4. Shearing

Lecture 1: Time, frequency and preparation for shearing

Angus Campbell

Learning objectives

On completion of Lecture 1 you should have an understanding of:

- How timing of shearing affects major wool production factors, including:
  - fleece weightfibre diameter
  - staple strength
  - staple length
  - vegetable matter and yield
- How timing of shearing affects sheep health and management, including:
  - effect on nutritional requirements of time of shearing
  - disease risk
  - aligning shearing time of young sheep with the main flock time
  - reproduction
- The relative importance of the above points and which should receive priority when deciding a shearing time
- The important aspects of preparation before shearing

Key terms and concepts

Shearing, staple length, staple strength, position of break, vegetable matter, fleece weight, yield, flystrike, hypothermia.

Introduction to lecture 1

Timing of shearing (*when* and *how often*) is one of the major management decisions for a wool producer. These two choices have a significant impact on the quality and quantity of wool produced by a farm, as well as on sheep health. Woolgrowers have many different reasons for shearing at a particular time. In a survey by Irving (1991), the most common reason farmers gave for their shearing time was that it was when shearers were most available. Is this putting the cart before the horse? The second most popular reason was a concern of higher flystrike risk in unshorn sheep run over summer.

Time of shearing has been observed to affect staple strength, the location of weakness along the staple ('position of break'), fleece weight, yield and fibre diameter. It also can have important consequences for a flock's nutritional requirements and disease risk. How time of shearing of young sheep is managed to line them up with the adult flock can significantly influence the value of weaner or hogget wool. Preparation of sheep and the shearing shed before shearing is also important for wool quality.

A particular time of shearing that improves one aspect of wool production or animal management often undesirably affects another factor. By the end of these lectures, you should appreciate that deciding on a time of shearing is seldom a clear-cut choice, but rather involves balancing the advantages and disadvantages of any particular time in a particular region.

4.1 Time of shearing

In Australia, wool is grown in many different climatic and geographical regions. Assuming that wool is commonly offered for sale 4-8 weeks after shearing, the volume of wool on offer each month gives an indication of the wool volume shorn one or two months previously (Figure 4.1) Such information indicates popular shearing times but these are not necessarily *correct* times!

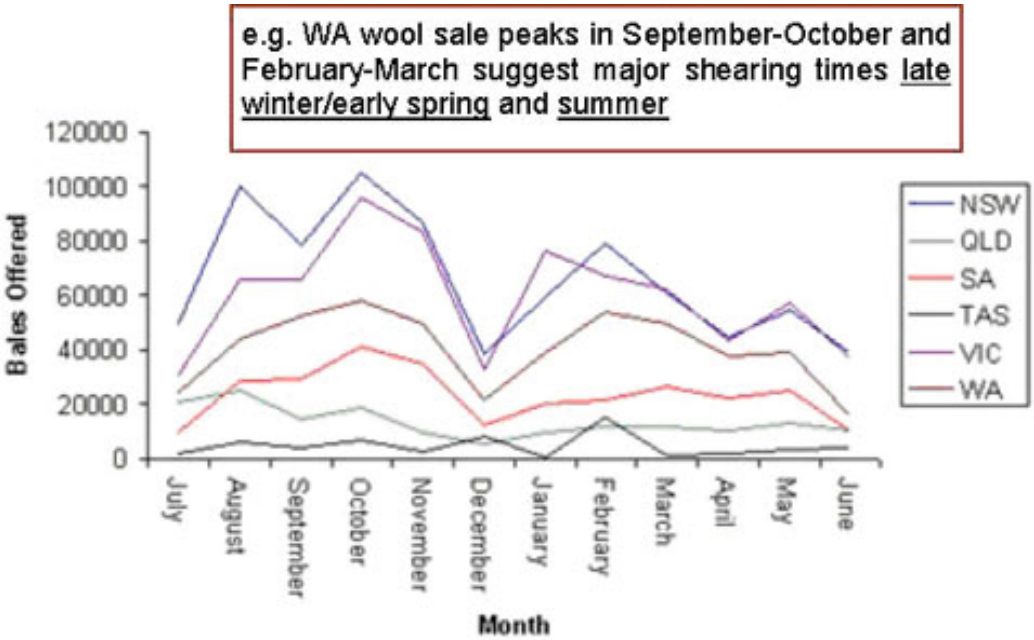

Figure 4.1 Volume of wool offered for sale each month. Source: AWEX (2000/01, 2001/02 and 2002/03 seasons).

Shearing time and other management decisions should be chosen to sustainably maximise enterprise profitability. Stocking rate is a key driver of enterprise profitability (Abbott 1991). Although shearing time can influence stocking rate, time of *lambing* influences stocking rate more (Morley 1983). It is therefore appropriate to choose time of shearing once an appropriate lambing time has been decided for an enterprise.

