossbred wool accounts for approximately 90% of total production; fine to medium-fine wools account for the remaining 10% of production. We will look in more detail in later sections on the definition of wool fineness.

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<sup>1</sup> Beef and Lamb New Zealand Economic Service, August 2015.

Most of New Zealand's wool is shorn (around 85% of total production). The remaining 15% is slipe wool. Slipe wool is a by-product of the meat industry and refers to wool that is recovered from pelts of slaughtered animals.

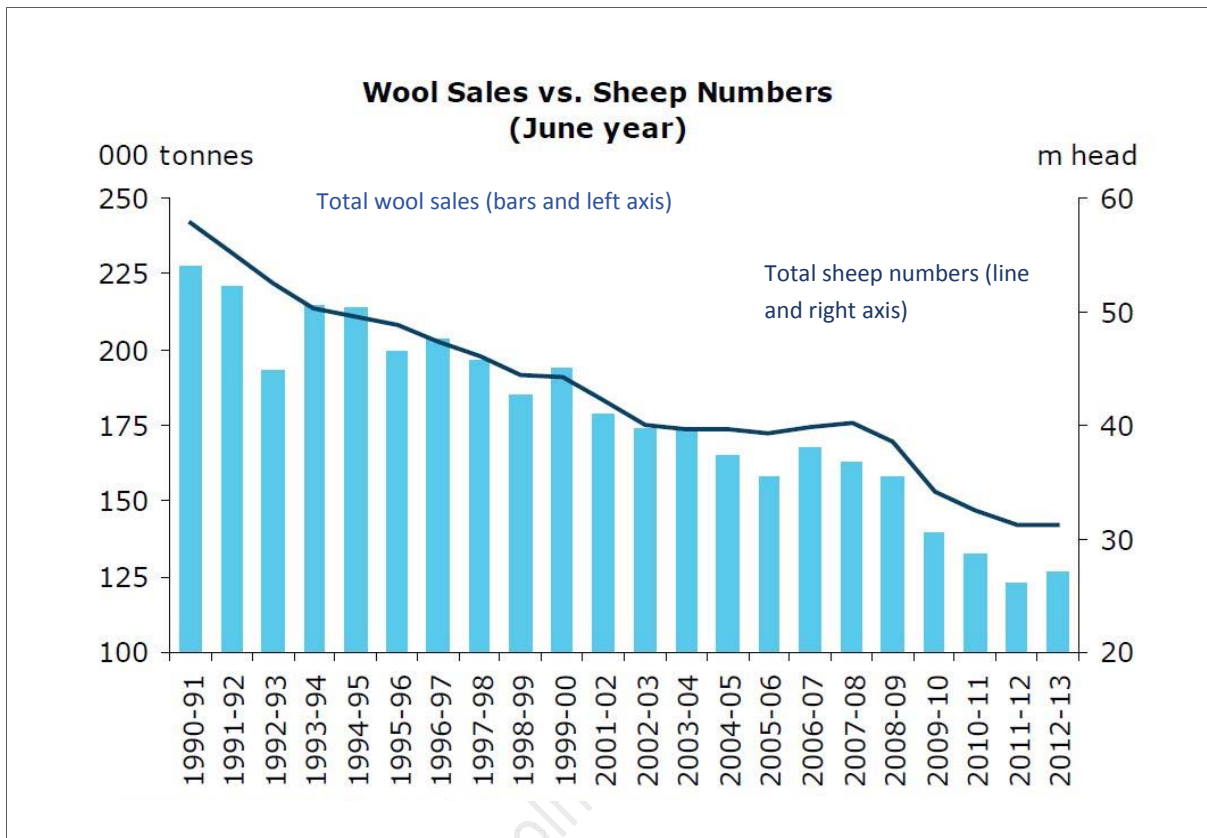


Figure 1 ANZ Research. (April, 2013). *New Zealand Economics, ANZ Agri Focus*

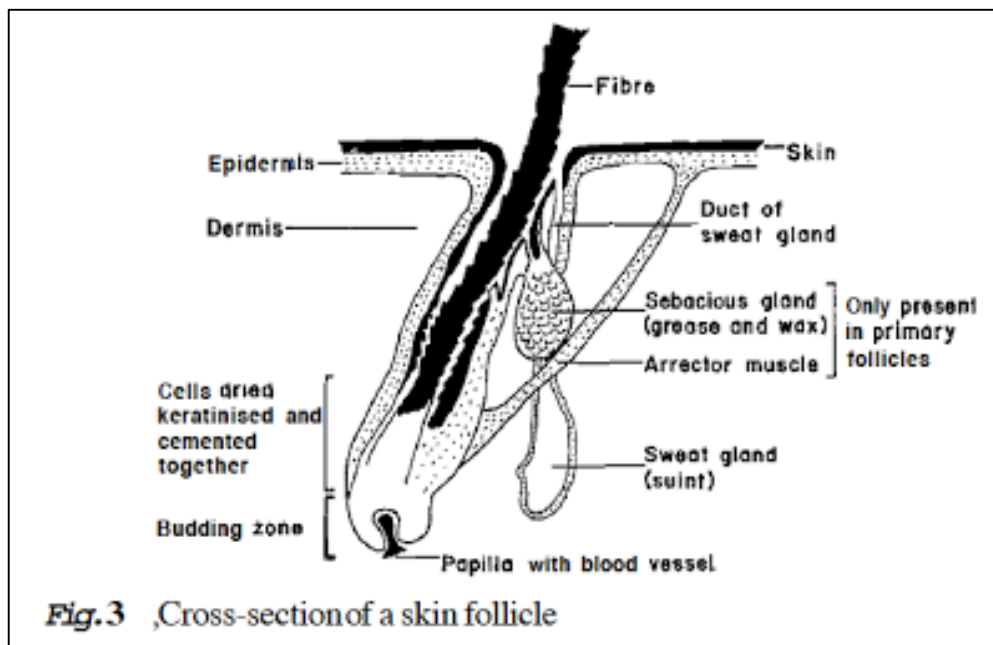
Retrieved on 30 November 2015 from <http://www.anz.co.nz/resources/5/0/50193a804f1ec3d1b89ffa146f64e4a5/ANZ-AgriFocus-20130403.pdf>.

## Wool fibres and follicles

A sheep fleece is made up of between 10 and 50 million individual fibres or strands. A wool fibre is relatively tough. It is resistant to abrasion (being rubbed or scraped) and can usually be bent and twisted many times without being damaged. Wool fibres are also very elastic (stretchy). When dry, the fibre can be stretched by about 30% of its natural length, and while wet it will stretch by 60 to 70%. After stretching, the wool fibre will return to its original length.

The fleece weight of an individual sheep depends on the number and size (length and diameter) of wool fibres. The number of wool fibres is in turn determined by the number of wool follicles present on the sheep. The number of follicles is predetermined before a sheep's birth (genetically inherited).

Wool fibres grow from follicles which are tube-like structures in the skin. Sheep have primary and secondary follicles.



*Figure 2 Primary wool follicle showing the skin layers (epidermis, dermis) and papilla which provides nutrients and energy for wool*

[http://woolshed1.blogspot.co.nz/2009/05/introduction-to-practical-animal\\_14.html](http://woolshed1.blogspot.co.nz/2009/05/introduction-to-practical-animal_14.html)

(Image used with permission)

Primary follicles:

- Primary follicles are typically arranged in groups of three.
- A primary follicle has a sweat gland, a sebaceous gland and an erector (arrector pili) muscle.
- The sweat gland produces suint (pronounced soo-int) and the sebaceous gland produces wax or grease (also called sebum). The wax produced by the sebaceous glands contains lanolin. The erector muscle helps control the 'uprightness' of the follicle, hence fibre.
- A primary follicle produces true wool fibres but can also produce kemp (a hard, brittle, opaque, medullated fibre) and hair-like fibres (intermediate between wool and kemp).

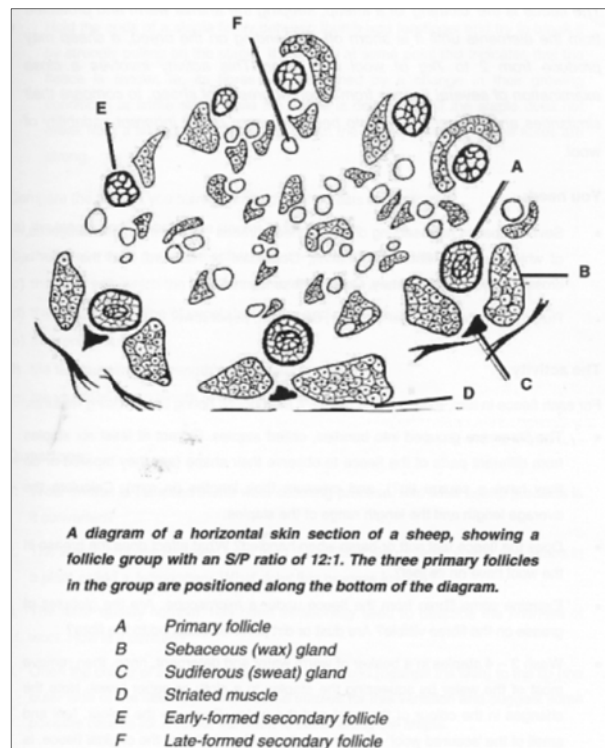


- The fibres primary follicles produce are typically of greater diameter than those from secondary follicles.

Secondary follicles:

- Secondary follicles and their fibres are more numerous and lie to one side of the primary follicles.
- A secondary follicle does not have a sweat gland or an erector muscle but it does have a sebaceous gland.
- Secondary follicles are the smallest follicles and tend to grow finer wool fibres than the primary follicles.

The primary follicles (usually three) with their associated secondary follicles make up a follicle group.



**Figure 3 Wool follicle group**

The S/P ratio referred to in Figure 3 is the ratio of secondary to primary follicles; in this case 12:1 or 12 secondary follicles to 1 primary follicle.

In coarse wool breeds the primary follicles are relatively large and there may be only a few secondary follicles (e.g. about 22 total follicles/mm<sup>2</sup> of skin for Romney). In fine wool breeds the primary and secondary follicles are all small and there may be many secondary follicles in each group (e.g. about 60 – 70 total follicles/mm<sup>2</sup> for Merino). Fine wool fleeces typically feel waxier or greasier than coarse wool fleeces because sheep producing fine wool have significantly more follicles so have more sebaceous glands.

During development of the skin in the womb, genetic factors influence wool follicle size and number, and therefore the type of fleece that can be produced, but environmental factors also have an effect:

- **Nutrition:** Wool follicles develop in the womb in the last half of gestation and in early postnatal life, and the level of feeding affects follicle development. The critical time for good feeding of pregnant ewes for maximum follicle development is from 60 days gestation to at least 70 days after birth. Poor nutrition of the ewe and consequently of the lamb during this time means that the lamb may never realise its full potential for wool production. This is particularly important in the Merino in which many secondary follicles are important for a full fine fleece. Poor nutrition in late gestation will mean fewer secondary follicles in the lamb and consequently a coarser and lighter fleece.
- **Iodine deficiency:** Foetuses from ewes with iodine deficiency may die or they may be born with goitre (swollen thyroid glands) or, rarely, they may develop few secondary follicles so that they are born with a sparse fleece.
- **Infection:** If a ewe is infected with 'Hairy Shaker Disease' virus during pregnancy, the virus can cause an increase in the size of the primary follicles during development of the skin in the foetus. This means that a Romney type fleece will end up looking like a Drysdale fleece. Depending on the stage of pregnancy when it is infected in the womb, the foetus might die, or its brain and spinal cord might be damaged (resulting in a 'shaker' lamb) or its fleece might be coarse (a 'hairy' lamb).
- **Temperature:** Very high temperatures during pregnancy, coupled with a low intake of feed can impair follicle development but this is very unlikely in New Zealand.

Wool staples are wool fibres grouped together in bundles. Staples are usually formed from the fibres of more than one follicle group. Tight, dense follicle groups tend to form thin staples and less dense follicle groups with little skin between groups tend to form thicker staples. The shape and size of each staple varies greatly between one sheep and another. It also varies between one part of the sheep's body and another.



**Figure 4: Wool staples (the groups of fibres) on a Merino (left) and Crossbred (right). Fine wool staples tend to be 'thinner' than crossbred wool staples due to the density of wool follicles.**

Cgoodwin, 2008

[https://commons.wikimedia.org/wiki/File:Wool\\_staples.JPG](https://commons.wikimedia.org/wiki/File:Wool_staples.JPG)

(CC BY-SA 4.0)

## Wool fibre structure

Like human hair, wool is made of a protein called keratin. The wool fibre grows in the same way as hair grows on human skin. At the base of the follicle, fibre cells are continuously being formed, and as they multiply they move upwards into the follicle where they flatten and combine to form the wool fibre.

A wool fibre is made up of two layers:

- cuticle - the outermost layer of flattened cells overlapping like tiles on a roof
- cortex – area inside the cuticle, with solid fine fibres and hollow larger fibres

The cuticle allows wool fibres to both repel liquid and absorb moisture vapour (such as humidity and sweat). As the fibre grows up out of the follicle, the cuticle cells are flattened and become overlapping, like scales on a fish. The overlapping nature of the cells causes liquids to drain off. They can also lead to matting or felting of wool as they act like barbs when wool fibres are pulled apart. Matting can also occur in wool on the sheep when cast, and broken fibres and vegetable debris become tangled.

The cortex, which usually makes up about 90% of the fibre, is made up of very small, cigar-shaped cells. The keratin in these cortex cells enables wool to absorb up to 30% of its own weight in moisture vapour without feeling damp. The physical and chemical structure of the cortex also allows wool to quickly release the moisture through evaporation. Keratin can also bind with dyes so dye is absorbed into the core of the wool fibre, resulting in a true and lasting colour.

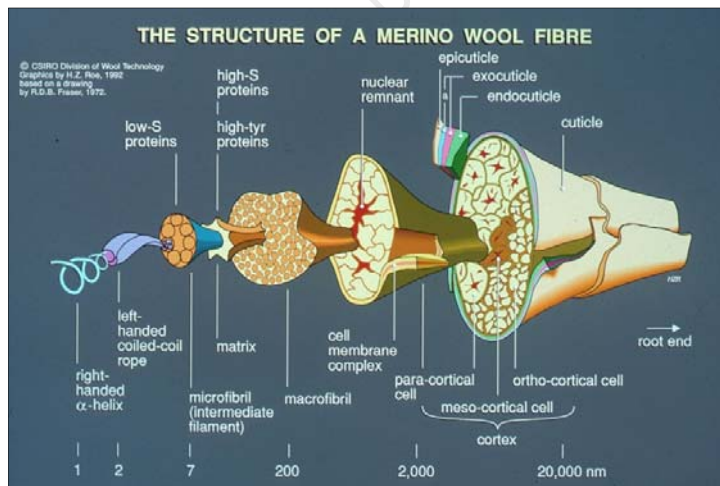
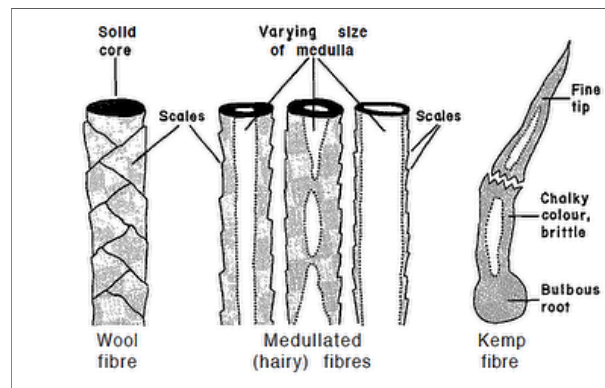


Figure 5: Wool fibre structure

Textile and Fibre Technology, CSIRO  
<http://www.scienceimage.csiro.au/image/2489>  
(CC BY 3.0)

## Medullation

In many coarse fibres, a central hollow in the cortex is filled with an open lattice-work of keratin filled with air which is called the medulla. In some fibres the centre is completely hollow and filled with air (see the



**Figure 6 Medullated Fibres**

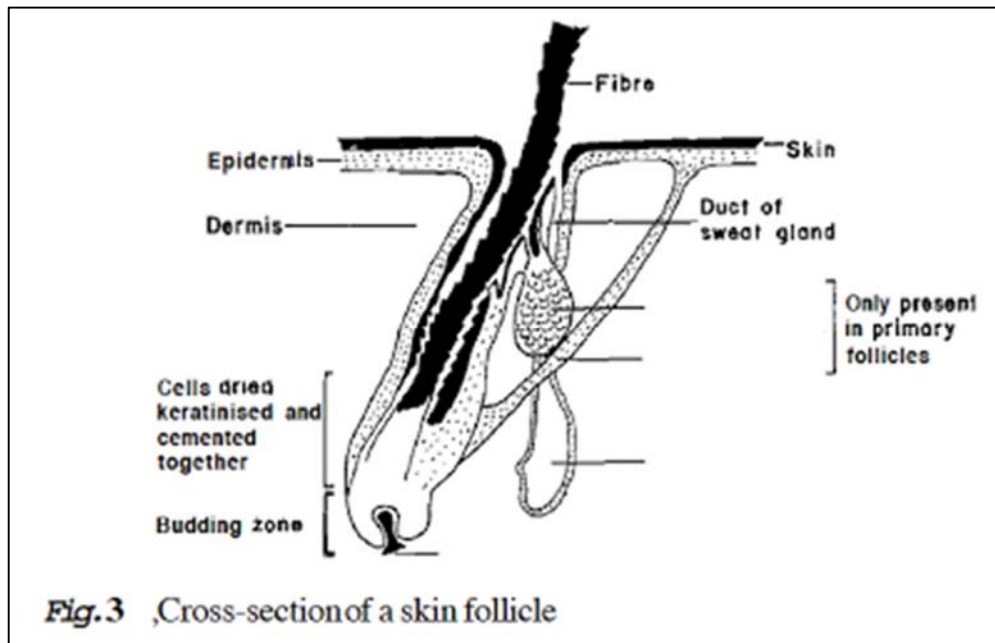
Source: woolshed1.blogspot.co.nz

diagram below). In general, the coarser the wool fibre, the larger the medulla. When most of the interior of the fibre is medullated, the fibre tends to become flattened, chalky-white and brittle. Fibres with a medulla are called medullated fibres and feel 'hairy'. Short, highly medullated fibres that are often shed or fall out from the skin are generally known as 'kemp'.

