1
Wool production and fibre marketing

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1.1 General introduction

Sheep husbandry is an important pastoral activity across most of Europe, the Americas and Asia. Its purpose nowadays is primarily meat production, although the wool harvest has for centuries been an important basis of local textile industries. European colonisation of large areas of the southern hemisphere suitable for pastoral production led to much larger numbers of sheep and a more dominant emphasis on wool production.

A large proportion of the wool harvest from Australia, New Zealand, South Africa, Argentina and Uruguay is exported to textile manufacturers in the northern hemisphere. For about a century (from 1860–1960) these manufacturers were almost entirely to be found in Western Europe. Since 1960, wool manufacture has declined in some of these countries and more volatile trading patterns have emerged. Russia, Japan, Iran and China are some of the countries that have fluctuated between minor and major importers of southern hemisphere wool.

Another trend, which gathered momentum since the end of the 1939–45 war, has been the drive for greater productivity from textile machines and consistent high-quality standards for textile products, so that standardised raw material is demanded. This turned the spotlight on wool marketing practices. Competition from synthetic fibres intensified. Their prices were usually stable, or actually reduced as the scale of production increased. Particularly important were technological advances in converting petroleum gases into reactive monomers suitable as starting materials for synthetic fibre production. Moreover, the consistent and precisely specified properties of synthetic fibres were very much in harmony with the ability to fine-tune textile machinery for high production rates.

In the face of this growing competition it was inevitable that the historic reliance of buyers and sellers of raw wool on intuitive judgement and experience in making trades came under pressure for change. Basically, the onus for developing, testing and implementing more sophisticated wool marketing systems fell mainly on Australia and New Zealand. Australia is by far the dominant producer of fine Merino wool and accounts for almost half the quantity of wool worldwide that comes onto the open market. The Australian Wool Corporation (AWC), over the approximate period of 1950–1990, chaperoned the wool producers towards more efficient fleece preparation, and the wool trade into more efficient wool handling, packaging, transportation and sale methods. The AWC would also fund a considerable portion of the R&D efforts of Australian CSIRO scientists who were to verify new test methods and develop equipment for wool-brokers and test houses. In Australia, numerical specification of wool would focus on those measurements of most importance to the worsted industry.

New Zealand had a closely parallel responsibility as the predominant producer of crossbred wool for open sale. These wools, in many respects, posed a greater problem in sampling and testing because of the greater variability within and between sale lots and the diversity of end-uses. Although carpets were mainstay products after the 1939–45 war, considerable segments of the crossbred wool clip were destined for woven and knitted clothing, blankets, furnishing fabrics and many other products. In similar fashion to the AWC role in Australia, the New Zealand Wool Board (NZWB) encouraged the wool trade to participate in trials of new marketing procedures, and contributed a high proportion of funds to enable scientists at the Wool Research Organisation of New Zealand (WRONZ), formally incorporated in 1961, to develop sampling and testing methods and equipment, as well as scientific, manufacturing and product research relevant to coarser wools. The numerical specifications would emphasise those features of most importance for spinning on the woollen system.

By about 1990, almost all the testing and marketing procedures had been implemented in both Australia, New Zealand and South Africa. The last had a very similar fine wool profile to that of Australia and co-operated very closely in all aspects of wool testing, adoption of standards and marketing procedures. The regular meetings of the International Wool Textile Organisation (IWTO) meant reviews of outstanding concerns to the wool textile industries could be aired and responsibility for redress taken by the appropriate research laboratories, test houses, or trade committees.

Representatives of long-established wool manufacturers could expand their historic emphasis on such things as tariffs and regulation of trading in woollen goods to participate in IWTO sub-committees examining the technical and practical issues involved in routinely using the proposed new wool specifications. These were not all the problems to be addressed. Not only were the major traditional wool manufacturers confronting stiff competition from a burgeoning type of new textile industry featuring relatively cheap synthetic fibre products, but consumer interests increasingly required proof of product performance. On the one hand, the primary fibre needed to be free from agricultural chemical residues, and on the other, retailers of wool products wanted a performance endorsement. Both aspects were fairly solidly secured in the 1980s, particularly through a very successful promotion campaign headed by the *Woolmark* label on products approved according to International Wool Secretariat (IWS) Standards.

New problems have arisen during the 1990s, not so much with sales and test methods, where continued improvements in equipment and computer technology remain in vogue, but rather a renewed competitive pressure on wool prices. This has occasioned calls for relief from wool growers who wish to see wool marketing overhead costs, such as levies collected by AWC and the NZWB, to be much reduced. Another change is some revival of direct sales between consortiums of specialist wool producers and corresponding clubs of manufacturers in Europe or Asia.

Irrespective of these continual shifting patterns in wool trading, the wool industry does now possess a sophisticated array of sampling and testing procedures that provide reliable support in terms of technical data. Whether the transaction is made through the auction system, private treaty or increasingly, one would expect, through electronic means such as the Internet, the packages of wool test methods described later in this chapter will remain relevant.