Staple strength and position of break

Wool shorn at different times of the year, from many locations, has been observed to have different staple strengths (for example, see Butler, Gibson and Head 1994; Oldham 2000c). In addition, the hauteur and romaine of tops made from these different shearing time wools varies (Arnold, Charlick & Eley 1984).

Wool growth is amazingly variable, as can be seen in the example of a wool fibre profile from a spring-shorn wether in Western Australia). Shearing time affects the shape of a profile because shearing determines *where the ends of the wool staple lie along the fibre diameter profile*. Where the thinnest part of the fibre, which is usually the position of break (POB), lies along this profile then becomes an important consideration.

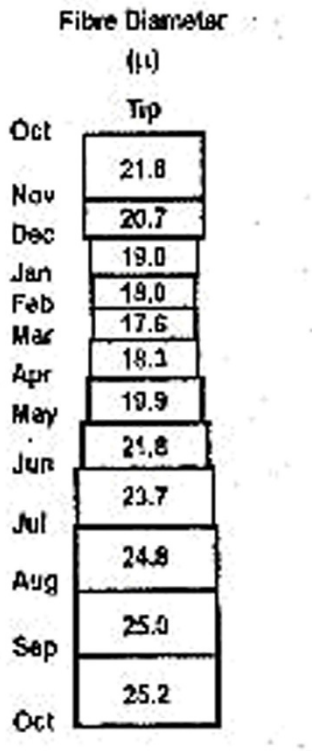

Figure 4.2 Monthly wool fibre diameter profile from an unsupplemented spring-shorn wether at Mt. Barker, WA. Source: Doyle and Thompson (1992).

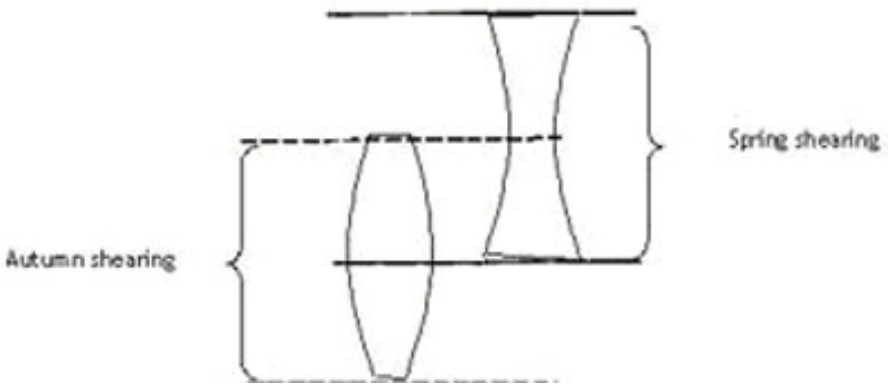

Figure 4.3 Comparison of spring- and autumn-shorn fibre diameter profiles. Source: Campbell, (2006)

The measured staple strength of wool will be improved if shearing occurs through or near the thinnest part of the fibre diameter profile, which puts the POB near the tip or base of the staple. Machines that measure staple strength clamp up to 15mm of wool at either end of the staple. If clamping includes the POB, the staple will have to break at another, stronger, point and the machine will record a higher breaking force. In this way, a time of shearing that places the POB near the staple's end improves the *measured* staple strength of wool (Butler, Gibson & Head 1994).

Does the thin part of the fibre always coincide with autumn? Many surveys and trials have shown higher staple strength due to autumn shearing (Lightfoot 1967; Ralph 1971; Arnold, Charlick & Eley 1984; Oldham 2000c). See Figure 4.4. Autumn often coincides with the thinnest part of the fibre diameter profile - in winter rainfall areas (south-eastern and south-western Australia), sheep

nutrition is poorest on the low quality, dry pastures preceding the autumn rains. This corresponds to the thinnest part of the fibre diameter profile. When the autumn rains come and nutrition improves dramatically, fibre diameter increases quickly. The POB lies in the trough created by this sequence of nutritional events.

In Tasmania, POB may occur later than autumn because sheep nutrition may be poorest during the low pasture production of winter. The fibre diameter profile may be further thinned in autumn-lambing ewes. They come under nutritional stress because low winter pasture availability fails to meet their higher requirements during lactation (Butler, Gibson and Head, 1994). In this situation, winter shearing improves staple strength compared to spring shearing, although it may not be the best for the farm (see Introduction and below).