Medullated fibres do not dye as uniformly as non-medullated fibres due to the air in the medulla. In most cases, medullated fibres are undesirable in wool used for making clothing but some degree of medullation is seen as desirable in carpet wool. It gives a 'crisp' handle or feel, a higher resistance to compression (being stood on by people or furniture), less tracking and helps retain the overall appearance of a carpet.

## Test Yourself #1

1. Name the parts of the wool follicle indicated by the arrows in the diagram below.



*Figure 7: Primary wool follicle showing the skin layers (epidermis, dermis) and papilla which provides nutrients and energy for wool*

<http://woolshed1.blogspot.co.nz/2009/05/introduction-to-practical-animal-14.html>

(Image used with permission)

2. Is the wool follicle above a primary or secondary follicle? Explain your answer.
3. Name the substance wool fibre is made of.
4. Name the two main parts of a wool fibre.
5. Describe the difference between a 'normal' wool fibre and a medullated wool fibre.
6. Describe what medullated fibres do to the 'feel' of the wool.

7. Briefly describe why medullated fibres are used in carpet making.
  
8. In terms of follicle number and density, briefly describe the main differences between crossbred and fine wool breeds of sheep.
  
9. Name the parts of a wool follicle that produce a) suint and b) grease.
  
10. Briefly describe how primary and secondary follicles are typically arranged on the skin.

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## Wool Properties

Wool has many properties that make it suitable for many end uses; from soft, warm under clothing to carpet and housing insulation. The variations in wool properties allow for these diverse end uses.

Individual wool fibres vary in diameter along their length. Within a staple, the fibres vary greatly in diameter and usually also in length. The staples vary in different parts of a fleece, not only in mean diameter and length, but also in foreign body contaminants and yield (yield is the amount of pure wool fibre compared to the greasy fleece straight off the sheep). Animals in a mob vary in fleece properties and mobs making up a flock are likely to be different. As an example, the relative size in variations in fibre diameter is shown in the following pie charts. In sound wool, the biggest source of fibre diameter variation is found between the different fibres within a staple, whereas in tender wool, the main sources of variation are found between the fibres within a staple and along the individual fibres.

In general, major variations in wool properties occur between different sheep breeds. However, for a particular breed or line of sheep, factors such as season, climate, nutrition, disease and timing of shearing can also influence the level of variation in wool properties.

The following wool properties are the main causes of variation that affect the price of wool, hence they form the basis of wool tests. Farmers and/or wool brokers submit wool samples to laboratories, such as the New Zealand Wool Testing Authority Limited, for testing prior to sale.

Further Reading:

<http://www.sgs.co.nz/~media/Local/New%20Zealand/Documents/Technical%20Documents/Technical%20Bulletins/Wool%20Testing%20Info%20Bulletins/SGS-AGRI-5-12-Sampling-Wool-A4-EN-11-V1.pdf>

### Fibre diameter

Fibre diameter (the width of wool fibres) is typically the most important factor affecting price for most wool types. It determines how the fibre will be used because the handle (how it feels) and visual appearance of the final product is significantly affected by the diameter of the wool. In almost all cases the price of wool increases as the diameter decreases, i.e. fine wool is higher priced than coarse wool.

However all wool fibres in a fleece are not perfect straight cylinders all of the same size, so when measuring diameter, the mean fibre diameter (MFD) is used. It is measured in micrometres; commonly called microns (e.g. 31  $\mu\text{m}$ ). A micron is a millionth of a metre or a thousandth of a millimetre. Fibres are cleaned (scoured) before the diameter is measured.

There are three broad groups or classes of wool based on their mean fibre diameter. These classes are largely related to sheep breeds. The following table shows the three fibre diameter classes, the name given to these classes and breed examples.

Table 1 Fibre Diameter Classes

Wool class name	Mean fibre diameter	Subclasses	Examples of breeds
Crossbred wools (strong or coarse)	> 31 microns	fine (25 to 31 micron) medium (31 to 35 microns) coarse (>35 micron)	Romney, Perendale, Coopworth, Border Leicester, Texel and crosses of these breeds
Medium wools (mid-micron)	25 – 31 microns		Corriedale, New Zealand Halfbred, Cheviot
Fine wools	< 25 microns	Super fine ( $\leq$ 16 microns) Extra fine (17 – 18 microns) Fine (19 – 20 microns) Medium (21 – 22 microns) Strong (23 – 24 microns)	Merino, Polwarth

A specialist coarse wool breed is the Drysdale. The fibre diameter of Drysdale wool is typically greater than 40 microns. It is used mainly in the manufacture of carpets.

The following graph indicates the amount of variation in New Zealand crossbred wool fibre diameter from tests taken by the New Zealand Wool Testing Authority in 2012/13. Over 50% of crossbred wool was greater than 35 microns, i.e. it was coarse crossbred wool.

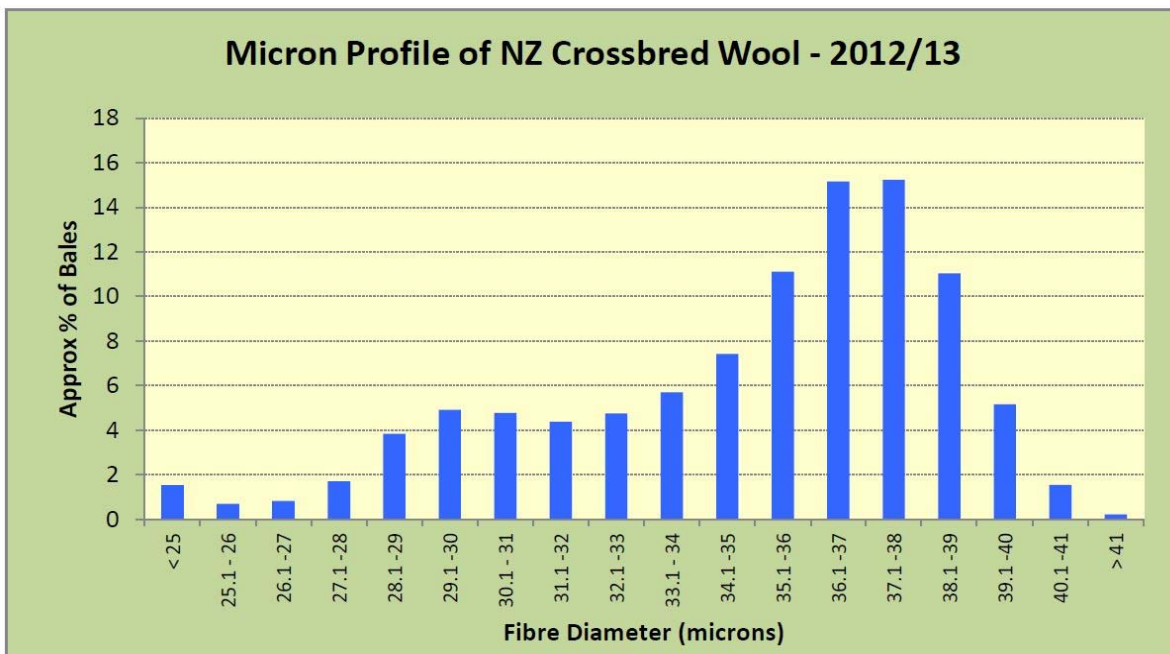


Figure 8 Micron profile of NZ crossbred wool - 2012/12

New Zealand Wool Testing Authority Ltd, 2015  
<http://www.nzwta.co.nz/assets/Images/crossbred-wool-12-13.jpg>  
 (Image used with permission)



The following graph indicates the amount of variation in New Zealand Merino wool fibre diameter from tests taken by the New Zealand Wool Testing Authority in 2012/13.

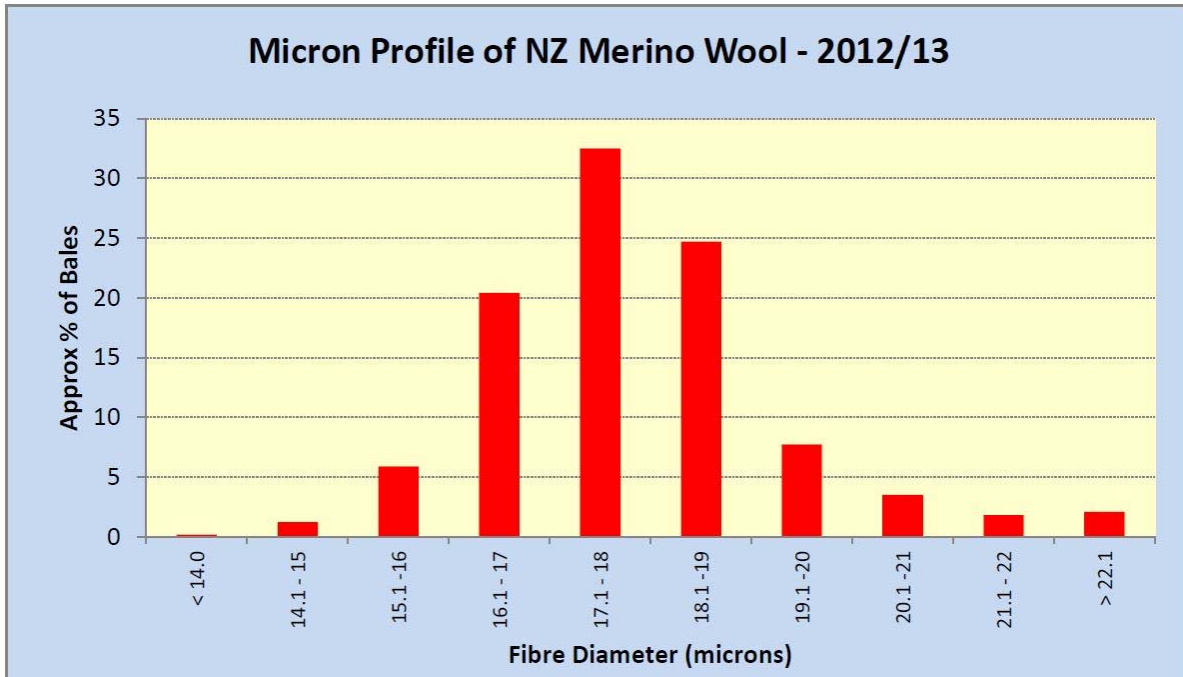


Figure 9 Micron Profile of NZ Merino Wool - 2012/13

New Zealand Wool Testing Authority Ltd, 2015  
<http://www.nzwta.co.nz/assets/Images/merino-wool-12-13.jpg>  
(Image used with permission)

Over 75% of Merino wool was between 16 and 19 microns. There is less overall variation in Merino wool fibre diameter compared to crossbred wool because crossbred wool comes from a range of different breeds rather than just one breed. Crossbred wool also comes from regions all over New Zealand with varying climates and management strategies (e.g. meat and wool production) whereas most Merinos are farmed in South Island high country areas which focus on wool production.

The variation in fibre diameter is assessed using three different measures:

1. standard deviation (a statistical measure of variation compared to the average fibre diameter)
2. coefficient of variation
3. comfort factor – the proportion of fibres less than 30 microns (when the individual fibre diameter is greater than 30 microns the “prickle” sensation is felt on skin)

The coefficient of variation of diameter, or CvD, is an indication of total fibre diameter variability in a sample of wool. Wool processors making worsted<sup>2</sup> yarn generally prefer lower CvD values because they usually produce more even yarns. Low CvD values are also associated with higher staple strength. For New

<sup>2</sup> Worsted yarn refers to a fine smooth yarn spun from combed long wool staple.

Zealand merino wool, the CvD is reasonably similar (20% to 25%) for typical mean fibre diameter values (16 to 21 microns).

Comfort factor (CF) or prickle factor (PF) is related to mean fibre diameter and CvD in a relatively complex manner but basically as the mean fibre diameter increases, the comfort factor decreases. Also, at a fixed mean fibre diameter, an increase in CvD also decreases the comfort value. In other words:

- coarser wools have a lower comfort factor
- for wools of the same mean fibre diameter, wools with high variation around mean give a lower comfort factor than wools with low variation

**Further Reading:** refer to Appendix I SGS Wool Testing Services Information Bulletin on Airflow, OFDA and Laserscan. These are the three main methods used for measuring and certifying fibre fineness.

## Strength

Along with fibre diameter, fibre strength is an important characteristic in determining the price of wools, particularly fine wools. Wools with good strength are called 'sound' and those with poor strength are called 'tender'. Don't get confused with 'strong' wools which refer to wools with a large fibre diameter.

The strength of the wool determines whether the fibres break during processing which in turn affects the overall length of fibre used to manufacture the end product. Tender wools produce more waste during processing. Tenderness is usually caused by an area of narrower diameter along fibres due to factors such as seasonal growth, stress, pregnancy or nutrition. Any weakness in the staple tends to be located across a short, well-defined band. Farmers can time their shearing so that any tender zone is as close to the staple end as possible, but this may mean the wool is relatively short for processing.

Fibre strength is measured by pulling apart wool staples of a given mass and length (linear density – similar to volume, measured in kiltex – units 10g/m), and recording the force required to break the fibres. The average staple strength is expressed in Newtons per kiltex – Newtons being a unit of force.

The following measurements indicate the fibre strength of wool:

- < 25 N/ktex usually tender
- 25-30 N/ktex tender/sound
- > 30 N/ktex increasingly sound
- > 40 N/ktex very sound

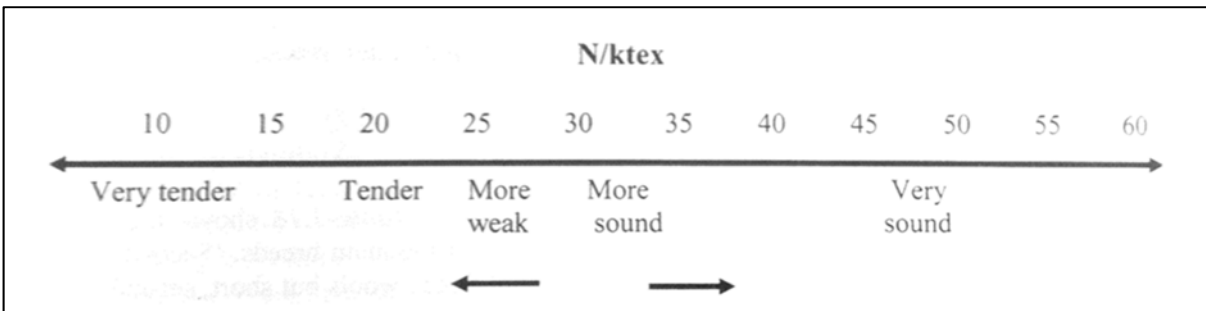


Figure 10 Fibre Strength Measurements

Trafford and Trafford. (2011). p A-39

Note that it is differences in diameter along fibres that determine weakness. Fibres can achieve a given linear density (imagine it as volume) by being even in diameter or by being thick in some parts and thin in others. If they are the latter, the strength of the fibres is determined by the strength of the thinnest point. As that point will be thinner than any point in the even-thickness fibre of the same linear density, it will break with a lower force. Therefore fibres with the most variable diameters have the lowest reported staple strengths.

The position of the break is also measured. Wools that break in the middle typically result in shorter fibre lengths when processing. Wools that break near the tip or base result in longer fibre lengths and are typically more valued by wool processors.

## Length

For most end uses, wool buyers prefer mean staple lengths of greasy wool of 75 – 100 mm. Fibre length before processing typically gives an indication of fibre length after processing (i.e. scoured, carded, etc. and ready for making into yarn or fabric). However, as discussed above, processed fibre length is also linked to wool strength. Mean fibre length is measured in millimetres. Left unshorn, wool can grow about 125 to 150 mm per year. Sheep breed and timing of shearing are the main factors determining fibre length. Depending on the shearing interval, wools are generally available in a range of staple lengths between 60 and 125 mm.

The coefficient of variation of staple length is an indication of total fibre length variability in a sample of wool. The following coefficient of variation values indicates the fibre length uniformity of a line of wool:

- < 12% excellent uniformity
- 13 – 20% good to average
- > 21% increasingly mixed length

### Activity

If you have access to raw wool:

- a) Take a wool staple and tease it apart to look at the variation in length of individual wool fibres.
- b) Take a small sample of the fibres and hold at each end. Try pulling them apart to see where they break. This may prove difficult with sound wool.

## Colour

Greasy or raw wool colour is important to processors as only white wool can be dyed to pastel shades, whereas off-coloured wool (cream or yellow) is only suited to dyeing to darker colours. Raw wool that is black or dark coloured is not acceptable to the main wool processors but may be used in niche markets such as natural coloured wool yarn for knitted clothing or fabrics.

The base colour (unscoured) of greasy wool is regarded as an important price factor for New Zealand crossbred wools in particular. In general, fine wools such as Merino are naturally whiter than crossbred wools.

Wool colour is assessed as being either scorable or unscorable. Scorable colour is a discolouration that will wash out during processing. It is visible in the wool as a creamy colour or a very light yellow and is common in 'old' wool that may have been stored for some time. Scorable colour will wash out in early stage processing (scouring) to give a creamy-white product.

Greasy wool with unscorable colour will result in an end product that will come out off-white or yellow, even after washing. Unscorable colour is usually visible as brighter yellow shades in greasy wool. Unscorable colour in wool can be influenced by climate (high rainfall and humidity levels), diet, animal health and external parasites.

Wool brightness, as well as colour, is also valued by processors. Bright wool looks 'light' rather than 'dingy'. Brighter wools have a wider range of uses and often receive a higher price.

Raw wool is commonly tested for colour and brightness. Colour measurement avoids the need to estimate whether the visible yellow is permanent. A colorimeter or spectrophotometer measures light reflected from scoured wool. Results appear on the test certificate as values in the X (red/orange), Y (green/yellow) and Z (blue/violet) parts of the visible light spectrum.

The measurements of most use to the farmer are:

- Y a measure of brightness: the higher, the better.
- Y minus Z a measure of yellowness: the lower, the better.

Ideally, wool should be bright and white.

Typical values are:

Wool type	Y	Y minus Z (Y – Z)
Good Merino	> 68	< 0
Good cross-bred	64 - 68	0 – 3
Poor cross-bred	< 59	> 6

## Crimp and bulk

Crimp refers to the number of bends per unit length along the wool fibre (the crinkles along the staple – see images below). The number of crimps in a fibre largely determines wool 'bulk'; in general, the more crimps the greater the bulk. Bulk is the ability of wool to fill space. A high bulk wool will fill a larger volume of space for a given weight of wool than a low bulk wool. For example, a quilt filled with high bulk wool would feel lighter than a quilt filled with low bulk wool. High bulk wools are able to resist compaction during processing and produce a bulkier yarn so they can improve the pile density of a carpet and increase insulation and warmth in knitted fabrics without increasing their weight.