1.2 World wool production

Table 1.1 is reproduced from the *1998/99 Statistical Handbook* of New Zealand Wool Group, a division of the NZWB.[1] The major trend is a reduction in Australian wool production in the 1990s due to poor prices, which in turn was initiated by a recession in Japan and other important wool consumers. Recovery has been hindered by acquisition of a considerable stockpile in Australia early in the decade. Economic disruption has also halved wool production in the Soviet Union (now CIS), but it is growing significantly in China. New Zealand production is fairly stable, in spite of modest prices and several droughts during the 1990s. The slow downward trend is, in part, a result of buoyant investment in dairying as a more profitable use of grassland.

There are several features of world wool production worthy of additional comment. Australian wool production is highly concentrated on the Merino breed and it therefore has a very dominant position in fine wools, accounting for about half of world supplies. Although approximately 75% of New Zealand production is categorised as crossbred type, i.e. about 140 000 clean tonnes, this represents just 30% of world supplies. The UK is a very substantial producer of coarse carpet wools and most of its 46 000 tonne production competes directly with New Zealand offerings to the carpet industries in Europe and elsewhere. Halfbred wools comprise a quite high

Table 1.1 World wool production [Reproduced from the 1998/99 Statistical Handbook of New Zealand Wool Group, Wool House, Wellington]

Country	World wool production (thousand tonnes clean)							
	1992–93r	1993–94r	1994–95r	1995–96r	1996–97r	1997–98r	1998–99p	% change 1997–98 to 1998–99
Australia	573	544	473	452	472	455	443	–3%
New Zealand	193	214	213	199	203	197	185	–6%
China	119	120	128	139	149	146	151	3%
Soviet Union/CIS	207	194	157	124	118	103	90	–13%
United Kingdom	47	45	45	44	43	44	46	5%
Uruguay	64	66	60	56	60	55	45	–18%
Argentina	60	52	48	43	41	37	37	0%
Turkey	38	38	37	37	36	36	36	0%
South Africa	44	43	38	38	36	33	34	3%
India	28	28	28	28	28	28	28	0%
Pakistan	21	21	22	22	23	23	24	4%
Iran	21	21	22	23	23	23	23	0%
Ireland	18	18	18	18	17	18	18	0%
Spain	16	17	17	16	16	16	15	–6%
Morocco	14	14	14	14	14	15	15	0%
USA	23	22	19	18	15	15	14	–7%
Mongolia	12	12	11	11	11	11	11	0%
Romania	13	12	11	11	10	10	10	0%
France	12	11	11	11	11	11	10	–9%
Chile	11	11	11	11	9	9	9	0%
Brazil	17	13	11	11	11	11	8	–27%
Peru	7	6	7	7	7	8	8	0%
Germany	7	7	7	8	8	8	7	–13%
Greece	6	6	6	6	6	7	7	0%
Iraq	7	7	7	6	6	6	6	0%
Italy	6	6	6	5	5	5	5	0%
Portugal	5	5	5	5	5	5	5	0%
Other countries	132	124	127	126	125	127	127	0%
World total of which:	**1721**	**1677**	**1559**	**1489**	**1508**	**1462**	**1417**	**–3%**
Merino	813	777	681	643	653	626	609	–3%
Halfbred	405	388	383	365	368	363	350	–4%
Crossbred	503	512	495	480	487	473	458	–3%

r = revised; p = provisional; Source: IWTO.
Data extracted from 1998/99 Statistical Handbook of New Zealand Wool Group.

fraction (25%) of the total world wool production. This classification notably includes a large proportion of the predominant Corriedales and Merino cross wools sold out of Argentina and Uruguay.

World wool production in total is, however, modest compared to the volumes of cotton and synthetic fibres. Wool available for manufacturing from all sources at the end of the twentieth century accounts probably for no more than 3% of total world fibre supply.

1.3 Wool harvesting

Most wool is harvested by shearing live sheep using powered hand clippers. Blade shears are still preferred for flocks run where harsh weather can occur, because about 10 mm of fleece can be left on the sheep for protection. Slipe wools are produced at meat-works. Woolly sheepskins from slaughtered sheep and lambs are chemically treated to weaken the fibre roots so that the wool can be pulled off the pelt.

The main wool classifications are full fleece (a year's growth), second shear and early shorn (part-year's growth), and crutchings (shorn from the hindquarters before lambing). Lambswool (shorn at about six months), woolly hogget (shorn at one year) and shorn hogget (shorn as lambs and then at 18 months) are other descriptions used in New Zealand. Each wool-producing country uses a variety of other classifications.

1.4 Clip preparation

During shearing, each fleece is examined with the objective of removing faults relating to colour, length and contamination, and collecting each separately. The main categories are belly wool, short discoloured crutch wool, stains and dags. Vegetable matter and cotted (i.e. felted) parts of the fleece are also separated.