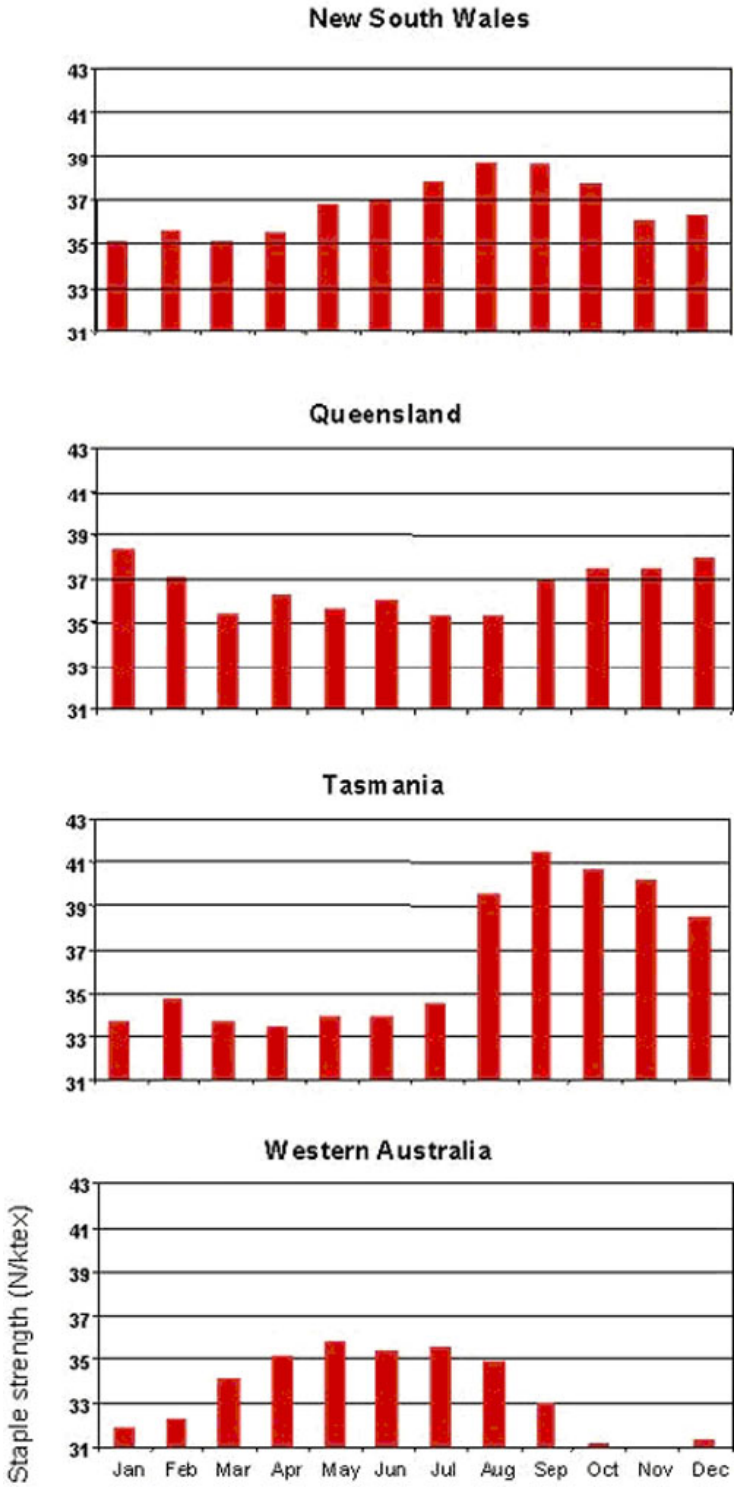

Figure 4.4 Staple strength by month of shearing. Source: Oldham (2000c).

Few investigations into shearing time and staple strength in Queensland have been performed. However, it would be reasonable to assume that the same mechanism applies. Queensland's 'autumn break' (change from poor quality dry feed to green feed) is actually in spring in the summer rainfall environment. Shearing through the spring-associated POB improves staple strength.

Even if the staple strength improvement is only a 'measured' one, moving the POB away from mid-staple still improves wool quality. The TEAM equation predicts improved hauteur from wool where few staples have a POB in the middle (Trials Evaluating Additional Measurement 1988). A wool fibre is less likely to become entangled and break during carding if its POB is near the end because a lower force is exerted upon the flexing weakness when it is near the fibre's end. Even if it does break, one short and one long fibre are produced. The long fibre does not reduce hauteur substantially (the short fibre having been removed as noil) (Arnold, Charlick & Eley 1984).

Vegetable matter (VM)

The availability of seeds, burrs and other vegetable matter (VM) contaminants that develop in the pastures in spring and summer varies throughout the year. VM accumulates in longer wool, so sheep destined to be shorn in autumn are particularly at risk of accumulating VM in their fleece. Vegetable matter lowers wool quality and can threaten animal health (McDonald 1981) and is especially a problem in regions dominated by annual pastures, whose seeds cause substantial VM problems. One survey of different regions in NSW did not find a change in *overall* VM due to different shearing times (Warr, Gilmour & Wilson 1979). This is because, over a whole region, changing shearing time might have reduced one vegetable contaminant but another took its place. This study's results contrast with the data presented in 4-5. Even Warr et al.'s work still has implications for individual farms, however. If only one or two species cause vegetable fault, then shearing before those seeds mature may considerably reduce VM contamination. A small study in Victoria showed this, where the later in the year the clips were shorn, the lower the VM percentage (Court 1991; Court & Lawless 1995).