**Figure 11 Wool Crimps**  
*Merino wool has more crimps per unit length than Finn which has more crimps than Romney*

Diane Falck, 2011  
<http://spinningshepherd.blogspot.com.au/2011/02/ouessant-wool-101-n-5-of-locks-style.html>  
(Image used with permission)

Bulk affects the appearance and feel of the end products, as well as in performance during processing. Bulk is regarded as an important characteristic for wools which are processed into carpet and hand knitting yarns and in wools used for filling, in such products as quilts, mattress overlays and Japanese futons (a type of mattress). Bulk is expressed in terms of the volume occupied by a certain mass of wool (cc/g – cubic centimetres per gram).

It was once thought that the higher the number of crimps/fibre the finer the wool but this relationship has proven to be not very accurate.

The following graph shows typical bulk measurements for wool of different sheep breeds. Typically, the higher the number of crimps per fibre, the greater the bulk.

Low crimp wools tend to be more lustrous (glossy or shiny). Both Lincoln and Leicester breeds have lustrous wool. Lustre can be important for some end products such as fashion fabrics, furnishing fabrics and hand-knotted carpets where a soft silky handle is desired. High lustre wools have cuticle scales that are relatively large, flat and smooth, reflecting more light than low lustre wools, so look shinier.

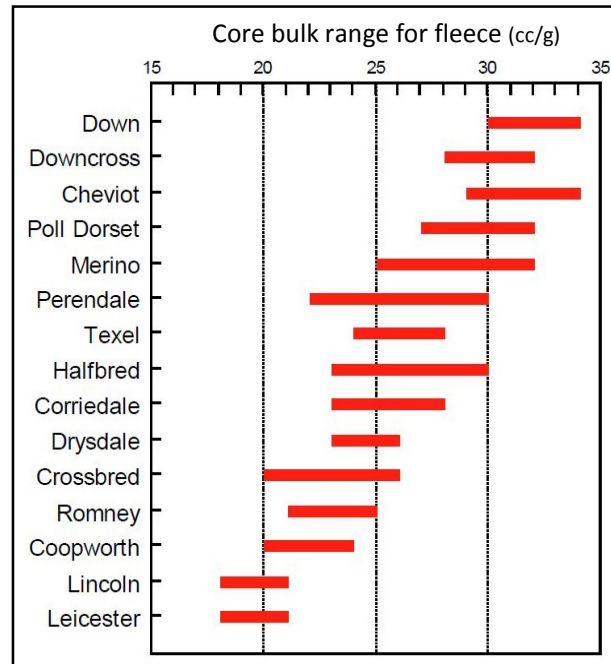


Figure 12 Typical Wool Bulk for Different Sheep Breeds

Source: SGS Wool Testing Services; Wool Bulk; Info Bulletin Vol 5.1a

Commercial measurements of crimp and bulk are not usually available because of the difficulties in providing reliable measurements.

## Yield

Yield is the weight of clean wool, after impurities have been removed. It is expressed as a percentage of the greasy wool weight.

$$\frac{\text{Clean weight (kg)}}{\text{Greasy weight (kg)}} \times \frac{100}{1}$$

Impurities include grease, suint, seeds, twigs, sand and soil; basically anything other than the wool fibres. In addition, wool naturally absorbs moisture and this can vary from day to day depending on climatic conditions. To overcome this variability, as well as removing impurities, wool is dried. The clean dried wool is called 'wool base'. The wool base weight is used to calculate yield using slightly different methods. The yield most buyers use to calculate greasy prices is the 'Schlumberger dry' yield.

Yield is important in deciding the price per kg of greasy wool, since the processor wants only wool, not dirt and grease. Suppose the buyer decides two similar lots are both worth \$4.00 per clean kg of wool and Line 1 yields 78% and Line 2 yields 83%. The buyer can therefore pay a greasy price of \$3.32 per kg (\$4.00 multiplied by 83%) for Line 2, but only \$3.12 for Line 1 (\$4.00 x 78%). The price per kg of clean wool is the same for both.



*Figure 13 Fleece*

Retrieved with permission from [www.woolclassers.co.nz](http://www.woolclassers.co.nz) on 10 December 2015.

Breed influences yield. Fine-woolled sheep like the Merino have lower yields than strong-woolled breeds like the Romney. Management and climate, especially rainfall, can affect the weight of impurities and moisture in wool, so also affect yield.

## Vegetable matter

Vegetable matter can reduce wool processing performance. Hay and twigs drop out easily but seeds and burrs with strong hooks are hard to remove. Vegetable matter is measured by dissolving away the wool with a strong alkaline solution. The percentage by weight of vegetable matter that remains, and type, are shown on the test certificate.

Most New Zealand wools have less than 0.4% vegetable matter, which is low relative to wools from other countries. Vegetable matter is not usually a problem until it is more than 0.5%. Some Australian wools have vegetable matter levels of more than 5%.

## Wool testing

Wool testing, for all the above parameters, is important because buyers can use objectively and independently measured characteristics to help decide the suitability of wool for their processor clients. Wool measurements (as a result of scientific tests) have an increasing influence on the price paid for wool, while the appearance of the clip (judged by its look and feel) is becoming less important.

Measured characteristics can also help in decision-making about future breeding and clip preparation. When farmers sell a line of wool at auction they receive a copy of the test certificate, which shows the major test results measured by a registered wool testing laboratory. If the wool is sold privately, the seller has to arrange for testing. He or she samples the wool and sends the sample to a testing laboratory. The laboratory provides guidelines on sampling method.

How can test results be used?

- Most test results are used to decide the price of wool. They can be compared to prices for similar wools.

- The yield can be used to convert clean prices to a greasy price as quoted by potential buyers (see 'Yield' section above).
- The results can be used to assess the standard of the clip preparation. If 'yellow' wool (fleece or oddments) does not have a Y minus Z result at least two units greater than the main line, then it was not different enough to justify removal. Fine wool clips classed for fibre diameter should show at least 1 micron difference between fleece lines in the 19 to 20 micron range and 1 to 2 micron difference for medium and strong Merino clips.
- Length and strength testing also gives useful feedback about management. Fibre tenderness is largely determined by nutrition so a bad break and its position, both highlighted by testing, will help identify the period of nutritional stress so that improvements can be made in future.
- Objective measurements of individual fleeces can be used to make retention/culling decisions, such as selecting Merino hogget's based on fibre diameter. Some cross-bred stud breeders use yield to convert greasy hogget fleece weights to clean weights for selection. Mid-side samples from each sheep can be used with fleece weights to provide useful information for stud recording purposes. The data is used when selecting breeding stock.

### Activity

If you have access to a wool test, look at the results and use all the information in the sections above to help determine the properties of the wool.

## Wool faults

There are certain characteristics of the wool fibre that limit its use in some manufacturing processes. Collectively, these characteristics are called 'faults', and faults can be classified as genetic or inherited faults and acquired faults. Wools that contain faults are not totally useless, but faults mean that the range of products that the wool can be used for may be limited.

### Genetic wool faults

#### Hairy/medullated wool

Medullated (hairy) wool fibres are coarse, strait and have a chalky appearance.

They are usually regarded as a fault in wools destined for use in clothing. This is because they tend to give wool a stiff or prickly feel and they do not take dye well so wool with a lot of medullated fibres appears off-coloured. Medullated wools also decrease the efficiency of spinning.

Because of its genetic basis, the amount of medullated wool in the clip can be reduced by culling affected sheep from the flock.



### Hairy tip

Fibres with a coarse medullated tip are 'hairy' fibres. This causes pointed tips to the staple. The tip is formed by the longer, thicker fibres sticking out above the shorter finer fibres. As with normal medullation, culling of sheep with this type of wool is the best control method.

### Kemp

Kemp fibres differ in their structure from normal wool fibres. Their tip is sharply pointed and not medullated, but the shaft of the fibre is heavily medullated with the very large medulla cells surrounded by a thin ring of cortex cells and then the usual layer of cuticle cells. Kemp fibres are usually shorter and more flattened than normal wool fibres. Most of the hair fibres on the face and legs are kemp fibres.

Kemps are useful in the production of heavy tweed cloth but they have few other uses as they are rough, harsh to touch and difficult to dye. Production of kemp is a strongly genetic characteristic and control can be achieved by careful selection of breeding stock.

### Pigmented wool

For all but coloured wool breeds, it is a fault for sheep to have any pigmented fibres (black or dark coloured) in their wool clip. Fortunately most New Zealand wool is free of black and pigmented fibres.

### Physical damage

#### Cotted/matted wool

Cotting or matting in the fleece is the result of extensive and severe entanglement of the wool fibres. Although fibres on the outside of the fleece may get slightly tangled due to rubbing, this does not usually cause matting. Severe entanglement is caused when fibres are first shed from the skin and then become entangled within the staple.

Factors known to cause the wool to be shed include poor feeding during the winter, stress during pregnancy and lactation, and lice infestations that cause the sheep to rub their fleece. Once shed, the wool fibres migrate through the fleece and their cuticles 'catch' to cause tangling. Cycles of wetting and drying of the wool increase the entanglement.

The most effective way to prevent this fault is to cull sheep with cotted fleeces from the flock, ensure there is no lice infestation and provide good feeding during the winter and during periods of stress.

### Discolouration

Yellow discolouration (commonly called yellow staining) is another common fault in New Zealand wools, especially in late shorn cross-bred wools grown in warm moist conditions. Some yellow staining may be removed by scouring, but severe staining (called canary stain) is permanent and it cannot be scoured out. High rainfall with warm humid temperatures encourages the proliferation of bacteria that cause bands of this discolouration, especially on areas that do not dry out well like the fleece line, the shoulders and back leg.

Yellowing of the fleece can be minimised by shearing in late winter early spring, before the moist warm conditions that cause it develop. Where this is not possible, selecting and culling affected sheep may help, although it is important to cull only sheep with non-scourable stain.

Low rainfall and low humidity levels result in good colour, i.e. white wool.

A range of micro-organisms including mites, fungi and bacteria can directly and indirectly cause faults in wool. Some of the bacteria that can proliferate in the surface layers of the skin and just above the skin surface can cause skin inflammation and exudation. This can result in scabbiness and various discolourations such as green and blue. Control is often difficult because it is hard to identify infected sheep until the infection is severe.

Black and brown pigmentation are also forms of discolouration.

Pen stain is faecal staining of the wool. Avoid pen stain by dagging at least a week before shearing and letting the sheep empty out on a bare area for at least 8 hours and up to 24 hours before penning up. Some faecal stains and urine stains are unscourable. Urine stains scours to an orange/brown colour, and it should be treated as pigmented wool when handling the clip.

Dags should be removed carefully as fragments can fall into the fleece and affect wool processing.

**Table 1.16: Fleece Discolouration Guide**

<i>Name</i>	<i>Caused By</i>	<i>Initiation Factor</i>	<i>Appearance</i>	<i>Scourable</i>
Scourable diffuse Yellow	Wool yolk, Grease and Suint	-	Creamy Yellow	Yes
Canary Yellow	Chemical	Prolonged Wetness	Bright Yellow	No
Fleece Rot / Yellow Banding	Bacterial	Prolonged Wetness	Bands of Yellow	Yes / No *
Green and Brown Banded Stains	Bacterial	Prolonged Wetness	Bands of Green and Brown	No
Blue Banding	Bacterial	Prolonged Wetness	Blue bands	No
Apricot Stain	Unknown **	Prolonged Wetness	Pink - red shades	No

\* Fleece Rot - the bands of fleece rot exudate are scourable, however often Canary Yellow can form under the bands - which is not scourable.

\*\* As yet unknown, although possibly bacterial.

**Figure 14 Fleece Discolouration Guide**

Trafford and Trafford (2011).

## Earth and vegetable matter

The environment where sheep live will have a major effect on the amount of contamination from seeds and other vegetable matter, dust and dirt that can penetrate into the fleeces.

A common fault in New Zealand is the discolouration of wool caused by penetration of soil or sand into the wool. This can be caused by windblown material, or by sheep rubbing up against clay banks and muddy slopes. A certain amount of sand and soil falls from the fleece during shearing, and this is a good reason for keeping the shearing area swept clean. However most soil and sand scours out of the fleece fairly readily.

Another common fault with New Zealand wool is contamination due to vegetable matter. Given the extensive nature of pastoral farming in New Zealand, this is not surprising. Hay contamination does not usually cause too many problems but biddy bids, and fragments of thistles and gorse are more difficult to remove.

When sheep graze on scrubland they pick up leaves, twigs and pieces of bark that contaminate the wool along their back. These wools are called 'moity'.

The least troublesome material falls from the wool during ordinary processing, but if there is a lot of severely tangled material it requires extra processing, resulting in lower returns to the farmer.

Vegetable matter contamination can be controlled by having good pasture and an efficient weed eradication programme.

## Test Yourself #2

1. Briefly describe why wool strength is important to manufacturers.
2. For each of the following strength measurements indicate if wool would be considered tender or sound:
  - a) 23 N/ktex
  - b) 36 N/ktex
  - c) 42 N/ktex
3. Name a sheep breed that has high lustre wool.
4. State the main factor affecting the length of wool.
5. Briefly describe the main way in which fibre diameter affects wool products such as fabric.
6. Name the predominant fine wool breed.
7. Name three crossbred wool breeds.
8. List the mean fibre diameter range for crossbred, medium and fine wools.
9. Briefly describe why there tends to be more variation in mean fibre diameter in New Zealand's crossbred clip compared to the Merino clip.
10. In terms of Comfort Factor, what type of wool is considered most comfortable?
11. Briefly describe why wool colour is important to manufacturers.

12. If a wool sample test result was  $Y = 54$  and  $Y - Z = 7$ , what does this indicate about the wool?
13. Describe what is meant by 'cotted' wool and the factors that predispose cotting.
14. Yellow discolouration is a common fault in New Zealand wools. What are some predisposing factors?
15. How can you minimise 'pen stain' before shearing?
16. Briefly describe what is meant by the term 'bulk' and how crimp affects bulk.
17. Define wool yield.

Lincoln University

## Factors affecting wool growth and quality

Three main factors affect wool growth and quality:

- season
- nutrition
- physiological state

### Season

The main factor that controls the rate at which wool grows is day length. Light acts on a gland at the base of the brain stimulating the release of a hormone called prolactin. Sheep show a seasonal rise in their prolactin levels in spring, and this remains high in summer, then drops in winter. Low prolactin levels in winter inhibit development within the wool follicle, leading to slower fibre growth or in some breeds, such as the Wiltshire, a complete break in the wool fibres which results in the fleece falling off (moulting). Poor nutrition, sudden changes in nutrition and stress can also result in wool breaks for any breed.

Romney and other crossbred wool breeds are very light sensitive whereas Merinos are less sensitive. This means for crossbred wool breeds, the more daylight there is, the faster the rate at which wool grows (see following graph) and generally the greater the fibre diameter. However season does not affect Merino wool growth as much. Winter-grown Merino wool may be finer but this is often due to a lower level of nutrition.

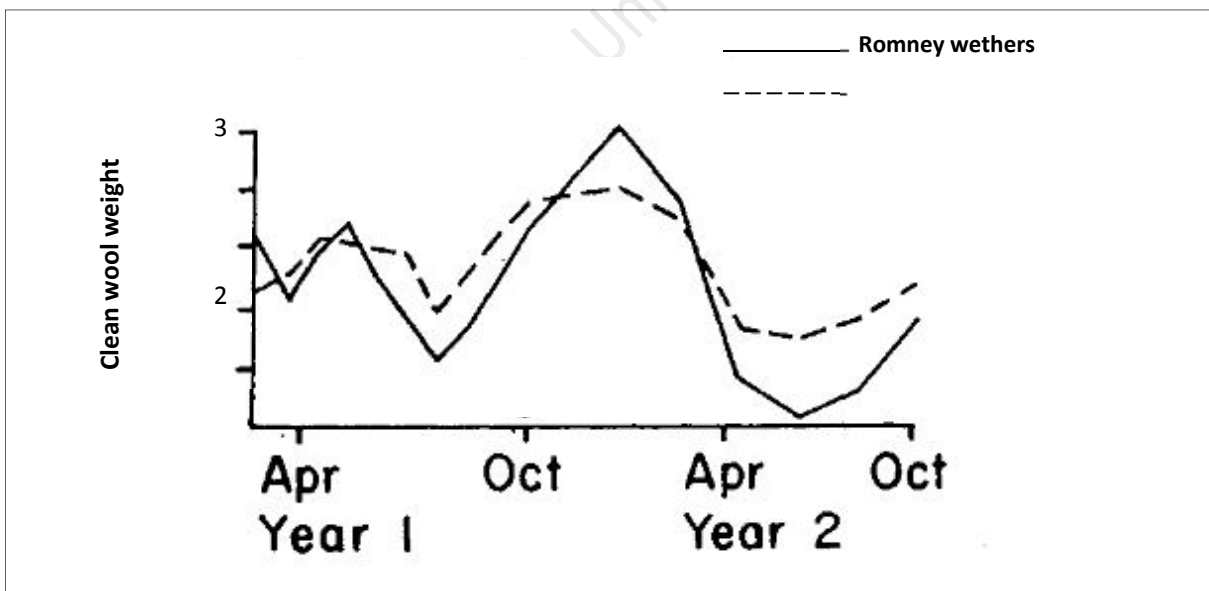


Figure 15 Seasonal wool production (g/patch/28 days) for Romney and Merino wethers

Source: Adapted from *Seasonal wool production of Romney and Merino x Romney wethers*. Bigham, M L; Sumner, R H W; Dalton, D C (1977), NZ Journal of Experimental Agriculture, 5:257-260.

Although the overriding factor controlling wool growth rate is day length, both nutrition and physiological state can affect potential wool growth during each season.

## Nutrition

Wool requires very little energy to grow; 40 – 50 MJME/kg of wool or 3.6 – 4.5 kgDM/kg wool of good quality feed (11 MJME/kgDM). However, in terms of the way in which sheep prioritise energy use, wool growth is a low priority. Energy for maintenance and warmth comes first; then the demands of the developing lamb in the womb; then milk production, ewe body growth and last, wool growth. In times of severe feed shortage, sheep usually grow just enough wool for survival, but no more. So although wool doesn't need much energy to grow, this 'partitioning' of energy means ewe nutrition does affect wool yield and quality:

- Underfeeding reduces the fibre output from wool follicles resulting in finer, shorter wool.
- Generous feeding levels support longer, coarser and heavier fibres, hence heavier fleece weights.
- Sudden changes in amount or quality of feed can reduce staple strength and fleece yield.