Skirted fleeces are sorted into uniform groups or lines. Fine wool lines will discriminate on the variables of fibre diameter, length, strength, colour and vegetable contamination. The main sorting principles for carpet wools are discolouration and fleece tenderness.

Slipe wools, produced in meat works, are classed along similar lines, the main difference being a wash that removes most of the woolgrease and suint, as well as any sodium sulphide depilatory adhering to the wool.

1.5 Participants in the wool trade

1.5.1 Woolgrowers

Sheep farmers have been constantly urged to improve their performance with respect to putting a better product into the start of the wool marketing and manufacturing chain. Apart from the obvious requirement for good sheep husbandry and a breeding and selection strategy, there are several aspects involving responsible farm management. Some pasture weeds produce burrs and seeds that become entangled in the growing fleece. Substantial contamination cannot be taken out by conventional mechanical processing, and carbonising (an acid process which embrittles vegetable matter) is required, adding costs in wool classing and processing.

Environmental concerns are another issue where the woolgrower is ultimately responsible for using approved pesticides, drenches and agricultural sprays, so that the shorn wool contains no unwanted residues. Finally, workers in the shearing shed need to be well informed on best practices and skilled in classing and skirting (Section 1.4) before loading the wool harvest into farm bales. Provided these responsibilities of the woolgrowers are reliably fulfilled, the onward task of taking the clip to auction, usually via a wool broker, or a direct sale at the farm gate, is much facilitated.

1.5.2 Wool brokers and wool buyers

For wool sold at auction, a reputable wool broker is the traditional intermediary who prepares farm lots. Nowadays, this entails aggregating similar sale lots, particularly small lots, weighing, sampling and cataloguing. There are formal procedures for core sampling and obtaining a pre-sale test certificate from a test house to be available at the auction. A grab sample of full-length wool is also obtained, which is displayed alongside the test certificate at the auction room. This is an enormous transformation that has mainly been effected since 1970, after which time the means for improved testing and their ratification by IWTO (Section 1.1) have come to dominate wool marketing.

Previously, a few large and many small wool-broking companies had relied upon the personal expertise of their staff. Their ability to judge the yield (i.e. the weight of clean wool remaining after scouring) and mean diameter, for example, were extraordinary. In the latter case, staff in both wool broking and wool buying companies were adept at assigning a fineness estimate for each sale lot in their notebooks prior to auction. For fine wool products, where wool mean fibre diameter is a critical parameter, these assessment experts were capable of discriminating readily between 18, 20, and 22 micron wools, and more often than not their subjective assessments correlated with laboratory measurements to within a fraction of a micron. They also included other judgements on 'style', which meant a synthesis of fibre crimp and other fleece characteristics that they and their clients believed to be a superior judgement of processing and product performance as compared to a limited array of objective measurements.

Efficient sampling and testing procedures (Sections 1.6–1.12) have largely eliminated this bias, and basically in the 21st century most wool trading will be underwritten by physical measurements. Exceptions will still exist, typically where a wool-buyer and a wool-grower agree at the farm gate on a transaction price.

Direct selling has the attraction of very low transaction costs. It is seen to best advantage when an atmosphere of mutual trust is developed between a manufacturer and a number of wool-grower clients. For example, Cavalier Corporation is a prominent New Zealand carpet manufacturer. The company has a subsidiary which has established a good record in arranging direct acquisition of wool on a regular basis. Many of the wool-growers became directly involved with individual carpet manufacturers about 1950 when the first commercial flocks of Drysdale sheep were taking shape. The Drysdale breed was named after Dr Dry, a geneticist who discovered a gene which led to remarkably coarse wool from the sheep which carried it, and it is particularly sought after for some styles of carpets.

In Australia in 1997, approximately 80% of the wool clip was sold at auction using the services of one of about 30 wool-broking companies operating in that country.[2] Private buyers account for the remaining 20% of the wool market, the larger companies being affiliated to the national Private Treaty Wool Merchants Association.

1.5.3 Test houses

The Australian Wool Testing Authority (AWTA) was established as a statutory body by an Act of the Commonwealth Government in 1937. With the advent of large-scale sampling and testing of wool sale lots, the activities of AWTA expanded greatly. The form of governance was changed, and since 1982 AWTA Ltd has operated as a public company limited by guarantee, without shareholders. Its guarantors nominate directors with an additional director representing CSIRO.

They are as follows:

- Australian Council of Wool Exporters
- Federal Council of Private Treaty Merchants
- National Council of Wool Selling Brokers of Australia
- Wool Council of Australia
- Wool Scourers and Carbonisers Association of Australia
- Wool Textile Manufacturers of Australia
- Australian Wool Corporation

Pre-sale wool test certificates comprise about 66% of all documents issued by AWTA Ltd since 1984. The remainder are certificates for scoured and carbonised wool, and the company is also active in testing of imported woolpack materials. Very similar organisations operate in New Zealand (NZ Wool Testing Authority) and South Africa. They are, themselves, subject to regular quality control audits.

The issue of reliable sampling was at the heart of introducing fundamental changes in wool marketing methods. Sampling technology is described in more detail in Section 1.6. It should, however, be emphasised here there are two basic methods of sampling, which have quite different and explicit purposes.

Objective measurements of core samples comprise yield (i.e. percentage of clean wool), diameter, colour and vegetable matter content. Pre-sale certificates are shown adjacent to a grab-sample of the same lot prior to auction. Post-sale test certificates for greasy wool may also be issued, notably when several sale lots are later combined. Most New Zealand wool is scoured prior to export and the pre-sale certificate is redundant. A different sampling and test regime applies to scoured wool shipments, and a notable replacement for the yield test of greasy wool is the 'residuals' test, i.e. the result of a solvent extraction of a representative sample in order to quantify wool fats and residues not totally removed by the scouring process.

1.5.4 British wool marketing

There are many similarities between marketing arrangements in Australia, New Zealand and South Africa and that in the UK, notably a strong reliance on the auction system and a Board which takes a broad overview of the industry.[3] The most recent report of the British Wool Marketing Board indicates there are about 75 000 farmers contributing to an annual wool production in the UK of 46 million kilos. Amongst their activities, the Board organises regular auctions, supports training of shearers and promotes British wools in carpets manufactured in the UK.

In the northern hemisphere, institutions such as the Bradford Conditioning House have for many years offered a weighing and testing service; in their case for the large number of wool manufacturers concentrated in the West Riding of Yorkshire.

The application of objective specifications of wool lots is clearly gaining increased support as the British Wool Marketing Board indicates[3] considerable investment in equipment for the purpose, and a stated interest in future marketing of British wools internationally using the Internet.

1.5.5 Wool exporters including wool scourers

There are two methods for obtaining wool from exporting companies. Under the 'indent buying' system, the overseas buyer nominates an upper price, wool type and quantity, and the exporter attempts to fill the order on essentially a commission basis. Under the 'firm offer' system, the exporter takes the initiative and makes a firm offer to a buyer including price and other details. If the offer, usually open for 24 hours, is accepted, the onus is on the exporter to fill the order on the terms of the offer.

In cases of dispute, the IWTO have regulations applying to trading, such as ordering retests when the specification of the delivery is questioned.

A good number of powerful European and Asian textile companies bid at auction, and essentially can be regarded as exporters who principally buy on behalf of their own wool manufacturing mills.

Wool scouring companies have several different objectives according to their ownership and, to some extent, their location. For some, their predominant business is scouring on commission for an exporter or a local manufacturer. Others may be owned in part or in whole by wool manufacturers, and a sizeable part of their business is essentially 'in house'.

Some of the largest wool scouring companies have a wool trading operation including wool exporting. One of the advantages of a wool scour is the ability to blend wool lots to make up large consignments to specifications of overseas clients. The technology supporting this type of wool export operation is described in Sections 1.12 and 1.13.

The major southern hemisphere wool exporting countries have well-established test houses (Section 1.5.3), which are regularly subjected to quality-control audits. Objective measurements of core samples comprise yield (i.e. percentage of clean wool), diameter, colour and vegetable matter content. Formal pre-sale and post-sale test certificates are issued for greasy wool. Scoured wool shipments have a somewhat different sampling and test regime before issue of a scoured wool test certificate. This would include a 'residuals' test, i.e. the result of a solvent extraction of selected samples in order to evaluate the presence of wool fats and other residues not removed during the scouring process.

Wool scouring presents a good opportunity to pool and blend similar lots purchased by a particular exporter. Following scouring, the wool is baled at medium or high density and commonly paralleled in container-sized lots of about 20 tonnes. Therefore, the principal advantage is an intelligent amalgamation of wool into consignments of a specification and regular tonnage appropriate to manufacturers.

1.5.6 Central wool facility

Central wool facilities are essentially strategically-placed port storage and packaging depots where greasy or scoured wool is made up into shipments. Greasy wool, for example, has traditionally been 'double-dumped', i.e. two bales pressed into one dense package to reduce shipping space. Ports around Australia with wool-handling facilities are serviced by three companies who specialise in this business.

Dumping has some technical problems that will be just touched upon here. The presses are themselves remarkable, working almost continuously for several months with thrusts of 300 or even 500 tonnes. The compression of two 150 kg bales together is demanding on the pack material, which must comply with strict specifications. Tensile strength is only one consideration. One of the problems discovered with polypropylene packs, for instance, is shattering of fibres, which contaminate fine wool and are visible faults in finished fabrics. Another problem with highly compressed wool bales is that, after some months in a compressed conditions, the wool is difficult to 'open', i.e. to break up into a manageable form for scouring. Bale-warmers and various opening machines have been devised to solve this problem.

Packaging of wool from farm bale to densely compressed shipping containers is itself an interesting topic. Jute was the dominant material until the advent of synthetic fibres. As noted above, these have not been troublefree. Nylon packs seemed likely prospects, because fibre contamination would essentially be invisible owing to the similar dyeing properties of wool and nylon. However, cost considerations are important too. It seems likely polyethylene will continue to develop as a preferred woolpack material.