In general, wool growth tends to increase as nutritional levels increase, with the extent of the response depending on the time of year. For all breeds, the best response is in summer when day length is long and blood prolactin levels are high. Good feeding of ewes after weaning typically results in higher wool growth rates and wool yield.

High levels of feed in winter have less effect on wool production of crossbred wool breeds because prolactin levels are low so the potential for wool growth is also low. On the other hand, underfeeding may accentuate the reduction in wool growth and result in very tender wools. Merinos have better winter wool growth potential but this is only met if feed quantity and quality is sufficient. Pregnancy accentuates the winter decline in wool growth for all breeds and delays the recovery in spring (see section on physiological state).

Research in Australia has also shown that good nutrition of Merino ewes during pregnancy and lactation increased the fleece weight and reduced the fibre diameter of wool produced by their progeny over their lifetime. For example, a trial in Victoria showed a loss of 10 kg in ewe liveweight between mating and day 100 of pregnancy (full gestation is around 150 days) reduced fleece weight of their lambs by approximately 0.2 kg at each shearing until 51 months of age (4 ½ years). In contrast, ewes gaining 10 kg from day 100 of pregnancy to lambing had the opposite effect, i.e. an increase in fleece weight of their lambs. Improving the nutrition of Merino ewes during pregnancy also permanently decreased the progeny's fibre diameter (made it finer, hence more valuable).

There is often concern among Merino farmers that feeding Merino stock well will cause fleeces to increase in average fibre diameter, or as it is commonly referred to, 'micron blowout'. Conversely if Merino sheep are underfed, their fleeces will be finer. Underfeeding is NOT recommended however, because, apart from animal welfare, growth and reproduction considerations, the fleece weights will be lower, the wool will be tender and of poorer quality. These wools are called 'hunger fine' and can receive substantial price discounts. A finer wool clip can be achieved by breeding from selected ewes and rams, and feeding ewes well during pregnancy and lactation. Rams in particular have a large influence in determining the average

fibre diameter of the flock because rams are responsible for the genetic makeup of much greater numbers of progeny than a ewe.



*Figure 16 Nutrition affects the growth rate and fibre diameter of wool*

Sudden changes in amount and quality of feed change the amount of nutrients available to wool follicles. This can cause significant narrowing of the fibre, commonly called a 'break' (although the fibre doesn't necessarily actually break), resulting in lower strength characteristics. To prevent wool fibre tenderness avoid periods of underfeeding and sudden changes of diet between pasture and forage crops, or from poor to high quality pastures. More gradual adaptation of the ewe's rumen to a new feed and/or offering hay or balage when changing diets can reduce the risk of tenderness or wool break.

In addition to fleece weight and strength, feed can also affect wool quality:

- Feeding out hay and silage can cause wool to be contaminated with vegetable matter. Placement of hay in places not favoured as 'camps' can help prevent sheep sitting on waste hay.
- When feeding on winter crops sheep may get mud contamination in their fleeces that may cause staining.

In general, for a breeding ewe farming system (coarse or fine wool), if ewes are fed to meet mating, pregnancy, lactation and liveweight gain targets, without underfeeding or undue stress at any time of the year, wool growth rate and wool strength is likely to be maximised. Consistency of feeding and feeding to maintain good body condition are the keys to maximising fleece yield and quality in ewes and their offspring.

Wethers in specialist fine wool systems fed a constant supply of sufficient feed, to maintain target liveweights and body condition, should produce more wool than fine wool breeding ewes because they do not have the stress and energy drain associated with reproduction.



## Physiological state

### Pregnancy

Pregnancy reduces the amount of wool grown by ewes by reducing the fibre diameter and rate of growth. By the second half of pregnancy, wool growth has decreased by approximately 30%. Lactation also reduces wool growth. This is because nutrients that might otherwise go towards wool growth are channelled to the developing lambs and milk production. Pregnancy and lactation together decrease the annual fleece weight by approximately 10 to 14%.

To some extent, this can be offset by better management, for example by scanning and preferential feeding of ewes carrying two or more lambs. In general, the extra weight of lambs weaned by ewes with twins and triplets more than compensates for the reduction in wool quality and quantity.

Poor nutrition during pregnancy and lactation amplifies the negative effects on wool yield and quality.

### Stress

Tender wool is the most common fault occurring in New Zealand wool.

Tender wool can result from nutritional or metabolic disorders:

- underfeeding especially in winter and/or during pregnancy and sudden changes of diet
- sleepy sickness or other metabolic disease around the time of lambing
- ill health (when sheep are stressed due to internal or external parasite infestation, fly strike, footrot, etc.)

## Test Yourself #3

1. Name the main factor that controls the growth rate of wool.
2. High wool growth rates are associated with a low level of the hormone prolactin. True or false?
3. Briefly describe the three main ways nutrition affects wool yield and quality.
4. Compared to non-breeding ewes, what percentage reduction in annual fleece weight would you expect for breeding ewes?
5. Briefly describe how Merino ewe nutrition affects fleece weight and fibre diameter of their progeny.
6. Break caused by thinning of wool fibres is the most common fault occurring in New Zealand wool. Describe what causes this.
7. Is it true that underfeeding Merinos will result in finer more valuable wool?

## Shearing

In New Zealand we typically use the term 'shearing' to cover all aspects of wool harvesting including the preparation for shearing, clipping of wool from the sheep, and classing and pressing wool into bales ready for sale. In this section we look at each aspect of shearing separately and its effect on wool quality and end use.

In preparation for shearing, a contract should be drawn up or an arrangement should be made between the shearing contractor and the farmer, and there should be a clear understanding with the classer or leading wool handler. The contract or understanding should cover the number of sheep to be shorn each day, the number of shearers and wool handlers who will be working and their standard and experience.



*Figure 17 Shearing.*

The farmer or grower has an obligation to present the sheep and the shed staff to handle them.

Retrieved with permission from [www.woolclassers.co.nz](http://www.woolclassers.co.nz) on 10 December 2015.

At shearing the woolshed should function as efficiently as a factory.

## Timing of shearing

Wool staple length and strength are significantly affected by shearing time and frequency. Wool colour can also be affected by timing of shearing particularly in warm, wet regions of New Zealand.

Traditionally, sheep are shorn once a year, producing full-length fleece wool. However, during the last 35 years a more frequent shearing pattern has been adopted, especially in the northern half of New Zealand where relatively high rainfall and warm temperatures can result in yellowing of long wool. Wool from sheep shorn twice a year is termed 'second shear', while that shorn at 8-month intervals is termed 'early shorn'.

The following diagram shows the shape of crossbred wool fibres (diameter and length) when sheep are shorn at different times of the year. The three fibres on the left illustrate 12 months growth between shearing's and the fibre on the right illustrates shearing after five and then seven months growth. The numbers indicate the month.

Mid-pregnancy 12-month shearing (shorn in winter – see diagram below) means the fleece is shorn close to the finest part of the fibre resulting in long, sound fibres usually of good colour. In contrast, shearing in summer (around January) means the fine or tender portion of the fibre is in the middle of the staple which

can reduce staple strength, restricting end use, hence price received for the wool. Annual shearing in late spring/early summer (around November) means the tender region of fibres is more towards the ends of the fibres so improves the length of sound fibre available for processing. The further into summer shearing occurs, the closer the break will be to the centre of the staple and the worse the colour. Shearing twice a year (e.g. May and November – fibres on the far right of the diagram below) produces short fibres, with the late spring (November) shorn fibres being sounder (more even fibre diameter) than the autumn (May) shorn fibres (with finer diameter near the middle of the fibre).

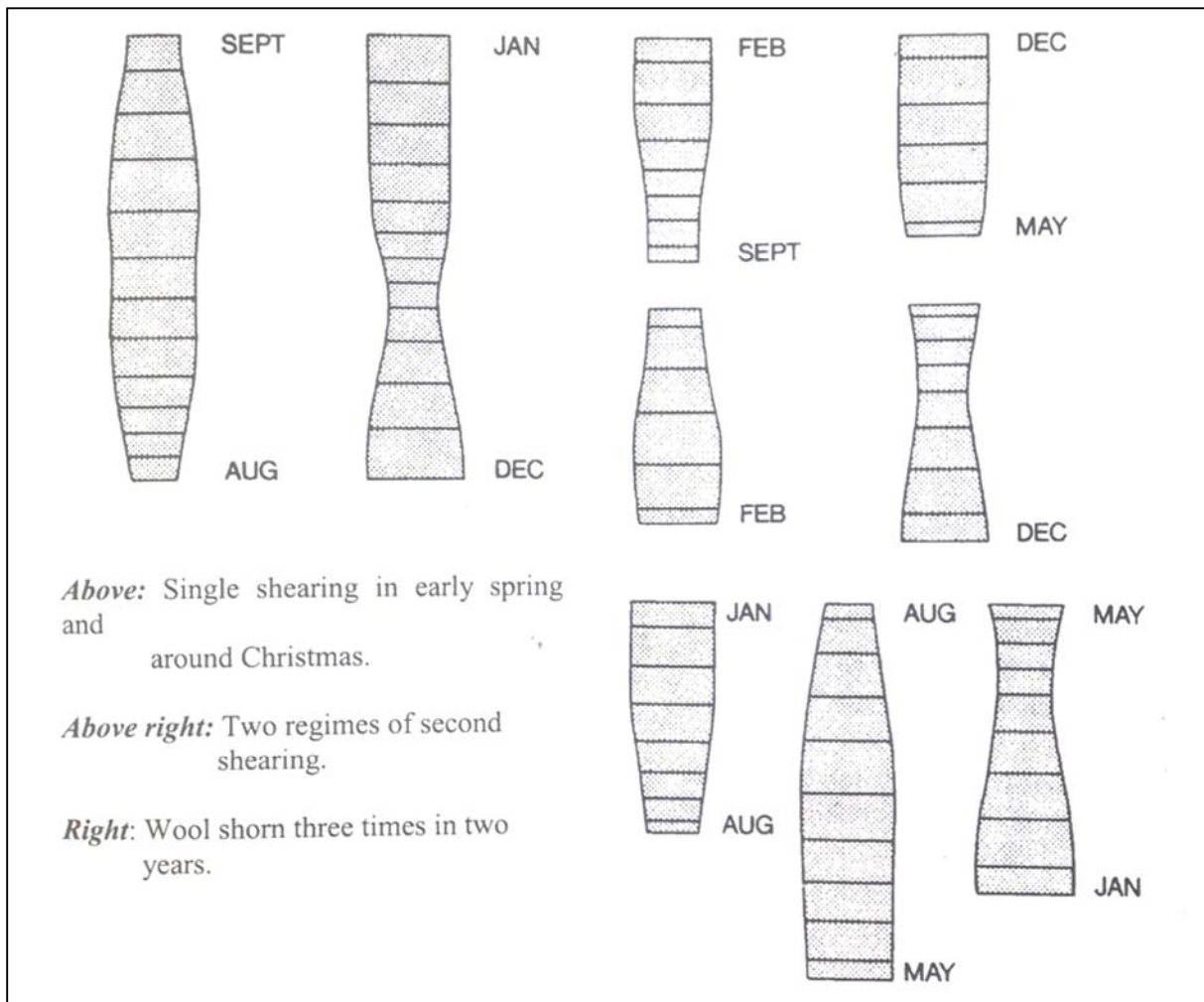


Figure 18 Shearing Times and Fibre Shape (Romney – cross type sheep)

Trafford & Trafford. (2011) p A-47.

Lower wool prices in recent years have resulted in more full fleece wool being offered at auction again, as farmers look to maximise their income by reducing shearing costs.

The key factors that influence farmers when they are deciding when to shear are:

- The optimum processing length for wool (100 to 125 mm).

- Minimising the effects of break/tenderness coting and discolouration.
- The manufacturer's requirements.
- With once-a-year shearing, shearing as early as possible before yellow discolouration and coting occur.
- With cross-breds, the pros and cons of an 8-month regime, splitting the flock into two shearing groups, and mid-pregnancy shearing.
- The need to handle sheep quietly at shearing to reduce stress, particularly when they are in-lamb.
- The need for extra feed and shelter for shorn sheep.
- The risk of animal health problems like fly-strike.

The farmer has to choose shearing times that are appropriate to the physical attributes of the farm, the type of farming enterprise and the farmer's aims. The times that suit one farmer may be unsuitable for another.

### Annual shearing

Sheep can be shorn at any time of year, although the traditional pattern of annual shearing is as follows:

*Table 2 Traditional pattern of annual shearing*

<b>Corriedale and Romney-based breeds</b>	Lactating ewes are shorn between October and January to tie in with weaning.
	Dry ewes and hogget's are shorn September to October.
<b>Merino and Half-bred</b>	Annual shear is pre-lamb in July, August or September.
<b>Lambs</b>	Lambs are shorn from January to March.

For the majority of farmers, particularly in the South Island, annual shearing takes place in late spring or early summer (November to February). In some regions, farmers are able to take advantage of warmer conditions and shear their sheep in early spring (August/September). Wool shorn at this time is less affected by tenderness that may have developed during the winter or as a result of stresses associated with lambing. Additionally, this wool also tends to be of a better colour than wool shorn later in the season.

### Multiple shearing

The first general rule for shearing more than once a year is that the wool should not be too short; ie not less than 75 mm (3 inches). The optimum and preferred length is 75 to 125 mm.

Sheep that are shorn in late summer and autumn tend to have discoloured wool, and multiple shearing provides an advantage in areas prone to warm and wet conditions as the shorter fleeces dry more quickly, reducing yellow discolouration and probably fly strike.

Sheep shorn twice a year have shorter wool, thus reducing the build-up of heat, moisture and the felting conditions that may degrade the quality of the fleece. Twice-yearly shearing usually takes place in autumn (March/April) and again in spring (October/November), giving farmers a more even cash-flow. In general, autumn-shorn wools are of better colour and strength. However, with only half the growth period, second-shear wool is shorter than full fleece wool, and therefore there are more limitations on its potential use. Shearing twice a year is common in high wool-producing Romney-cross flocks in the North Island.

### Eight-monthly shearing

The practice of shearing three times every 2 years, i.e. 8-month shearing, is possible in most Romney-cross flocks. This regime enables the farmer to improve cash-flow and at the same time produce wool that is long enough to satisfy most processing requirements.

Eight-monthly shearing is an alternative to annual shearing for Romney cross sheep. The resultant fibre length (100 -125 mm) can be more marketable than 12-month or 6-month-shorn wool.

As well as advantages in stock production and management, there is also the benefit of regular cashflow, i.e., three times a year compared with twice in one year and once the following, or only once as for a twelve month shearing system. Also only half the ewes are pre-lamb shorn at one time, making it easier to meet feed and shelter needs.

The recommended shearing times are January, September and May, and in colder areas, December, August and April. In practice, the interval between shearings may be anything from 6 to 9 months, typically longer over the slow wool-growing winter months and shorter over the summer/autumn period. This achieves a more even staple length at the different shearings and allows the farmer to avoid busy periods, particularly bad weather or shearing too close to lambing. Some farmers choose times immediately after weaning in December, before lambing in August and before tupping in March.

Eight-month shearing means a 2-year cycle, and it can be more efficient if the flock is split into two shearing mobs (A and B) and shearing is carried out at 4-month intervals on one of the shearing mobs each time:

*Table 3 Shearing pattern for split flock, eight month shearing, over two years*

	<i>J</i>	<i>F</i>	<i>M</i>	<i>A</i>	<i>M</i>	<i>J</i>	<i>J</i>	<i>A</i>	<i>S</i>	<i>O</i>	<i>N</i>	<i>D</i>
Year One	A				B				A			
Year Two	B				A				B			

Trafford and Trafford. (2011)..

### Six-monthly shearing

Six-monthly shearing or second shear is usually only possible with high producing Romney-cross sheep in which it is unlikely that feed will be a limiting factor. The wool must have a minimum length of 75 mm to

avoid a price discount for length. The common second shear regime is a 5- and 7-month split (e.g., October and March), capitalising on the high rate of wool growth over the summer months.

The farmer has to choose the shearing times that best suit him or her, and shearing has to fit around other fixtures in the farming calendar (e.g., lambing, weaning and mating).

### Mid-pregnancy shearing

Mid-pregnancy shearing is also often called pre-lambing shearing. Mid-pregnancy is a more appropriate term because the greatest advantages occur if shearing of crossbred type ewes is carried out around day 70 of pregnancy (full gestation is around 150 days). In practice, 'mid-pregnancy' shearing is often carried out between day 50 and 100 of pregnancy.

Advantages of shearing crossbred type ewes in mid-pregnancy include:

- increased lamb birth weights, especially in multiple-bearing ewes (by around 0.2 – 0.4 kg for twins and up to 0.8 kg for singles) - this results in an improvement in lamb survival and overall farm lamb production (weaning weights can be around 1 kg higher)
- some research shows a slight but significant increase in mean fibre diameter of twin-born lambs from ewes shorn mid-pregnancy (the effect was not seen in single lambs) – any decrease in value due to increased fibre diameter is likely to be offset by increased fleece weights
- improved ewe wool production of around 0.2 kg each year, with better colour and fewer cotts
- reduced ewe and lamb deaths from dystocia (lambing difficulties often associated with ewes bearing singles being too fat)
- reduced ewe and lamb deaths from ewes becoming cast due to wet, heavy fleeces at or around lambing
- a more even distribution of labour requirements throughout the year (less labour is needed for spring or summer shearing)

When air temperatures fall below a certain level, sheep must increase their heat production to keep their body temperature in the normal range. Wind and rain can speed up the rate at which heat is lost from the body. Wool insulates sheep from cold temperatures, with long wool having a better insulating effect than short wool. Shearing increases the energy requirements of sheep by 20 – 30% in summer and autumn, and by 50 – 70% in winter.

Pregnant crossbred ewes react differently to cold stress compared to when they are not pregnant or when they are lactating. They do not increase feed intake to compensate for increased heat loss, but undergo hormonal changes that allow them to burn up stored fat to provide extra energy. This energy, in addition to helping to keep the ewe warm, is the source of energy for the increased foetal growth associated with mid-pregnancy shearing. For this reason it seems that shelter is more important than better feeding immediately after mid-pregnancy shearing. Good feed is, however, still essential post shearing and leading up to lambing to help meet ewes' higher energy requirements.

Scanning after mid-pregnancy shearing enables the ewes to be split into dry, single and multiple mobs for differential feeding during the latter stages of pregnancy. Preferential feeding of multiples leads to improved ewe condition, early colostrum production, better milk yields and faster lamb growth. Reduced feeding in the singles mob reduces the risk of birth difficulties which could otherwise be a problem in these ewes.

Ewes shorn during winter need to be protected from exposure. Depending on the region, genuine winter combs (also called 'cover combs'), winter combs plus lifters (a plate with sleds that is screwed underneath the winter comb, raising it by a further 2.5 cm), and blades will leave sufficient wool to protect ewes from all except the worst weather.

After shearing, ewes should be put in sheltered paddocks with adequate feed. Shelter is essential to prevent cold stress, especially if the weather is bad. Wind and rain accentuate heat loss and in extreme conditions can cause death due to hypothermia.

#### IMPORTANT NOTE

- Lamb birth weight response does not appear to occur in ewes which are very light (<50 kg) or very heavy (>70 kg) or with very low (<1–1.5) or very high (>4) condition scores.
- Research to date shows the effect of mid-pregnancy shearing on lamb birth weights and lamb fleece characteristics does *not* appear to occur with Merino ewes under New Zealand conditions.

#### Crutching

Crutching means the removal of wool from around the sheep's crutch; the area immediately around the below of the tail, down between the hind legs and sometimes halfway along the underside of the body. Wool in these areas tends to get dirty because of urine, faeces and mud. Faeces and mud may form solid masses attached to the wool (dags).

Sheep are crutched at various times and for a variety of reasons:

- In early summer to remove dags that could attract blowflies.
- In winter in pregnant ewes to make lambing easier and clear the way for the newborn lambs to suckle.
- At any time to make it easier for shearers when the flock is fully shorn.

There are basically three kinds of crutching:

- The 'ring crutch'. Here only the wool around the anus and vulva is removed. This is done to prevent soft faeces sticking to the wool and causing dags, and to make it easier for the ram to locate the ewe's vagina for mating.
- The 'full crutch'. Here, in addition to a ring crutch, the wool is removed from inside both back legs, below the teats and udder of a female, and the rudimentary teats of the male. In a ram a



full crutch includes trimming any long wool off the scrotum and around the pizzle. Hair should not be trimmed from the end of the pizzle as this hair helps to drain drips away, preventing pizzle rot.

- The 'full belly crutch'. Here, as well as a full crutch, half the belly wool of the sheep is taken off. This is done before lambing to allow new-born lambs to find the udder of their dam. It may also be done before sheep go on to a crop to stop the belly wool being contaminated with mud.

Excess fleece wool should not be removed when crutching and no tassels of wool should be left hanging from the sheep.



*Figure 19 A mob of freshly crutched and wigged merino sheep*

Cgoodwin. (2008). Retrieved from <https://commons.wikimedia.org/wiki/File:Crutching1.JPG> on 10 December 2015. [CC BY-SA 3.0](#)

## Preparation and care of sheep before, during and after shearing

### The shearing shed

At shearing time, a large number of sheep will pass through the wool shed and a large amount of wool will be handled in a comparatively short period of time. To make sure that the entire shearing operation runs smoothly, it is important that steps are taken to prepare the wool shed.

The yards, pens, gates and grating should be checked for anything that should be repaired such as:

- Broken rails
- Missing gratings
- Damaged gates
- Protruding nails

It is important that repairs are done well before the shearing time because once shearing starts, there will be no time.

To ensure the best quality wool free of contamination, the shearing shed should have a working area that is of sufficient size, clean and tidy with sufficient clean pens. There should be good constant light over working areas including artificial light for dull days. There should be adequate bins, fadge holders, containers for dags and stencils, and a recording book.

The yards, pens, shearing and wool-handling areas must be free of all contaminants such as rat droppings, wire and string. This means sweeping the shed clean and washing down the shearing board.

Clear the wool shed of all items and material that will not be used during shearing and can contaminate wool – like food scraps and beer bottles!

The lighting should be good. For handling wool, good light over the tables is needed, e.g. two fluorescent tubes of the correct colour temperature above each table.

Tables for wool handling should be rectangular and about 2.7 m long, 1.5 m wide and 0.8 m high. One table is sufficient for two to four shearing stands.

There should also be scrapers for sweeping, and for the presser, packs, clips and branding materials. A rubbish bin and first aid kit are necessary and, of course, washing and toilet facilities.

About five fadge holders are needed in a two or three-stand shed and seven to ten for four to six-stand sheds. They are placed where the wool handlers can drop the wool into them.

There should be at least two or three bins in a cross-bred shed and eight to twelve in a fine wool shed. A convenient size is 1.5 m wide and deep and about 1.8 m high.

The bins, fadges and skips should all be clearly marked, e.g. with cardboard labels.

The layout of the shearing shed is vitally important and a good layout will help the efficiency and smooth work flow.

For full wool fleeces:

- The tables should be close to the board
- The press as close as convenient to the table
- A fadge for bellies close to the board
- A fadge for locks and second pieces close to the board
- Fadges for necks and for pieces at the far end of the table
- Adequate bins for lines if classing the clip
- Bins for cotts and offsort fleeces handy

- Separate containers for urine stains, dags and black wool

For short wools (second shear, lambs, crutching wools which do not hold together):

- The table is removed and a large blend pile made on the woolshed floor
- Fedges for bellies and pieces close to the board
- Wool press
- Bin for off-type fleeces
- Separate containers for urine stain, dags and black wool

The last very important stage is for the shearers to make sure all the shearing equipment is operating properly. Anything that is defective must be repaired or replaced and there should be enough spare parts to cover any breakdowns that might occur during shearing. The shearing gear should be cleaned and lubricated and the hand-pieces on each stand must be set up and tried out.

### Preparing the sheep

- Sheep should be dagged (crutched) at least 7 days before shearing. Do not try to dag them just before shearing in dirty or dusty yards.
- The sheep should be mustered and brought quietly into the yards. It is really important not to rush them. When shearing in summer or early autumn, heat stress can be a problem if sheep are rushed, particularly if they have 12 months fleece grown. They shouldn't be mustered during the heat of the day.
- Dusty roads and tracks should be avoided or dampened down if possible to help prevent pneumonia and avoid the wool becoming contaminated with dust and dirt. The sheep should be kept away from muddy areas too.
- To ensure the best quality wool the sheep must be dry, empty and drafted into appropriate mobs.

### Dry

Sheep with wet wool should not be penned or shorn until the wool is dry. This is because:

- Shearing wet sheep can increase the risk of the shearers developing abscesses or even arthritis
- Wet wool heats up and can be a fire risk
- Wet wool discolours and loses value

Wet sheep will not dry in the shed, they generally heat up and become damper. The best way to dry them is to let them out into the sun and wind. If you do have to shed wet sheep, they will need at least twice as much space as dry sheep.

### Empty

Allow the sheep to rest and empty themselves of urine and dung in the yards.

The advantages of emptying out sheep before shearing are:

- Emptied sheep struggle less on the board, so it is better for their welfare.
- Sheep that are adequately emptied out cause shearers fewer back injuries and ACC claims, and there is a reduced risk of disease for shearers and those working in the sheds and yards.
- Fasting reduces the incidence of pen stain in wool, resulting in better quality wool.

On the other hand, fasting sheep for too long before shearing can predispose them to health problems like metabolic disease (especially ewes in late pregnancy). The following is from [www.business.govt.nz](http://www.business.govt.nz) detailing the recommendations for emptying out sheep prior to shearing. This table forms part of the *Best Practice Guidelines for the New Zealand Shearing Industry*.

The recommendations above refer to the minimum and maximum periods of time without feed and water prior to shearing for any individual sheep. Thus, a recommendation of 18 hours minimum and 30 hours maximum off feed means that the time from when sheep are mobbed up during mustering to when the first sheep in that mob is shorn should be no less than 18 hours, and the time from when sheep are mobbed up during mustering to when the last sheep in that mob is shorn should be no more than 30 hours. Time off feed prior to shearing includes the time sheep spend mobbed up during mustering because feed intake is typically minimal during this time. Be aware that sheep shorn late in the day are likely to be fasted 10 to 12 hours longer than those shorn early in the morning.

Recommended Minimum and Maximum Number of Hours Without Feed and Water Prior to Shearing for Any Individual Sheep*					
	Hours Without Feed		Hours Without Water		Special considerations
	Minimum	Maximum	Minimum	Maximum	
<b>Ewes (and adult male sheep)</b>					
Non-pregnant, non-lactating	18	32	12	24	Exceeding these maximums may induce metabolic problems and/or precipitate clinical diseases.
Early - mid pregnancy	18	30	12	24	
Late pregnancy and lactation	12	24	8	20	Exceeding these maximums may induce metabolic problems and/or precipitate clinical diseases. Where practical, unweaned lambs should remain with their mothers until ewes enter the woolshed.
<b>Hoggets</b>					
Non-pregnant, non-lactating	18	30	12	24	Use special care when handling pregnant hoggets. Exceeding these maximums may induce metabolic problems and/or precipitate clinical diseases. Where practical, unweaned lambs should remain with their mothers until hoggets enter the woolshed.
Pregnancy and lactation	12	24	8	20	
<b>Lambs</b>					
Pre-weaning	6	24	6	20	Exceeding these maximums may precipitate clinical diseases.
Weaned	12	24	8	20	

**Figure 20 Summary of recommendations for emptying out sheep prior to shearing**

Source: Occupational Safety & Health Service, Department of Labour. (2003). *Health and safety recommendations for fasting of sheep prior to shearing*, p. 9. Retrieved from <http://www.business.govt.nz/worksafe/information-guidance/all-guidance-items/fasting-of-sheep-prior-to-shearing-health-and-safety-recommendations-for/PreshearingGuideline.pdf>

## Drafting

Once in the yards, draft the sheep as follows:

- Separate ewes from wethers and rams
- With flocks of mixed breeds, separate the wool types
- Take out any coloured sheep

The *Best Practice Guidelines for the New Zealand Shearing Industry* sets out that sheep should be drafted into mobs based on:

- Breed
- Sex
- Age (lambs, hoggets and mature sheep)
- Wool length (sheep previously shorn at different times)
- Sheep brought into the property since the previous shearing
- Illness or ailments including footrot, lice, ticks, flyblown and zoonoses<sup>3</sup>

With ewes and lambs draft off the lambs and leave them in the yards, shear the ewes and return them to the lambs as soon as possible.

As soon as the pens have been filled, close the gates so that the sheep do not turn back against those sheep coming behind them.

Do not pen sheep too tightly. Know the pen size and fill only to a safe loading density. Work on the basis of 1/3rd square metre or 4 square feet per sheep. In a correctly filled pen, a person should be able to work easily amongst the sheep.

If the pens are filled at night, put on the lights in the wool shed. This will draw the sheep into the pens.

Never shut sheep up without adequate ventilation.

## Penning up for shearers

To ensure best use of their time, shearers should not run out of sheep. The catching pens must be re-filled as often as necessary to keep a steady supply for the shearer. The best time to re-fill the pens is when the shearer is on the board. Sheep in the catching pen can be packed fairly tightly. This keeps them warm, which makes them easier to shear because the warmth brings the lanolin up into the wool.

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<sup>3</sup> Animals that have diseases which can be transmitted to humans.

## Shearing technique

Successful shearing means being able to restrain and move the sheep as they are being shorn in such a way that they are completely relaxed. Then there is no struggling and less effort required by both shearer and sheep. This means the shearer should be comfortable and balanced with feet positioned correctly.

The way the hand-piece is held is also important. It should be held lightly and sensitively so that the shearer can feel the comb on the skin.

In the Readings module you will find a Farm Production and Practise pamphlet. The diagrams show the technique used for all cross-bred sheep and lambs. The technique is modified for Merinos.

### Check the gender!

It may seem obvious, but the stockmen and shearers must always be on the lookout for the odd sheep that is not the expected gender. If a wether gets in with the ewes it could have the tip of its sheath removed. The odd dry ewe or wether in with lactating ewes could have its teats or prepuce damaged. The careful shearer will not make these mistakes but accidents do happen especially when workers get tired.

### Tallying the sheep

Tallying is the counting out of the shorn sheep and noting the number in the tally book. Counting out usually takes place at the end of a 1 or 2 hour run, depending on the arrangement with the shearer.

It is very important to be accurate with counting out as:

- Shearers are paid on the tallies
- Stock records depend on the tallies

To be accurate with your counting, always keep control of the shorn sheep and learn to count in threes, fours or fives as the sheep leave the pen. Before opening the gate, ease the sheep back from it. Open the gate just enough to let one sheep through at a time. Be ready to block the flow of sheep if necessary. Always keep control by using your body weight against the gate.

Count the sheep only as the sheep leave the pen. When the pen is empty, write the tally down in the tally book, making sure you have the correct shearer's name and stand number. Close the pen gate, latch it, and check it before moving to the next pen.

## Shearing shed procedures and methods

The wool industry wants uniform, fit-for-purpose lines of wool for the market. The wool must be free from contamination. Bales must be accurately identified and documented.

The New Zealand Wool Classers Association ([www.woolclassers.co.nz](http://www.woolclassers.co.nz)) has produced a document called “Clip Preparation – Best Practice Guideline” and this document should be displayed in woolsheds so that it can be referred to when necessary.

Other industry documents that are relevant include:

- *Fasting of Sheep Prior to Shearing* available from [www.dol.govt.nz](http://www.dol.govt.nz)
- *Animal Welfare (Sheep and Beef Cattle) Code of Welfare 2010* available from [www.mpi.govt.nz/biosecurity-animal-welfare/animal-welfare](http://www.mpi.govt.nz/biosecurity-animal-welfare/animal-welfare)

There is a team of people involved in good clip preparation:

- The farmer
- Shearing Contractor
- Classer
- Presser
- Leading wool handler
- Wool handler
- Shearer
- Q stencil holder

At all stages of the shearing process everyone in the team must stick to the standards outlined in “Clip Preparation – Best Practice Guideline”.

### The farmer

The farmer’s role is to ensure that:

- The working conditions of contracting staff are adequate
- The shed is properly prepared for shearing
- The shearing contractors, shearers, leading wool handler and classer are fully aware of the type of sheep to be shorn and wool handling requirements

The farmer must also present sheep for shearing that are dry, clean, dagged, empty and appropriately drafted.

He or she must ensure the bales of wool prepared comply with Export Packaging Standards.

### Shearing contractor

The shearing contractor is responsible for providing the appropriate number of appropriately qualified shearers, wool handlers, and a presser; also for recording bale details.

## Classer

A wool classer's job is to group together similar types of wool. Classers are usually employed only for fine or speciality wools. They are not usually employed for cross-bred flocks. The classer is responsible for the overall presentation of the clip. This includes the packaging, branding and recording. Care and accuracy are essential.

The classer should be registered with NZ Wool Classers' Association (NZWCA) and is responsible for management and supervision of the shed, clip preparation, and for classing the clip.

The classer works with the leading wool handler to ensure smooth work flow in the shed.

He or she ensures that wool is classed according to any special conditions that have to be complied with (as for some contracts).



*Figure 21 Wool Classing.*

Retrieved with permission from [www.woolclassers.co.nz](http://www.woolclassers.co.nz) on 10 December 2015.

During shearing, the classer sets up the minimum number of lines required and oversees handling procedures, bale recording and branding, and preparation of documents for the selling agent.

The classer works with the presser to ensure as even a flow in his or her work as possible.

The classer or farmer is responsible for preparing the specification form to cover each consignment of bales leaving the shed, ensuring that all the required information is neatly and accurately recorded.

## Presser

The wool presser is responsible for the wool pressing and baling phase of the shearing process.

Before shearing, the presser:

- Becomes familiar with the press and how to operate it
- Knows industry standards for bale descriptions and wool types

During baling, the presser:

- Ensures bale weights are between the minimum and maximum (100 kg and 200 kg)
- Presses to required weights
- Organises the pressing to minimise mixed bin bales where possible
- Ensures bales are capped and clipped properly
- Records the number of bales and descriptions in tally book



- Brands bales accurately and clearly
- For bin and reclass fleece lines, ensures careful individual packing of fleeces and puts paper divisions between layers in bin bales

The presser keeps the press area tidy and safe, and ensures foreign material does not get into the wool

### The leading wool handler

- The leading wool handler is sometimes called the Q-stencil holder
- He or she is answerable to the farmer or classer
- Q stencil holders have a current Q stencil and registration with NZWCA
- Before shearing they consult the farmer to find out what his requirements are
- He or she manages the wool handling team and oversees their grading of wool

If there is a classer, there will not be a Q-stencil holder. The Q-stencil indicates quality clip preparation and this is noted in the auction catalogue when the wool is sold.

If there is no classer, as for most cross-bred flocks, the leading wool handler takes responsibility for the standard of clip preparation. He or she organises the shed equipment for the smoothest work flow and guides the presser, to ensure that the bale number and contents are entered correctly in the bale book.



*Figure 22 Wool handling.*

Retrieved with permission from [www.woolclassers.co.nz](http://www.woolclassers.co.nz) on 10 December 2015.

In some cases, the farmer may take on this role.

### Wool handlers

The board hand picks up and throws the fleece on the wool table so that it spreads out to allow the table hand to quickly assess the amount of skirting required. Poorly thrown fleeces often result in the fleece being over or under skirted.

The board hands pick up and throw each fleece so that it is spread over the table and can easily be identified and tidied up.



*Figure 23 Throwing a fleece onto the wool table*

Table hands skirt the fleece. If necessary they separate off neck wool, bellies and crutch wool, second cuts, top knots and eye-clips. They separate off dags and urine-stained wool, discoloured belly wool,

Julie Blake, 2008

[https://commons.wikimedia.org/wiki/File:Shearing\\_08.JPG](https://commons.wikimedia.org/wiki/File:Shearing_08.JPG)

(CC BY-SA 4.0)

fribs and vegetable matter. They remove only the required amount of skirtings. They then roll the fleece correctly and neatly. They stack the fleeces into the correct bins.

Board hands sweep the board before the shearer starts the next sheep.

### Shearer

Shearers must have had sufficient training to ensure their competence and to ensure the minimum of cut sheep and second cut wool.

They try to shear sheep in such a way that the handlers can readily pick up and throw the fleeces.

Shearers must call 'black wool' if they encounter coloured wool, and mark (raddle) the sheep if required.