1.5.7 Wool flow patterns and the auction system

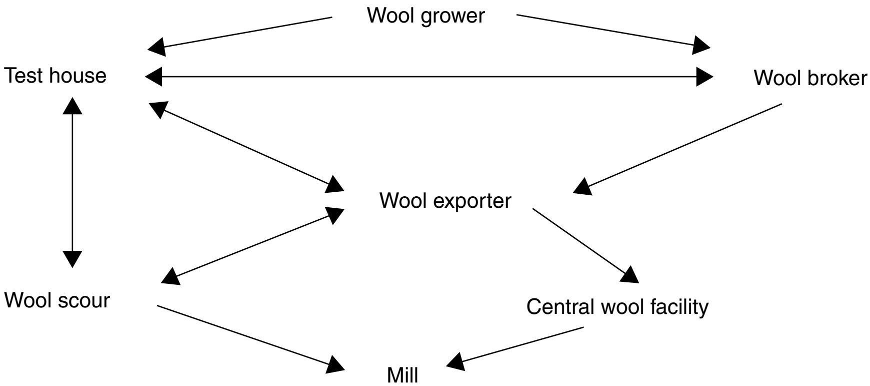
The full flow diagram for shorn wool sold at auction is shown in Fig. 1.1. The important auction process lies essentially between wool broker and exporter on the right of the diagram. Data flow describing wool samples involve a test house, shown on the left of the diagram.

Auctions remain the dominant feature of wool sales in Australia and South Africa, but as mentioned in the general introduction, in New Zealand in the final few years of the 1990s there has been a very significant movement towards private sales. Woolscouring companies are among those taking a more aggressive approach to acquiring greasy wool direct from the woolgrower, particularly in New Zealand.

In 1998/99 in New Zealand, the total sales of new greasy wool was about 185 300 tonnes, of which just 83 700 tonnes were sold at auction. Of the balance, growers sold 75 000 tonnes privately, and most of the remaining 26 600 tonnes was recovered as slipe wools.[1] The latter enters the international wool market as a specialty product favoured by particular wool manufacturers, or is sold to one of the prominent wool exporters.

1.5.8 Historic form of the wool auction system

Until changes began to be introduced after 1960, the historic form of the wool auction was identical in most respects to the commodity marketing of



1.1 Flow diagram for shorn wool to be sold at auction. Samples and test data involve a test-house.

a great many agricultural products. There was a roster of sale dates for all the wool producing regions and, on the day, all the product put up for sale was in full view for inspection, i.e. wool bales were cut open before lot-by-lot sale to bidders representing the international wool manufacturing community. Other than the weight of each greasy wool lot, buyers had no other factual information, but in practice they were highly skilled in judging the relevant attributes of each lot (Fig. 1.2).

The International Wool Textile Organisation (IWTO) had evolved over many years to become something close to a regulatory body. Delegates from all the member countries represent all the commercial interests to be found in the flow chart for the auction system (Fig. 1.1).

Adoption of regulations governing wool trading, accreditation and dispute procedures essentially gave IWTO the status of professional governance of the wool industry, with particular emphasis on standards and accreditation of wool supplies coming onto the international market.

1.6 Wool sampling

The largest obstacle to overcoming the cumbersome features of the old traditional auction system was the highly variable quality of sale lots. This could commonly be exacerbated by poor growing conditions or sloppy classing and skirting. Therefore, it was hardly surprising that wool buyers and manufacturers insisted on extensive and repetitive technical trials before they could be convinced on the key issue of sampling.

Wool sampling, in essence, replaces the opportunity for buyers to exercise their skills and judgement whereby they view the whole contents of every bale, by presenting to them a small sample attached to some test house measurements (Fig. 1.3). Nevertheless, this crucial victory in

1.2 Photograph of a traditional New Zealand wool-broker's store taken about 1957. Bales were opened for inspection several days before auction.

obtaining the confidence of all parties has rested upon the development of two methods of sampling greasy wool lots.

Grab sampling entails slitting open each bale and drawing out a regulated number of full-length wool staples to make up a composite sample of about 5 kg of greasy wool representative of a typical line of 3 to 20 bales (or even much larger lines in Australia). The entire wool lot is then weighed before undergoing the second method of sampling. Core sampling, as it is called, entails punching a sharp-ended tube through at least 97% of the length of each bale, sufficiently often to provide five samples of 150 g each, the cores being immediately sealed in a plastic bag for test house measurements complying with Core Test Regulations IWTO-19.

To set up the greasy wool auction, the grab samples are assembled in long lines of trays in a display hall, each rejoined by a test certificate derived from the core sample. This enables the buyer to see both a representative full-length staple display and have accurate data on fibre diameter, yield, colour, clean weight and vegetable matter content. To give some idea of the speed at which buyers must operate to fill their buying orders, about 300 lots are sold every hour, and up to 3400 lots in a single day, comprising up

1.3 Photograph of a complete assembly of representative grab samples of New Zealand wool lots to be auctioned. Each numbered viewing box has a data sheet from a test-house and other information.

to 35 000 bales of wool. In Australia, at peak times these volumes are greatly exceeded.