They must raddle-mark any sheep that is badly cut and requires treatment, and they face disciplinary action if they do not.

### Wool handling and classing

The aims of wool-handling and classing are to produce lines of wool that are of uniform length, colour and fibre diameter.

To help achieve this, during clip preparation the shed hands or wool handlers skirt off the following from the fleeces proper:

- Dags
- Crutchings
- Eye-clips and top-knots
- Cotted wool
- Pigmented fibres
- Mixed lengths
- Mixed fibre diameter
- Non-scourable stain (e.g. canary yellow)
- Urine stain
- Pen stain
- Mud or dirt contamination
- Vegetable matter
- Debris and rubbish
- Skin pieces



*Figure 24 Wool sorted into categories.*

Retrieved with permission from [www.woolclassers.co.nz](http://www.woolclassers.co.nz) on 10 December 2015.

Table 4 The main categories of New Zealand wool

	Body wool	Oddments wool		Misc. wool
Shorn wool	Full fleece	Necks	Crutchings locks 2nd pieces eyeclips topknots	Black fleece brands dead double fleece stains mud dags
	Early shorn	1st pieces Bellies		
	2nd shear	2nd shear bellies pieces		
	1st lambs	2nd lambs		
Slip wool	1st slipes	2nd and 3rd slipes		

The purpose of skirting is to minimise the extreme variation of style and staple length within individual fleeces, by removing faults that would otherwise downgrade the overall value of a line of greasy wool.

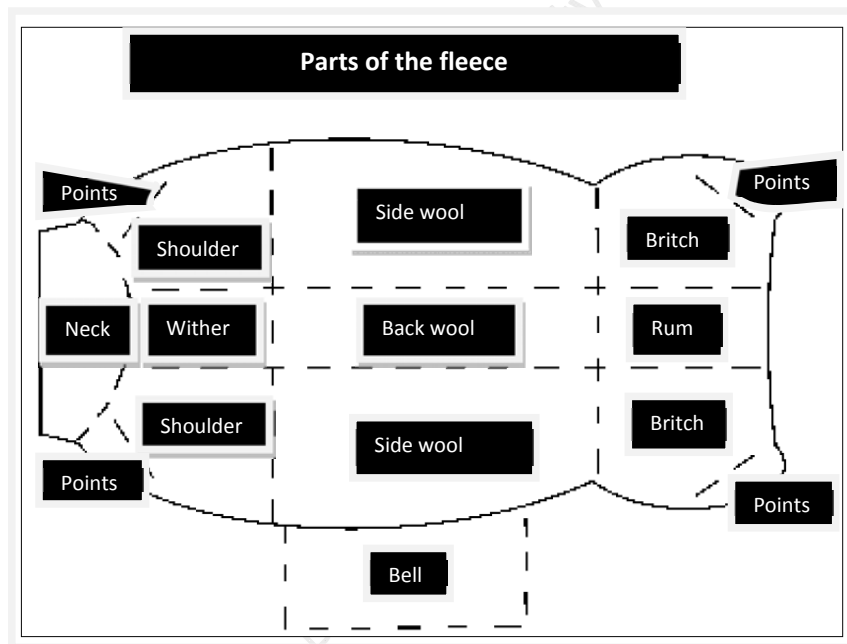


Figure 25 Parts of sheep fleece

The purpose of classing is to group fleeces of similar style, fineness, staple length, soundness and colour into lines for sale to a buyer.

### Style

Wools of good quality and quantity, i.e. good style wools, are pearly white, have excellent crimp definition along the entire length of a staple and are sound and free from fault.

Poor style wools have poor crimp definition, they are discoloured and have varying degrees of faults such as tenderness, degrees of cotting, yellow discolouration, water stain, vegetable matter and dust contamination. The individual staples within a fleece are tippy and pointed rather than blunt.

The quality and quantity of wool (its 'style') and the factors that affect them are discussed earlier in these notes (see 'Wool Properties').

Better style wool clips require high standards of clip preparation and it is very important for wool-handlers and classers to know how to assess the style grade of a wool clip and of individual fleeces.

When skirting, only inferior wool should be removed. All good quality wool should be left on the fleece. Improving the style grade of a fleece by skirting off inferior wool can add significantly to the value of the fleece provided the wool remaining is of good quality. However if skirting has been inconsistent or poorly done, then the value of both fleece and oddments could be much lower, and for the farmer this is additional to the cost of labour.

#### **Fibre diameter (fineness)**

Wool-handlers and wool-classers can do very little to reduce the overall variability of fibre diameter within or between fleeces from a mob of sheep. Attempting to make lines with minimal differences only adds to the cost of selling through additional testing, interlotting and re-classing charges. Classers should only separate fleeces that are obviously finer or stronger compared to the mob, and this is only justified with more valuable wool such as that from fine hoggets. For cross-bred wools, diameter classing is essentially non-existent because price variations with fibre diameter do not justify the extra hassle and cost.

#### **Fibre diameter in Merinos**

Fineness is the most economically important fibre characteristic of Merino wool. Average fibre diameter accounts for more than 50% of the variation in prices between lines of clean fleeces. The variation in fibre diameter within and between fleeces from a mob of Merinos is complex to say the least. 80% of the variation in fibre diameter is between individual fibres within a single staple, with a further 4% of variation between individual staples within a fleece, and a further 16% between fleeces.

The other important factor affecting fineness is variability along the length of the fibre. Nutrition has a major effect on wool follicle growth and development and on changes in fibre diameter along the length of individual fibres.

#### **Fibre length**

80% of fibre length variability is due to variation between fibres within a staple. Only around 10% of length variability is due to variation between staples within a fleece, the remaining 10% is due to variation between fleeces. Therefore wool-handlers and wool-classers cannot reduce fibre length variability by creating extra lines with minimal staple length differences. The classer only has 10% of the fibre length

variability between fleeces to work with, so should only remove the very short wool from individual fleeces, along with individual fleeces that are obviously very short compared to the mob average.

### Soundness

There are varying degrees of soundness within and between fleeces within a mob. Before making any decisions on fineness and staple length, the classer should assess every fleece for soundness to identify if the fleece is 'sound' or 'tender'. He or she does this by applying uniform pressure to several staples. If the staples break easily when a consistent tension is applied, the fleece is classed into a separate line of 'tender' wool.

If the main line is tender then there is little to gain from classing for fibre diameter or removing shorter fleeces, because 'tenderness' is the overriding quality issue. 'Long' fleeces become 'short' as a result of processing breakage.

Staples from within individual fleeces vary in strength, but the greatest variation in strength is between fleeces and different mobs. The classer's expertise is in being able to identify fleeces that are tender or part tender from fleeces that are sound.

Discussing the management of a mob since the previous shearing with the farmer will help the classer and wool-handlers to understand the reasons for the wool from different mobs being sound or tender.

Factors that can cause 'tenderness' include:

- Poor feeding. Individual sheep within a mob respond differently to nutritional stress, but the fleeces from a mob of sheep grazed in the same conditions tend to have a uniform pattern of wool growth. A loss of 2kg in body weight as a result of under-feeding is enough to cause wool tenderness.
- Illness such as footrot, sleepy sickness or worms
- Pregnancy and rearing lambs in underfed ewes (especially with multiple lambs)

### Colour

The skill and expertise of wool-handlers and classers is in knowing how to quickly distinguish between permanently discoloured wool such as canary yellow and water stain and wool that is heavier in condition, creamy and will scour to a pearly white colour.

A useful test for the handlers to 'get their eye in' is to wash some suspect wool with soap and water. If the yellow washes out, it is scourable and not a problem. If it does not, then it is genuine permanent discolouration and must be removed.

The whitest and brightest fleeces require careful and thorough skirting levels to remove vegetable matter contamination, stains, neck collars and dirty pieces. The poorer colour fleeces require minimal skirting,

because they cannot be improved much, and it is sufficient simply to remove urine stain and extremely yellow fribs (sweat stained wool).

### Classing full fleeces

#### Mid-micron wools

The wool handler (Q stencil holder) prepares the fleece by removing shorter or discoloured parts from the fleece as it is being shorn (e.g. crutchings, top knots, socks etc), and then when it is thrown on the table, first pieces, necks, seedy backs etc. During shearing, the belly wool is removed first and is collected separately. Shorter discoloured crutch wools, second cuts and pieces from the legs and head as well as stains and dags are separated as they come off the sheep and swept clear, leaving the main fleece clean of inferior wools.

The fleece is then thrown on a slatted table where it is skirted to remove faults (cotted portions, vegetable matter, shed stain etc) and permanently discoloured or very much shorter wools. During this operation, loose pieces and second cuts still adhering to the fleece are shaken free and fall through the slats to the floor from where they are collected and packed with the shearing board sweepings.

The aim is to prepare wool for processing by sorting it into lines even for length, colour and faults. Generally with Romney cross type wool it is graded into one principal line, and there may be two smaller lines, one for discoloured fleeces and one for shorter, cotted or 'tender' fleeces. If there is an obvious difference in fibre diameter or the clip is a large one, there may be grading into lines based on fineness.

#### Sorting and grading lambs and second shear wools

Lambs' wool and second-shear wools are prepared in a similar way, but they are prepared on the shearing board because they do not hold together for throwing onto the table. All short wool should be shaken onto a blend stack and checked for faults, colour etc.

Length and colour are important in grading these wools. They do not hold together so they are handled on the board, then taken to a stack on the wool room floor for blending and checking before pressing. Discolouration and shorter wool is removed from the main fleece as it comes off the sheep. There are generally only two lines – body wool and "bellies and pieces".

For lambs' wool, different breed types and very strong, lustrous or shorter body wool types are kept separate.

#### Classing full fleece fine wools

With wools finer than 33 microns a registered classer prepares the clip. These are classed for fineness as super fine, extra fine, fine, medium and strong although generally only two or three main lines are required. There are also secondary off-type lines with different lengths, colour or faults.

### Crutchings and eye clips

- Full crutch: Wool from the back legs, crutch and tail areas is sorted for length, colour, urine stain and dags.
- Ring and fly crutch: Short and urine stained. Any good wool is separated off.
- Eye clips: Usually short and medullated.

### Pressing, Branding and Dispatch

The bale weight should be not more than 200 kg and ideally around 180 kg. Bales that are significantly heavier or lighter can be dangerous to stack and transport.

The flaps should be overlapped just 100 mm or the width of a closed hand, and clipped. The inner flaps are secured with three clips, pushed well home, and the outer flaps with four clips. The outside clips should point well down the sides of the bale. If long skewers are used, care should be taken in withdrawing them to avoid tearing the pack.

The wool packs should be good quality so that they do not tear or burst at the seams. There should be no more than two grab-holes (i.e. used no more than once previously), there should be no visible brands from previous use, and all rips or tears must have been adequately repaired.

The branding or marking must be accurate and clear using approved inks. Permanent black felt pens are commonly used on capless pack labels. Markings should be placed on the bale label and should indicate brand, bale number and description, and a record of this is made in the wool book.

When capping bales, the labeled flap must be on top using permanent black felt pen to record farm brand, bale description and bale number. This information must also be recorded in the wool book.

In bin bales, the different wools should be separated by layers of newspaper.

### Key points

At shearing:

- Keep belly wool out of fleece
- Put cotts and cotted pieces aside
- Take out necks and backs with vegetable matter
- Skirt lightly, only the permanently discoloured wool
- Take out penstain
- Use only good quality packs
- Keep string, caps and rubbish out of bales
- Do not press over 200 kg

## Shearing faults

Shearing faults include cuts on the sheep and second cuts of wool.

Cuts on the sheep's skin can result in skin pieces and blood contaminating the clip. Bloody wool and pieces of skin must be removed by wool-handlers. Skin dries and hardens and can damage processing machinery. Blood is set by hot water during scour and must be washed off first in cold water.

Second cuts of wool are too short to incorporate in yarns and can increase 'prickle' in the finished product.

Skin cuts can cause animal health and welfare problems, especially if they are severe or numerous or if even one becomes infected. Clumsy shearing can result in serious injury to the sheep such as removal of a teat or part of the vulva or sheath, an ear or an eyelid. In the worst cases the sheep may have to be killed. The scars left by healed cuts cause problems in processing hides, especially lambskin.

Severe cuts should be stitched and dressed with antiseptic. Iodine spray is suitable for treatment of minor cuts.

## After shearing

Newly-shorn sheep suffer from cold stress if the air temperatures are cold, especially when there is rain and wind. Newly-shorn sheep will also eat very much more than unshorn sheep. This is because shearing causes physiological changes in their bodies that result in an increased metabolic rate and increased appetite, as they attempt to maintain normal body temperature. Newly shorn sheep will eat up to 50% more than when unshorn, and they must be offered enough food to meet their requirements.

As they need to eat more to keep warm, more protein and energy (carbohydrate) in the form of good pasture should be made available to them. This can result in a short-term increase in both wool production and liveweight.

Good feeding encourages rapid re-growth of wool. By the time the wool has re-grown to 20mm (in about 4 to 6 weeks), the insulation properties will be as good as full-length wool.

Another good reason for providing plenty of good feed after shearing is that a belly-full of herbage produces heat as it is digested and this helps keep the sheep warm.

To help prevent wind chill, newly shorn sheep should have access to effective shelter (low dense shelter at their level).

## Wool testing

Wool testing is important because buyers can use objectively and independently measured characteristics to help decide the suitability of wool for their processor clients. Wool measurements have an increasing



influence on the price paid for wool, while the appearance of the clip is becoming less important. Measured characteristics can also help in decision-making about future breeding and clip preparation.

When farmers sell a line of wool at auction they receive a copy of the test certificate, which shows the major test results measured by a registered wool testing laboratory. If the wool is sold privately, the seller has to arrange for testing. He or she samples the wool, preferably using a core tube, and sends the sample to a testing laboratory. The laboratory provides guidelines on sampling.

Lincoln University

## Test Yourself #4

1. What is 'second shear' wool?
2. What is the name for wool shorn at 8-month intervals?
3. What are the most popular months for annual shearing for Romney-based breeds and for Merino types?
4. What is the minimum wool length for shearing?
5. What are the advantages of shearing at 8-month intervals?
6. What are the advantages and disadvantages of shearing ewes in mid pregnancy?
7. What can be done to prevent deaths after winter shearing?
8. Why are sheep crutched?
9. Draw a plan for typical shearing shed and note the number and type of sheep it would be suitable for?
10. Describe how to prepare sheep for shearing from a week beforehand until just before shearing.
11. Why should you not shear wet sheep?

12. What are the advantages of fasting sheep before shearing?
13. What is the maximum time a non-pregnant ewe should be held off food and water?
14. What is the maximum time a pregnant or lactating ewe should be held off food and water?
15. Apart from the farmer and shearers there are quite a few others in the shearing shed. Name them.
16. What is the role of the classer?
17. What is the role of the wool handler?
18. For crossbred sheep, what wool is removed from the fleece as the sheep is being shorn?
19. What wool is removed on the table?
20. Where is lambs wool prepared? On the shearing board or on the table?
21. For what types of wool is a registered classer required?
22. The bale weight should be roughly what?

23. Newly-shorn sheep suffer from cold stress if the air temperatures are cold, especially when there is rain and wind. Offering extra feed can help them generate heat. How much more feed do they need? 20%, 30%, 40% or 50% more?
24. Wool testing tells you four main characteristics of wool – yield, fibre diameter, vegetable matter, and what else?
25. What is yield?

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## Selling wool

For generations, wool growers in New Zealand have offered their wool for sale at public auction through wool brokers. Only twice has the wool auction system ever been abandoned in New Zealand - during World War One and World War Two. On both occasions, the British Government commandeered the whole of the New Zealand wool clip. In recent years, however, there has been a move to private sales. It is now estimated that approximately half of New Zealand's wool is sold via auctions, with the other half sold privately.

Farmers have four main channels through which they can sell their wool:

- public auction
- private wool buyers
- exporter and manufacturer direct buyers
- slipe wool

The two major auction brokers are Elders Primary Wool (EPW) and PGG Wrightson. Wool sold privately is purchased by independent wool merchants that often have long-term relationships with farmers on a regional basis. Meat processors pay farmers for the wool harvested from slaughtered sheep (slipe wool). Some exporters and manufacturers also have purchasing divisions that deal directly with farmers.

### Activity

If you have internet access, explore the website of an auction broker:

1. <https://pggwrightson.co.nz/services/wool/wool-auctions>
2. <http://www.carrfields.co.nz/wool/>

## Public auction

Wool is purchased at auction by buyers acting for wool exporting companies, local and overseas processors and scourers. There were originally eight locations where these auctions were held, but now they have been reduced to two. In the North Island wool auctions are held in Napier, while in the South Island, auctions are held in Christchurch. These centres usually have an auction at least once a month.

The small number of auction sites was made possible with the introduction of a system called 'sale by sample'. With this system, a 'grab' sample of each lot of wool is taken and displayed at the auction centre before the auction. A core sample will also have been taken and tested, and this gives a more representative sample of the wool in the bale. The core sample is taken by a special machine that compresses the bale and drives a number of core tubes through about 90% of it from end to end, making for a very representative sample.

The core sample test certificate for each lot of wool is displayed as well as the grab sample. This sale by sample system replaced the traditional system of having all the bales in each lot available for inspection at each auction. The use of samples means that the bales of wool can be held somewhere else until they are sold. Considerable savings in handling and transport costs have been made since this system was introduced.

In the long term, once reliable and acceptable methods of objectively measuring all the commercially important properties of wool have been established, sale by description will be possible, where buyers purchase wool without actually seeing it.

Sale by description will enable:

- wool to be sold by specification
- greater efficiency in handling and transporting wool
- computerised trading

### The auction sales process

Woolbrokers arrange the pre-sale handling and post-sale despatch of the wool, and conduct the auction on behalf of their farmer clients. Woolbrokers do not own the wool, but act as selling agents. They charge a fee which covers receiving, weighing, sampling, storage, cataloguing, insurance, sale and transport costs.

Once the farmer's wool arrives at the woolbroker's store, it is weighed and prepared for sale in one of three ways:

- Main lot – A main lot is an even line of wool which has come from one farm, and is sold under the farmer's name; there is no set number of bales needed to form a main lot but most brokers work on the basis of at least ten bales per lot.
- Grouping or interlotting – When an individual farmer provides only a small number of bales for sale (e.g. three bales or less), they will be grouped with other bales of wool which have the same characteristics. For example, two bales of bellies and pieces and one bales of lox (a general term for sweat, dung-and urine-stained wool, brisket wool, etc.) would be grouped with other similar wool types. These other bales have come from other farmers. Usually there is no brand. Each farmer is paid according to the amount of their wool in the grouped lot.
- Binning – When a bale of wool from a farmer contains more than one type of wool (i.e. lambs, bellies and pieces, crutchings, eye clips, etc.), or only a very small amount of a single type of wool, all the wool is taken out of the bale, and each fleece individually assessed. They are then binned with other fleeces of similar characteristics until there is enough to form a full bale for sale. Growers are paid per kilogram contributed to each line.