1.7 Fibre diameter

No measurement could better exemplify the divergence in priorities between fine and coarse wools than measurement of fibre diameter. For fine Merino wools, the predominant average within a lot lies between 18 and 21 microns and there is a useful price premium at the finer end of that range. The mean diameter, of course, relates closely to both the spinning limit and the luxury handle, where every micron finer creates an advantage. Increasingly in recent years, a new niche sector has developed in production of super-fine wool with breeders going to extraordinary pains to produce tiny amounts of wool in the 14 to 17 micron range, which can sell at extreme prices.

For crossbred wools destined for carpets, the mean diameters are most commonly in the 30–38 micron range and the New Zealand Romney and Coopworth wools that dominate this class have a good reputation for efficient processing. For some products in the carpet market the fibre blends are actually improved by addition of very coarse wools, e.g. Drysdale or British moorland sheep fleece wools. (For a better appraisal of matching wool blends to carpet styles see Chapter 10.) However, there is a significant intermediate diameter range (halfbreds, Corriedale and Down breeds) of 25–30 microns where diameter **variability** becomes a significant issue. A few very coarse fibres can affect the comfort of wearers of knitwear constructed from these wools.

The airflow method has been almost exclusively employed by test houses to measure mean fibre diameter until recent times. It is calibrated to record mean diameter of a wool lot reduced to a plug of clean core sample material through which air is forced under pressure. The method depends on a pressure drop principle; the greater the drop, the finer the wool. It is a simple, cheap measurement but has the drawback of inaccuracy when testing lambswools and medullated wools, where the diameter is increased relative to sample weight by empty spaces and hollow cells within the fibres. Much painstaking work over many years was required to produce calibration samples that were fully acceptable to wool manufacturers.

Definitive measurement of mean fibre diameter and variability has, for many years, depended on expensive microscope measurements of fibre snippets. This laborious technique has been employed by test houses but was generally regarded as suitable mainly for research workers. Since about 1970 however, there has been a series of brave attempts to master the problem of providing a representative array of fibre snippets and analysing them with a scanning instrument. Computation of the fibre profile of the sample is rapidly becoming a trivial procedure with the advent of powerful computers. Presently, it seems inevitable that there will soon be complete reliance on cost-effective equipment to record wool fibre diameter profiles using laser-scanning devices, such as OFDA (Optical Fibre Diameter Analyser), a development of BSC Electronics in Perth.

1.8 Fibre length

Objective testing of fine Merino wools has come to include a measurement of wool staple length and strength (IWTO-30 test method) applied to greasy wool samples. The *Atlas* machine developed about 1985 for this purpose has since been somewhat improved but essentially it has remained a fairly daunting and expensive test. Individual wool tufts are fed into a grip-break device. In addition to a calculated fibre tenacity it also records the position of break along the sample. Attention given to this technically difficult measurement reflects the desire of manufacturers to know, in advance, every feature of processing performance. For manufacturers, the results of this test can indicate the percentage of fibre that breaks during processing. Short fibres unsuited to further worsted processing are extracted in the form of noils in the combing process to prepare tops.

For New Zealand crossbred wools, where a very high percentage of the clip arrives via the auction or other routes at a woolscour prior to export, the more useful index of fibre length is actually a critical test of fibre entanglement induced by the scouring process, in addition to accounting for breakage at weak or thin places in some or all of the fleeces making up the scourment. Consequently, WRONZ developed a test based on processing representative samples through a dedicated, narrow-width wool carding machine. A minimum of five samples of the output sliver are analysed by the well-known Almeter equipment, which then produces a statement of short fibre percentage, mean fibre length, and a coefficient of variation of hauteur. This 'length after carding' test (NZ Standard 8719:1992) is essentially only available using equipment tested and validated in New Zealand. However, with active collaboration from other countries this test is steadily becoming recognised and applied on an international basis.

Testing wool scourments in this way results in a substantial consolidation of the data at the 'sale-by-sample' stage provided to auction buyers. Whereas the latter lots are commonly in the range 500–2000 kg, scourments are generally exported as one or several container loads of dense-packed bales, each holding about 16–20 tonnes.

1.9 Wool colour

A colour parameter in wool specification has no relevance to dozens of wool breeds around the world where the wool harvest is a great mixture of brown, yellow and white colours. However, it has a strong relationship with the value put on New Zealand wool sale lots since these vary widely in the incidence of yellowness (Section 5.4) in otherwise basically white fibre. Australian fine wools are very substantially protected from yellowing during wool growth because of the dense structure of a Merino fleece so that colour measurement at point-of-sale of fleece wools is of minor commercial interest. A relatively low priority for colour testing of Merino fleece is not to be confused with the importance of exceptionally good whiteness, often achieved by bleaching, for many fine wool products.