Once the sale lots have been prepared, the woolbroker arranges for them to be sampled and tested. A representative core sample is taken from each bale in the lot by a special machine for laboratory testing, and a grab sample is taken for display at the auction. The grab samples are displayed at the auction centre along with the test certificates. All lines are inspected by the auction manager with a wool type and price

indication placed on all catalogued lots. Two to three days before the auction, wool buyers are allowed to view the grab samples and test results.

Farmers are advised on the details of their wool type and price indication prior to the sale by their woolbroker and have the opportunity to specify their selling instructions on main lines, i.e. place a reserve on the wool (lowest price they will accept), a sell instruction or leave it to the company to sell to best advantage. These instructions are advised to the auction manager prior to the sale date.

On the auction day, each woolbrokering firm in turn conducts the auction for their clients' (farmers') wool. The woolbroker identifies the lot by number and calls for bids, which are increased by a minimum of 1 cent per kilogram. The lot is sold to the highest bidder. The buyer and price are announced by the woolbroker on the fall of the hammer. If a lot fails to reach the reserve price placed on it by the farmer (the reserve price), it is 'passed in', which means that it is not sold. It may be purchased by the highest bidder by negotiation after the auction, or offered for re-sale at a later auction.

Payment is typically required within 14 days, at which time the wool becomes the responsibility of the buyer. Proceeds of the sale are paid to farmers usually within 14 days of sale, less the woolbroker's fees. The woolbroker will now receive instructions from the buyer as to what to do with the wool. The broker is responsible for delivering the wool to ships if it is being exported, or to the wool processor (wool scourer or woollen mill).

### Activity

Look on the following website to see the latest wool prices for wool sold at auction:

[www.interest.co.nz/rural/sheep/wool](http://www.interest.co.nz/rural/sheep/wool)

The first table gives wool prices for the Christchurch auction and the second for Napier. The prices are shown in cents/kg clean wool, e.g. 501 – 550 (in dollars this is \$5.01 - \$5.50). Scroll down to the bottom of the page to see price trends for coarse crossbred, fine crossbred and mid micron wool.

Note that knowledge of the terminology, or words and abbreviations used to describe wool are important to be able to understand the information on this webpage.

## Private wool buyers

There are over 100 registered private wool buyers in New Zealand. The private wool buyer purchases wool directly from the farmer and then usually sells it to a wool exporter or processor. Sometimes they may sell it through the auction system. The prices paid by private buyers are generally closely related to the current auction prices.

While the grower may receive a slightly lower price than the wool would return at auction, there are savings with no transport costs or brokerage fees being involved. Payment is also usually made immediately so there is no delay waiting for the next auction date. Also there is no uncertainty of whether or not the wool will sell or reach the reserve price the farmer may have set.

### Activity

Check the yellow pages or internet to locate private wool buyers in your region. Contact one of the buyers and explain you are studying about the wool buying process. Find out what type of wool the buyer purchases and about their purchase process.

For example, questions you may ask them include:

- do they have regular customers they contact to purchase wool and/or do they rely on farmers to ring them regarding wool for sale
- when do they arrange to view and buy the wool, i.e. before shearing or after
- do they require farmers to have wool tested (for diameter, strength, etc.) before agreeing to buy it
- what does the farmer have to do regarding organising the wool for sale
- what paperwork is required for the sale and purchase (both buyer and seller)

## Exporters and manufacturers

Some farmers are now selling directly to exporters and manufacturers. For instance, some carpet manufacturers have buyers that buy direct from the wool grower rather than purchasing all their wool through the auction system. Some Merino farmers supply New Zealand manufacturers with superfine wool for production clothing. A group of Romney sheep farmers supply wool to a Nepalese company that makes hand-tufted carpets and rugs. This type of sale is basically a private sale but the farmer is selling directly to the business that uses the wool whereas, other private buyers and wool brokers buy the wool to on-sell to exporters or manufacturers; they do not process the wool in any way (other than sorting into lines if needed).

## Slipi wool

Slipi wool is the wool that is harvested from sheep after slaughter at a meat works. A depilatory system (using chemical preparations) is used to free the wool from the skin, and allows it to be easily pulled off the skin. Slipi wool has the same textile values as conventionally-shorn wool with the same properties, the only difference being the method of harvesting it. The 'wool pull' is visually estimated on the sheep before slaughter and the farmer is paid for the skin plus estimated wool pull. The meat processor then sells the wool to an exporter, wool scour or mill.



## Factors influencing the price of wool

Typically the value or price paid for wool (or any product or service) is determined by supply and demand. For example, if wool is in high demand (lots of manufacturers and customers want it) and it is in short supply (there are not many sheep or farmers are not farming breeds that produce the type of wool wanted), prices for wool are typically high. In contrast, if demand is low and there is a lot of wool for sale then prices tend to be low.

In practice, depending on supply and demand, the price paid for wool is established by two groups:

- Firstly, export companies and foreign buyers negotiate a price for a set amount of wool to be delivered at a set date some time in the future.
- Secondly, at the wool auction, wool buyers bid freely for wool. The price paid by private wool buyers, slip wool purchasers, and exporters and manufacturers buying directly is influenced by the current auction price.

At the auction, buyers bid in cents per kg of greasy wool, for wool that has come from many farmers (at least 2000 lots per auction). This ensures that a competitive price is obtained, and that no one party is able to dominate or manipulate the price. However, there are a number of outside factors that will influence the auction price including:

- the prices agreed to between the various exporters and their overseas buyers
- wool characteristics - these are the test results on the test certificate and for untested mid-micron wool, its length, strength and visual appearance. Generally a premium is paid for very fine wools, but this changes from season to season. Wool shorter than 75mm receives lower prices because it is harder to process. Colour also attracts a premium, especially for fine wools
- exchange rates with trading partners
- consumer demand, which is influenced by promotion and economic factors
- supply of wool - prices will change according to the levels of wool stockpiles around the world
- seasonal patterns for prices – e.g. Merino wool is usually sold over just a few months and it is not always sought after and consequently prices fall out of season because buyers are not putting together major orders at that time
- price of competing fibres that manufacturers could use instead of wool, e.g. synthetic fibres
- competition between buyers at the auction

## From farm to consumer

The following two diagrams summarise the path wool takes from sheep on the farm to the manufacture of carpets or fabric for sale to consumers, via the auction system. Farmers are paid early on in the system, after the wool is sold at auction (or, if sold privately, at the time of purchase by the buyer). Before the final consumer product is ready for sale a number of other steps are required to clean and process the wool.

Continued on next page:

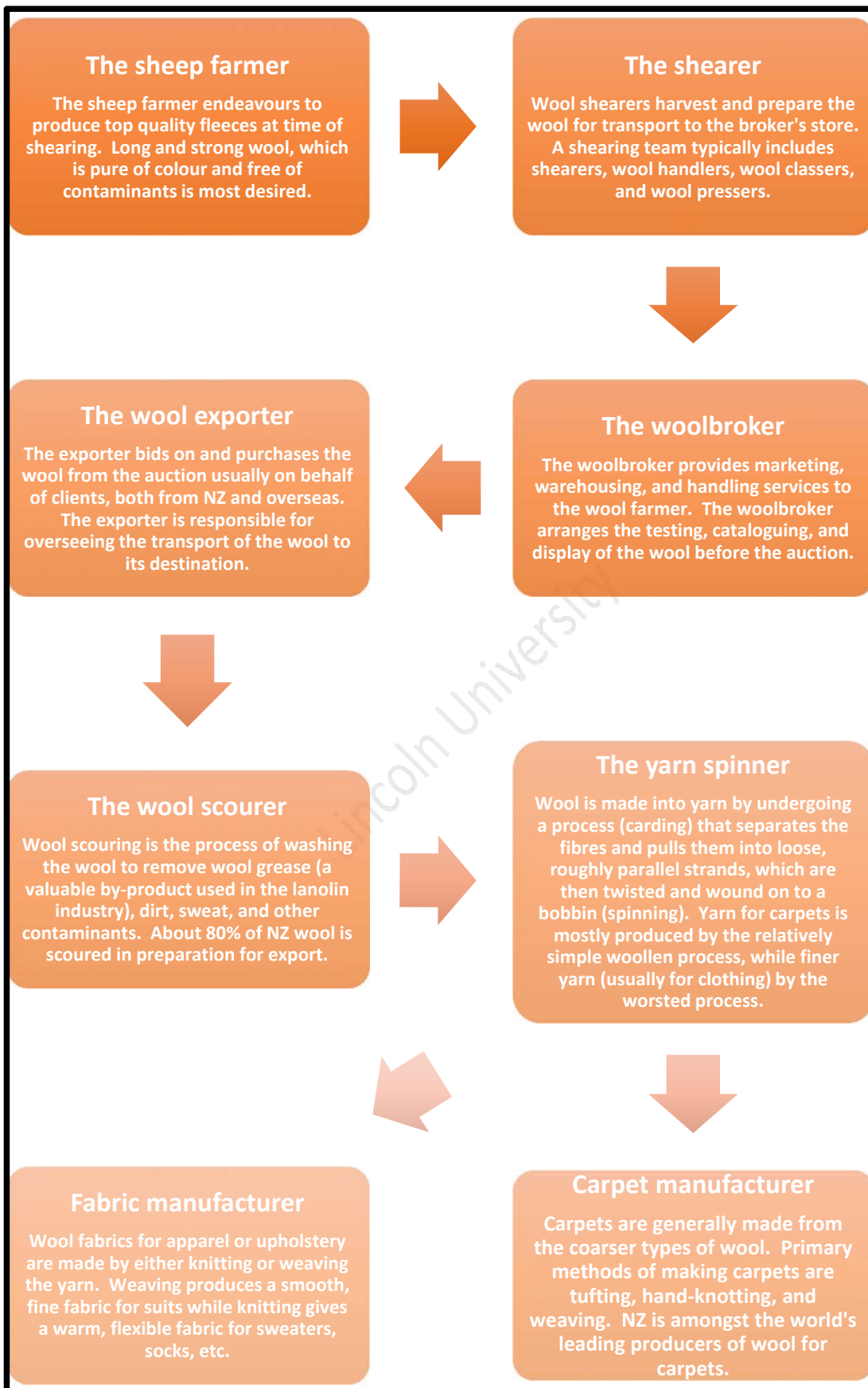


Figure 26 People in the wool industry

## Quality assurance

Quality assurance has become a huge component of farming systems in New Zealand today. Such programmes have been developed to ensure quality is maximised at each step throughout the supply chain whilst maintaining a high level of animal welfare. Some programmes have been established for traceability - advances in technology now allow the 'consumer', when purchasing a woollen garment for example, to view the farm online where the wool has been grown.

There are several quality assurance programmes developed for wool and its products. Some examples include:

- FernMark Quality Programme – this programme considers the supply chain - from farmers to shearers to scourers – an on-farm plan is built with emphasis on facilities, the preparation of sheep, standards and records, staff requirements, prevention of contamination, animal welfare, woolshed procedures, dip residues.
- Laneve – a companion to the *Wools of New Zealand brand* (visit <http://www.woolnz.com/content/en-GB/brands.aspx> for further information). Consumers purchasing woollen carpets or rugs branded with the Laneve brand are guaranteed 100% traceability i.e. the product purchased back be tracked back to the very farm it was grown on, these farmers must meet a comprehensive range of environmental, social responsibility and animal welfare standards.
- NZMerino's fibre option – Zque

## Test Yourself #5

1. What is the most common way of selling wool?
2. In what towns are public auctions carried out?
3. What is the “sale by sample” system?
4. What is the main advantage of this system?
5. What do Woolbrokers do?
6. Approximately how many registered private wool buyers are there in New Zealand? 2,10 or 100?
7. What is slipe wool and how is the farmer paid for it?
8. Give an example of farmers selling directly to processors.
9. What are some of the factors that affect the price paid for wool?

## Glossary

### *The fleece and sheep*

<b>Back wool</b>	Usually weakest part of fleece as it is the most exposed and may lack crimp definition.
<b>Belly wool</b>	Separated from fleece by definite line (waterline) removed first during shearing and usually baled separately; has a compressed staple and often stained.
<b>Britch wool</b>	From the back end of the sheep, usually the coarsest part of the fleece, often stylish but heavier than the rest.
<b>Cross-bred</b>	Romney cross type sheep producing wool in mid-micron range.
<b>Fribs</b>	Stringy bits of wool that are thick with lanolin. Most common on the brisket, the groin and under the forelegs.
<b>Half-bred</b>	Merino cross with the English Leicester, Lincoln or Romney.
<b>Mid-side</b>	A site (for wool sampling) half way down the side of the sheep and half way along the body.
<b>Moit</b>	Fragments of leaves, bark, twigs in fleece.
<b>Neck wool</b>	Usually finer and softer than the rest of the fleece, and may contain more vegetable matter.
<b>Points</b>	From the top of the legs and towards the rump wool may be short and stained.
<b>Romcross</b>	Romney crossed with another breed from mid-micron range.
<b>Rump wool</b>	Slightly coarser than shoulder and side wool.
<b>Side wool</b>	Covers 40% of the fleece.
<b>Shoulder wool</b>	The most stylish and best grown wool covers about 25 to 30% of the fleece.
<b>Wither wool</b>	Wool from over the shoulder may be relatively high-yielding but a bit coarser and with flatter staples than the rest of the fleece, and may have more vegetable matter contamination.

### *The wool fibre and fleece*

<b>Bulk</b>	The resilience or 'bounce-back' of wool or lack of it. Measured by a bulkometer and expressed in cubic cm space occupied per gm under a test load.
<b>Coarse wool</b>	Diameter more than 31 micron.
<b>Cotting</b>	Matts of tangled shed and broken fibres.
<b>Crimp</b>	The natural waviness of the wool along the length of the staple.
<b>Cross-bred wool</b>	Fine (24.5 to 31.4 micron), medium (31.5 to 35.4 microns) or coarse (>35.5 micron).
<b>Dual purpose</b>	Sheep bred for meat and wool.

<b>Fine</b>	Fine wool has a fibre diameter less than 20 microns.
<b>Lustre</b>	The natural sheen or shine property of the coarser cross-bred wools.
<b>Medullation</b>	Hairy fibres possessing a medulla or air-filled core of cells
<b>Micron</b>	The unit used to measure fibre diameter (a micron is a millionth of a metre).
<b>Mid-micron</b>	Fibre diameter in middle of range, from about 25 to 30 micron.
<b>Skirting</b>	Removal of vegetable matter and debris and short or discoloured dags and staples of wool from the fleece spread on a skirting table.
<b>Slupe wool</b>	Wool removed after slaughter from skins after loosening with depilatory chemicals.
<b>Staple</b>	Lock of wool, bunch of wool fibres
<b>Strong</b>	Fibre diameter at top of range, about 30 micron.

### *Selling wool*

<b>Auction</b>	The predominant method of selling growers' wool where the auctioneer monitors called bids from a bench of buyers and 'knocks down' (sells) to the final and highest bidder. All participants work from a previously valued catalogue rather than having the wool in front of them.
<b>Binning</b>	An enterprise that provides the service of selling small quantities of assorted wool on behalf of its woolgrower clients.
<b>Broker</b>	Woolbrokers arrange the pre-sale handling and post-sale despatch of the wool, and conduct the auction on behalf of their farmer clients; they act as selling agents and charge a fee that covers receiving, weighing, sampling, storage, cataloguing, insurance, sale and transport costs.
<b>Buyer</b>	Wool buyers are purchasers of wool at auction or by private treaty. Most fall into the categories of either merchant, overseas mill or local mill.
<b>Limit</b>	The maximum price which a buyer is prepared to pay
<b>Lot</b>	A separately catalogued line of sale wool.
<b>Line</b>	Saleable number of bales, containing wool of similar type and usually from the one grower.
<b>Private sale</b>	Wool sales made between two parties, i.e. the grower and the buyer, and conducted outside the auction system.
<b>Reserve</b>	An instruction from a grower to his or her broker notifying them of the minimum price to accept for the wool. The lot is passed-in if the reserve price is not reached.
<b>Valuation</b>	The estimated market price based on previous auction sale quotes.

## References and further reading

### Wool production books available from Telford

Wool Harvesting Resource Kit – A practical reference guide by WoolPro

Fine Wool Growers Handbook – New Zealand Wool Board

Wool Presser Handbook – New Zealand Wool Board

The A to Z Glossary of Wool Terms by G. L. Squire

Profitable Wool Handling - New Zealand Wool Board

Pocket Guide to Sheep Breeds of New Zealand by Graham Meadows, 2008

Trafford, G. and Trafford, S. (2011). *Lincoln University Farm Technical Manual 2011*. The Caxton Press, Christchurch, New Zealand.

### Articles and papers available on the internet – search for the headings

‘Does mid-pregnancy shearing affect lamb fleece characteristics’, R. G. Sherlock, P. R. Kenyon, S.T. Morris, Proceedings of the New Zealand Society of Animal Production, 2002, Volume 62, 57 – 60.

‘Seasonal wool production of Romney and Merino x Romney wethers’, M. L. Bigham, R. H. W. Sumner, D. C. Dalton, NZ Journal of Experimental Agriculture, 1977, 5:257 – 260.

‘The Chemical & Physical Structure of Merino Wool’ available from [www.csiro.au](http://www.csiro.au)

‘Improving the nutrition of Merino ewes during pregnancy increases the fleece weight and reduces the fibre diameter of their progeny’s wool during their lifetime and these effects can be predicted from the ewe’s liveweight profile’, A. N. Thompson, M. B. Ferguson, D. J. Gordon, G. A. Kearney, C. M. Oldham and B. L. Paganoni, Animal Production Science, 2011, 51:794 – 804. CSIRO Publishing.

## Useful websites

There are many websites that contain information about sheep, wool and shearing. Make sure the sites you source information from are reputable and applicable to the New Zealand industry and conditions.

Note that Beef + Lamb New Zealand is **not** involved with wool production so there very little information about wool on their website ([www.beeflambnz.com](http://www.beeflambnz.com))

<b>Website</b>	<b>Type of information</b>
<a href="http://www.woolclassers.co.nz">www.woolclassers.co.nz</a>	New Zealand Wool Classer Association website – the following information can be downloaded from this site: Clip Preparation – Best Practice Guideline (called ‘Shearing Code Of Practice’ on the site) Woolclassers Code Of Business Conduct other information on wool classing
<a href="http://www.tectra.co.nz">www.tectra.co.nz</a>	Tectra is a private training organisation specialising in wool industry training including shearing and wool classing. There are a lot of very useful information leaflets that can be viewed and downloaded from this site.
<a href="http://www.mpi.govt.nz">www.mpi.govt.nz</a>	New Zealand Ministry for Primary Industries – the following information can be downloaded from this site: Animal Welfare (Sheep and Beef Cattle) Code of Welfare 2010 Situation and Outlook for New Zealand Primary Industries (SOPI)
<a href="http://www.nzwta.co.nz">www.nzwta.co.nz</a>	New Zealand Wool Testing Authority website with articles on wool properties and testing
<a href="http://www.sgs.co.nz">www.sgs.co.nz</a>	SGS (Société Générale de Surveillance) website with articles on wool properties and testing
<a href="http://www.biotechlearn.org.nz">www.biotechlearn.org.nz</a>	University of Waikato website – search for ‘wool fibre’ for a good graphic presentation of a wool fibre
<a href="http://www.wool.com">www.wool.com</a>	Australian Wool Innovation Ltd website with information on many aspects of fine wool production in Australia
<a href="http://www.lifetimewool.com.au">www.lifetimewool.com.au</a>	Information on Merino nutrition and wool growth under Australian conditions



## Test Yourself Answers

### Test Yourself #1

1.

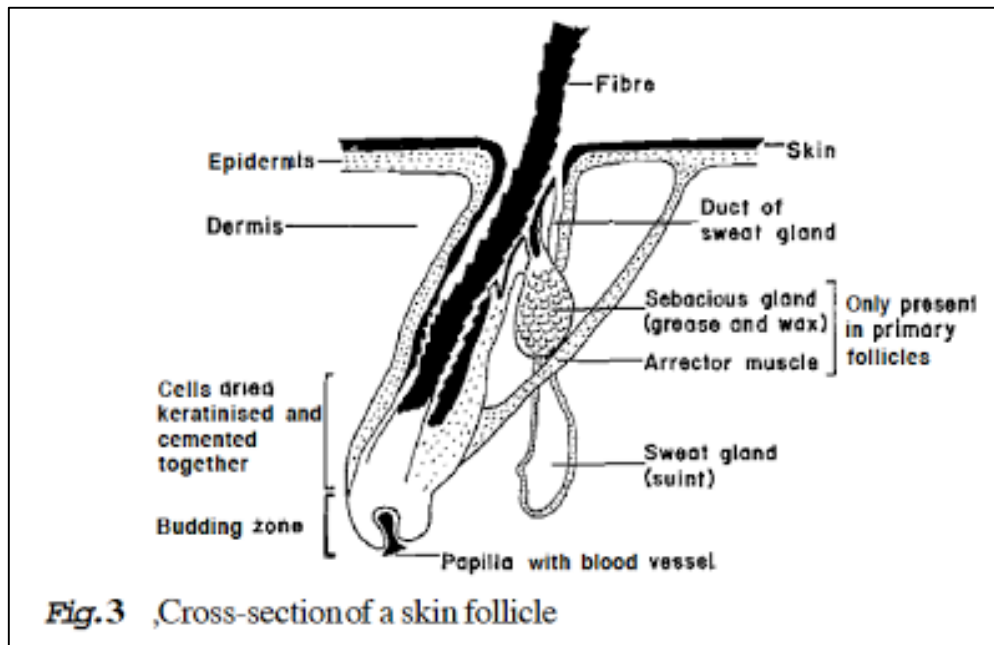


Figure 27 Primary wool follicle showing the skin layers (epidermis, dermis) and papilla which provides nutrients and energy for wool

[http://woolshed1.blogspot.co.nz/2009/05/introduction-to-practical-animal\\_14.html](http://woolshed1.blogspot.co.nz/2009/05/introduction-to-practical-animal_14.html)

(Image used with permission)

2. The wool follicle above is a primary follicle because only primary follicles have a sweat gland. Secondary follicles only have a sebaceous gland
3. Keratin
4. Cuticle and cortex
5. A 'normal' wool fibre has a solid cortex whereas a medullated wool fibre has a central hollow in the cortex filled with an open lattice-work of keratin filled with air which is called the medulla. In some fibres the centre is completely hollow and filled with air).
6. Medullated fibres feel brittle and hairy compared to solid wool fibres.
7. Medullated fibres are used in carpet making because they give carpets a 'crisp' handle or feel, a higher resistance to compression (being stood on by people or furniture), less tracking and helps retain the overall appearance of a carpet.
8. In coarse wool breeds the primary follicles are relatively large and there may be only a few secondary follicles whereas in fine wool breeds the primary and secondary follicles are all small and there may be many secondary follicles in each group.
9. a) Suint is produced by the sweat glands associated with the wool follicle and b) grease is produced by the sebaceous glands.

10. Primary follicles are typically arranged in groups of three with associated secondary follicles to one side of the primary follicle group.

### Test Yourself #2

1. The strength of the wool determines whether wool fibres break during processing which in turn affects the overall length of fibre available to be used to manufacture the end product. Tender wools produce more waste during processing.
2. a) 23 N/ktex = tender    b) 36 N/ktex = sound    c) 42 N/ktex = very sound
3. Lincoln or Leicester
4. Timing of shearing
5. It affects the feel and visual appearance of end products.
6. Merino
7. Any three of the following: Romney, Perendale, Coopworth, Border Leicester, Texel and crosses of these breeds
8. Mean fibre diameter range: > 31 microns = Crossbred wools (strong or coarse); 25 – 31 microns = Medium wools (mid-micron); < 25 microns = Fine wools
9. There is less overall variation in fibre diameter of the Merino wool clip compared to the crossbred wool clip because crossbred wool comes from a range of different breeds rather than just one breed. Crossbred wool also comes from regions all over New Zealand with varying climates and management strategies (e.g. meat and wool production) whereas most Merinos are farmed in South Island high country areas which focus on wool production.
10. Fine wools with little variation around the mean diameter have a high comfort factor.
11. Wool colour is important to manufacturers because only white wool can be dyed to pastel shades, whereas off-coloured wool (cream or yellow) is only suited to dyeing to darker colours.
12. Moderate brightness and poor colour.
13. Cotting is when matts form in the fleece as a result of extensive and severe entanglement of the wool fibres. Predisposing factors include severe stress that causes a break in the wool so fibres shed and become entangled and lice infestation (because sheep rub against fences etc. to relieve the discomfort associated with lice).
14. High rainfall with warm humid temperatures encourages the proliferation of bacteria that cause bands of discolouration, especially on areas that do not dry out well like the fleece line, the shoulders and back leg.
15. Penstain or faecal contamination of fleece can be minimised by dagging at least a week before shearing and letting the sheep empty out on a bare area for at least 8 hours and up to 24 hours before penning up.
16. Bulk is the ability of wool to fill space. The number of crimps in a fibre largely determines wool 'bulk'; in general, the more crimps the greater the bulk.
17. Yield is the weight of clean wool, after impurities have been removed. It is expressed as a percentage of the greasy wool weight.

### Test Yourself #3

1. Day length
2. False. High wool growth rates are associated with a high level of the hormone prolactin.

3. *i) Underfeeding reduces fibre output from wool follicles resulting in finer, shorter wool. ii) Generous feeding levels support longer, coarser and heavier fibres, hence heavier fleece weights. iii) Sudden changes in amount or quality of feed can reduce staple strength and fleece yield.*
4. *10 – 14% lower annual fleece weight from breeding ewes compared to non-breeding ewes*
5. *Good nutrition of Merino ewes during pregnancy and lactation increases the fleece weight and reduces the fibre diameter of wool produced by their progeny over their lifetime.*
6. *Sudden changes in amount and quality of feed change the amount of nutrients available to wool follicles and fibre growth slows dramatically. Stress can also lead to this effect.*
7. *No. Apart from animal welfare, growth and reproduction considerations, the fleece weights will be lower, the wool will be tender and of poorer quality*

#### Test Yourself #4

1. *Wool from sheep shorn twice a year is termed 'second shear'.*
2. *Early shorn.*
3. *Romney types Oct to Dec. Merino types July to Sept.*
4. *Wool should be not less than 75 mm (3 inches) long.*
5. *It improves cash-flow and the wool length (100 -125 mm) can be more marketable than longer or shorter wool, and only half the flock are shorn at one time, making it easier to provide extra food and shelter.*
6. *The main advantages:*
  - *Increased appetite and food intake mean better lamb birth weights (for multiples), better lamb survival, better lamb growth rates, more milk after lambing and heavier lambs at weaning.*
  - *Winter shearing means more wool and wool of better quality.*
  - *It means ewes do not have to be mustered and shorn when they have lambs at foot.*
  - *For the ewes, increased appetite when there is sufficient food can mean less metabolic disease like sleepy sickness.*
  - *The ewes are less bulky so less likely to become cast.*
  - *Winter shearing means a more even distribution of labour requirements throughout the year (less labour is required for shearing over the spring and summer.*

*The disadvantages are:*

- *When they suddenly lose their wool, ewes are very susceptible to cold stress. If they do not have sufficient shelter and food in cold weather they will become hypothermic and may die.*
  - *Their food requirements increase by up to 50% for at least 4 weeks after shearing at a time when food may be scarce.*
  - *It may be difficult to get the ewes dry enough for shearing.*
7.
    - *The sheep can be shorn with winter or cover combs. Lifters or blades may be necessary in some environments.*
    - *Ewes can be shorn in mob sizes that can be adequately fed and sheltered.*
    - *Shorn ewes can be given well-sheltered pasture and moved onto it well before dark.*
    - *Covered yards and/or the woolshed can be made available for emergency shelter.*

8.
  - *In early summer to remove dags that could attract blowflies*
  - *In winter in pregnant ewes to make lambing easier and clear the way for the newborn lambs to suckle*
  - *At any time to make it easier for shearers when the flock is fully shorn.*
9. *See diagrams in teaching notes.*
10.
  - *Sheep should be daggged at least 7 days before shearing, and yards should not be dusty.*
  - *The sheep should be mustered and brought quietly into the yards.*
  - *Sheep must be dry, empty and drafted into appropriate mobs.*
11.
  - *Wet sheep can cause skin shores on shearers*
  - *Wet wool discolours and loses value*
  - *Wet wool heats up and can be a fire risk*
12. .
  - *Emptied sheep struggle less on the board, so it is better for their welfare.*
  - *Sheep that are adequately emptied out cause shearers fewer back injuries and ACC claims, and there is a reduced disease risk of disease for those working in the sheds and yards.*
  - *Fasting reduces the incidence of pen stain in wool, resulting in better quality wool.*
13. *32 hours food, 24 hours water.*
14. *24 hours food, 20 hours water.*
15.
  - *Shearing contractor*
  - *Classer*
  - *Presser*
  - *Leading wool handler*
  - *Wool handlers*
  - *Q stencil holder*
16. *A classer is usually employed only for fine or speciality wools, not usually for cross-bred flocks. The classer is responsible for the overall presentation of the clip. This includes the packaging, branding and recording.*
17. *The leading wool handler manages the wool handling team and oversees their grading of wool and takes responsibility for the standard of clip preparation.*
18. *Shorter or discoloured parts e.g. crutchings, top knots, socks etc and belly wool, shorter discoloured crutch wools, second cuts and pieces from the legs and head, stains and dags.*
19. *first pieces, necks, seedy backs*
20. *On the shearing board because they do not hold together for throwing onto the table.*
21. *For wools finer than 33 microns.*
22. *No more than 200 kg and ideally around 180 kg.*
23. *Newly shorn sheep will eat up to 50% more than when unshorn, and they should be offered enough food to meet their requirements.*
24. *Colour.*

25. This is the proportion of clean wool present after the grease, sweat and dirt are washed out and vegetable matter is removed. Yield is expressed as the percentage of clean wool derived from the greasy sample.

#### Test Yourself #5

1. Public auction.
2. At two sites, one in Napier, one in Christchurch.
3. A grab sample is taken and displayed with the wool testing results. This has largely replaced the traditional system of having all the bales in each lot available for inspection at each auction.
4. The bales of wool can be held somewhere else until they are sold so there are considerable savings in handling and transport costs.
5. They arrange the pre-sale handling and post-sale despatch of the wool, and conduct the auction on behalf of their farmer clients. Woolbrokers do not own the wool, but act as selling agents. They charge a fee, which covers receiving, weighing, sampling, storage, cataloguing, insurance, sale and transport costs.
6. There are 100.
7. *Slip* wool is the wool that is harvested from sheep after slaughter at a meat works. The 'wool pull' is visually estimated on the sheep before slaughter and the farmer paid for the skin plus estimated wool pull.
8.
  - A group of 100 Romney farmers has recently made a deal with a Nepalese company to provide wool to make carpets and rugs.
  - A number of Drysdale farmers through a specialist marketing organisation sell their wool directly to mills in New Zealand or overseas.
  - A group of Merino farmers supplies a New Zealand business with superfine wool for an outdoor clothing company.
9.
  - Exchange rates with trading partners.
  - Consumer demand.
  - Supply of wool.
  - Seasonal patterns for prices – e.g. Merino wool is usually sold over just a few months and prices fall out of season because buyers are not putting together major orders at that time.
  - Price of competing fibres that manufacturers could use instead of wool.

## AIRFLOW, OFDA & LASERSCAN

### FIBRE DIAMETER CERTIFICATION

Traditionally, mean fibre diameter of greasy and sooured wool was for many years certified using the airflow test method (IWTO-28) in the southern hemisphere grower countries. Processors used airflow (IWTO-6) or projection microscope (IWTO-8) to measure diameter of tops & slivers (see Info-bulletin 3.1).

Since the 1990's this situation changed, with the introduction of the OFDA and Sirolan-Laserscan instruments. These measure both mean fibre diameter and distribution of diameter using modern techniques.

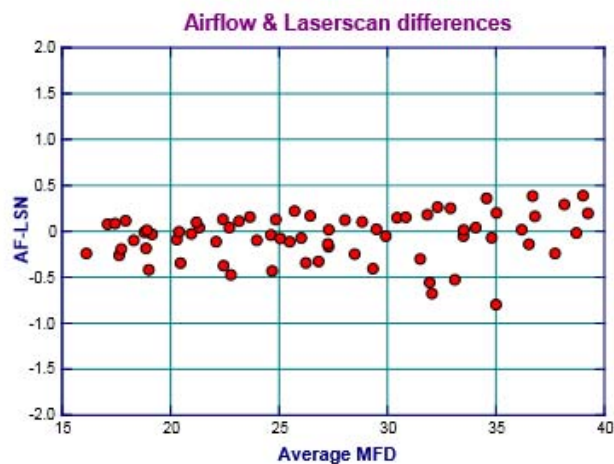
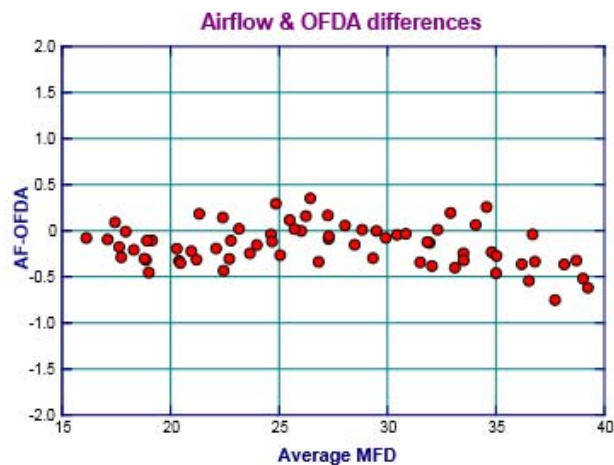
The newer instruments have been rapidly adopted over the last few years in all parts of the wool industry, from fleece testing through to top and yarn measurement. There are now over 200 OFDA instruments in use in over 30 countries. In 1995 both instruments were accepted by IWTO for raw wool and tops certification using the test methods IWTO-47 (OFDA) and IWTO-12 (Laserscan).

### DIFFERENCES BETWEEN METHODS

The projection microscope is still regarded as the reference method for wool and animal fibres. The width of projected images of individual fibre snippets are allocated to diameter classes, and after at least 600 snippets have been measured by at least 2 operators, the mean diameter can be calculated.

The airflow method is empirical. Mean fibre diameter is indicated by the rate of flow of air, at a fixed pressure, through a 2.5g mass of fibre compressed in a fixed volume. Each instrument is calibrated using internationally agreed calibration tops, whose nominal values are fixed after several international round trials using both airflow and the projection microscope.

The two newer instruments work in a similar manner to the projection microscope by measuring the width of fibre snippet images, although by highly automated methods. Whilst the details of measurement are different, both instruments allocate snippet widths to diameter classes, and the mean fibre diameter is calculated from at least 2000 snippets in the case of the OFDA, and 1000 snippets in the case of the Laserscan.



Combined grand mean differences data from the 1995 IWTO Airflow, OFDA, Laserscan round trial

### DIFFERENCES BETWEEN RESULTS

In 1995 two international round trials were organised in which 4 laboratories measured 40 raw wool samples by airflow, OFDA and Laserscan; and 16 laboratories participated in a trial in which 30 top samples were measured. The outcome from both trials was similar, and the combined results are shown in the two graphs following.

It can be seen that on average both of the newer instruments gave similar results to the airflow, but that on specific wools, differences of up to 0.5 micron were observed between the new methods and airflow. (Similar conclusions could be drawn when the results were compared to projection microscope measurements.)

The reasons for the individual differences are a combination of natural measurement variability, and minor differences arising from differences in the physical principles used in each system. However, it should be noted that the level of variability shown above is no greater than would be found between airflow measurements carried out on two samples of wool in different laboratories.

Eventually we expect that most measurements of fibre diameter will be made with the new instruments. IWTO has accepted that for tops and slivers the two new systems give similar mean fibre diameter results. However, IWTO has not allowed results from the different methods to be combined on one certificate, and continues to stipulate that retests must be carried out using the same test method as was used for certification.

The situation with raw wool is slightly different. In Australia, South Africa, and in New Zealand for merino wools, Laserscan measurement under IWTO-12 has now become the default.

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