A New Zealand Standard (NZS 8707:1984) developed by WRONZ has progressed to the status of an IWTO Draft Test Method (IWTO-DTM-56).[4] The actual measurements are made by observing the reflectance from a chopped fibre wool sample packed into an observation cell. Strictly speaking, all three CIE tristimulus X, Y, and Z values are needed to construct a total description of wool colour. It should be seriously emphasised there are two aspects of wool fibre colour measurement which are important in the context of the appearance of final textile products. Rather than resort to complex equations, the simple difference between green and blue tristimulus measurements (i.e. Y–Z) is an adequate measure of wool yellowness. The other important discriminator among wool lots is their total light reflectance or brightness and for this, the tristimulus Y value has satisfied all requirements.

To summarise, (Y–Z) yellowness measurements will usually rank between 0 (very good whiteness) to 8–12 (very yellow) and the brightness index Y will range from about 70 at best down to about 40 for very dull wools. These figures are, or are closely related to, the percentage of incident light reflected back to reach the eyes of the observer.

1.10 Bulk testing

Bulk testing has assumed considerable importance right through the chain from sheep breeder to manufacturer. The essence of the test is essentially to quantify the loftiness or space-filling capabilities of particular wool lines. This, in turn, is largely dependent on the degree of crimpiness, which is almost non-existent in some wool types and in general increases as the wool gets finer. However, the correlation with mean diameter is not always satisfactory. For example, carpet wools with a broad spectrum of fibre diameters will yield a bulkier yarn than those with a narrow range, even though the mean diameters are similar.

The procedure for the Core Bulk Test involves running a scoured core sample through a small card, loading 2.5 g into a cylinder, applying a loaded piston and measuring the volume occupied by the sample. The Core Bulk Test is one where it is mandatory for the wool sample to be held in an air-conditioned environment (65% RH and 20 °C) for at least 24 hours before testing. The regulations pertaining to some of the other tests described earlier also require the wools to be held and tested in the same conditioned environment.

1.11 Dark fibre contamination

Merino wools are particularly affected by even minute contamination with dark fibres. In fine white or pale shades of fabric, every dark fibre is a visible fault that entails close inspection and individual removal with tweezers by a mill operative.

Down breeds of sheep with a black face and legs present a problem of contamination too, as the main part of their fleece is white. The problem is largely pursued through training in fleece skirting procedures in the shearing shed and generally avoiding contamination along the processing chain. Counting individual coloured fibres on a microscope slide has been the traditional laborious method, appropriate mainly for research purposes. With the advent of laser scanning equipment for fibre diameter measurement, there are now better prospects for including a statistical measure of dark fibre contamination.

1.12 Specification of woolscour deliveries

Most New Zealand woolscours have acquired Near Infrared Reflectance Analysis (NIRA) instruments. These greatly improved in-house quality control, although an external certification is still necessary from a test house before the measurements are formally recognised by clients and manufacturers. The NIRA equipment provides rapid measurements of moisture regain, residual grease content and scoured wool colour. The instrumentation can also produce an unofficial measure of fibre diameter, wool bulk and fibre medullation.[5] Predictive equations are required for each of the measurements, derived from very extensive sampling and validation experiments. Considerable precautions are also needed in order to transfer the predictive data base between instruments sited in other laboratories.[6]

The measurement of fibre length of scoured wool is very important, and the relevant 'length after carding' test was described in Section 1.8.

The wool may have had faults such as cotting and the scouring process itself introduces some degree of fibre entanglement. By emulating, with carefully controlled equipment, the opening and carding process in industrial processing, the 'length-after-carding' test breaks a comparable proportion of fibres and provides important guidance about the future processing performance of the scourment.

In summary then, a scoured wool specification has test information on the variables of colour, fibre diameter, fibre length after carding, bulk, medullation content, and vegetable matter content. These six parameters have been shown to be a necessary and sufficient data set for predictive expectations of scourments.[7] Most of these tests have already been briefly described. However, in the context of specifying relatively large scourments some additional points should be made. These have particular significance for on-line quality control in the woolscour.

Although wool colour is measured as for auction lots of greasy wool (NZS 8707:1984 and IWTO(E)-14-88, which is based on the NZ Standard method), a significant additional development is the use of on-line colour monitoring. A video camera and computer display 'as-is' wool colour by viewing the wool-flow, thus facilitating corrective action and avoiding re-scouring if the scouring process deteriorates in quality.

The vegetable matter test (IWTO-19-85) has some problems when applied to most New Zealand scourments, because the commonly low levels of contamination make it difficult to carry out representative sampling.

The most important technology to come into use in woolscours in recent years is the adoption of Near Infra Red (NIR) equipment for quality control purposes. Modern NIR equipment scans a wide spectral range, extending into the visible region, so that 'as is' colour can be measured by this method. Predictive equations for bulk and medullation are constantly being improved. The core bulk test (NZ 8716:1994) may ultimately be replaced in test houses by an NIR test. Similarly, the long-standing method of measuring medullation by the definitive but expensive projection microscope method will ultimately be replaced. Although NIR instruments can be calibrated to obtain a measure of medullation, the newer forms of laser scanning instruments for fibre diameter measurement (see Section 1.7) are most likely to also quantify medullation.

1.13 Computer blend selection

A computer expert system has been developed to define objective fibre specifications appropriate for carpet yarns according to the processing route and product specification.[8,9] The system can be customised to suit the machinery and processing conditions in yarn manufacturing plants.

By way of example, if the product has been manufactured in the past, the customary blend, if still available, is sampled and measured to quantify its properties. This information can then be applied to currently available lines of wool to determine a computer-selected blend using least-cost-blending software. However, using a least-cost strategy for purchasing wool may not be the ideal solution because processors may find machine settings, processing efficiency and product properties need to be revised to take full advantage of the technology.

One of the interesting outcomes of relying on computer selection of lots comprising a blend has been the observation that visually different unscoured blends do indeed conform after processing to the end result sought.

A significant advantage of computer blend technology is the assistance that can be provided to new entrants into wool processing, or to processors wanting to quickly develop a new product using their existing equipment.

Following a series of successful validation trials[8,9] it became possible for wool exporters in New Zealand to provide an enhanced service to clients using 100% New Zealand wool in their product. It also offered a new marketing opportunity whereby mills unfamiliar with these wools, for example in emerging markets in China, could be supplied with blends suited to their equipment and the desired final product.

1.14 Wool promotion

The International Wool Secretariat (IWS) was formed in 1946, the three signatories being Australia, New Zealand and South Africa. In later years, Uruguay showed an interest and was eventually admitted to membership. Levies from their woolgrowers supported a head office in London, and somewhat later a large technical centre in Ilkley, Yorkshire. Branches in most leading countries provided technical and marketing support for their local wool manufacturers. They also had considerably autonomy in developing promotional campaigns appropriate for their particular market and these were usually strongly identified with the *Woolmark*, a quality certification mark. The quality assurance aspect involved labelling garments, textiles and carpets that met set standards of performance. This very extensive programme was generally admired and supported by retailers as well as manufacturers. Brand recognition by consumers worldwide was one of the highest for any type of product. Section 12.7 highlights the extremely competitive environment faced by wool products in achieving consumer awareness.

An effort by the Australian Wool Corporation to intervene and maintain high wool prices in 1991 led to stockpiling of almost a year's supply of Merino wool, followed by a long period of very slow recovery. New Zealand had experienced a long-term slow decline in wool prices and this was exacerbated by economic crises in Asia in the 1990s. They subsequently withdrew from the IWS and developed their own marketing strategy.

1.15 The Fernmark brand

New Zealand's share of world carpet wool usage had declined significantly in recent years and with that decline came a move from generic promotion under the *Woolmark* logo to a brand marketing programme that more specifically identified New Zealand as the country of origin of the pile fibre. This fundamental change in marketing philosophy saw Wools of New Zealand in 1994 take over the Interior Textiles Division of IWS, which it had previously fully funded, and strike out on its own with the new *Fernmark* brand entity. The fern leaf image was selected for its general association with New Zealand.

Initially, the emphasis for branding has been on carpet wools with the development of segmented brandnames for various classes of product, to be used in conjunction with the *Fernmark* brand. Other segment brands have been developed, such as Isolana, for use with bedding products. Ultimately, all major product segments that use New Zealand wool are likely to have specific brands used with the *Fernmark*.

1.16 Marketing of distinctive wool types

Over the past 30 years, the major thrust in wool marketing has clearly been driven by the objective measurements of important wool fibre variables. In the case of coarse and medium diameter wool types, the sheep breed and flock discriminations such as ewes, wethers and lambs have, in principle, become of minor importance compared to the physical specifications of wool lots. However, in a similar fashion to the emergence of direct selling to reduce transaction costs associated with wool auctions, there has been some revival of marketing based on particular features of fleece from certain breeds.

Superfine Merino wools are the best example of what is essentially niche marketing. It combines the commercial interests of woolgrowers who specialise in producing very fine lines of wool (<18 micron) and manufacturers with a capability and reputation for creating luxurious wool products.

Another instance is the development of breeding strategies for Perendale wool. Perendale sheep are the outcome of a long term breeding and selection programme at Massey University, New Zealand, led by Professor Peren. The notable marketing attribute of Perendale sheep is the additional bulkiness (see Section 1.10) of yarns made from their wool as compared to the general run of crossbred wools of otherwise comparable quality. The sheep farmers involved with the breed have formed a marketing alliance to promote their wools with the intention of extracting some price premium for their product.

Comparable marketing strategies have been extensively used in the UK to promote not just a brand name for knitwear or distinctive clothing such as tartans, but to put forward the particular credentials of British wools.

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