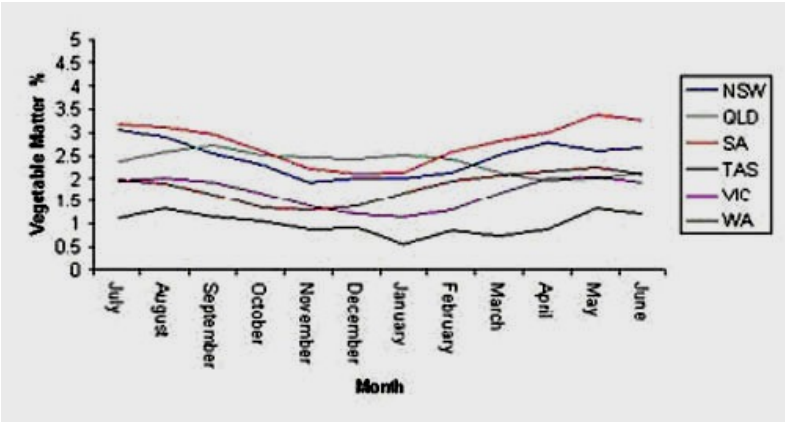

Figure 4.5 Average monthly VM%. Source: AWEX (2000/01, 2001/02 and 2002/03 seasons).

Greasy fleece weight and fibre diameter

Shearing time affects other wool quality factors besides staple strength and VM. In several experiments, autumn-shorn sheep cut more wool of broader micron than spring-shorn sheep (Lightfoot 1967; Ralph 1971; Arnold, Charlick & Eley 1984). Shearing removes a sheep's insulation and extra heat must be produced to maintain body temperature. In the weeks following shearing, this heat energy will either come from increased feed intake, diverting extra feed energy into heat production (if intake is already near maximum) or mobilising body energy stores (Bottomley & Hudson 1976). In spring, sheep are in good body condition with high feed availability. They are already eating near their maximum intake and can divert some of this energy into extra heat production. In autumn, however, sheep are in poorer body condition. This means they can increase their feed intake more in response to shearing (Arnold, Charlick & Eley 1984). This greater feed intake after autumn shearing, compared to after spring shearing,

results in greater greasy wool growth and autumn-shorn sheep cut heavier fleeces. Because it grows at a faster rate, the 'extra' autumn wool is also of higher fibre diameter. Autumn-shorn clips can be up to 0.7µm broader (Arnold, Charlick & Eley 1984) than similar spring-shorn clips.

Yield and clean fleece weight

Although greasy fleece weight is increased, autumn-shorn wool has lower yields. Dust accumulates over summer and autumn prior to shearing in the longer wool (Lightfoot 1967). The increased wool growth stimulated by autumn shearing also stimulates extra wax and suint production, further decreasing yield. In trials, the yield was not reduced enough to offset the gain in greasy fleece weight, and the clean weight of autumn-shorn fleeces is often higher than those shorn in spring (Lightfoot 1967; Arnold Charlick & Eley 1984).

Table 4.1 Comparison of greasy fleece weight, yield and clean fleece weight for Tasmanian shearings. Source: Lightfoot (1967).

	October	April
Greasy fleece weight	5.1kg	**5.9kg**
Yield	**X 70.9%**	X 66.0%
Clean fleece weight	3.6kg	**3.9kg**

Nutritional requirements

The extra energy required to maintain body temperature following shearing, as discussed above, is not insignificant. In late autumn-early winter, dry sheep need 75% more feed than unshorn sheep for the month following shearing (Elvidge & Coop 1974). An increased feed requirement of sheep following shearing in cold weather will reduce the stocking rate of the enterprise. The following table estimates potential stocking rate for different shearing times on a farm in eastern Tasmania (Black & Bottomley 1980).

Table 4.2 Predicted effect of time of shearing and lambing on winter stocking rate of a farm at Swansea, Tasmania. Source: Black and Bottomley (1980).

Lambing date	**Shearing date**				
	Jan 1	Apr 1	Jun 1	Aug 1	Oct 1
Jul 15	4.4	4.4	3.7	4.1	4.4
Aug 15	6.1	5.7	4.5	5.3	6.2
Sep 15	7.9	7.1	5.5	6.5	8.2
Oct 15	8.7	7.6	5.9	7.1	9.5
dry	9.2	7.8	6.0	7.3	10.0

Timing of cull sales

From Table 4.2, it can be seen that there is an interaction between shearing time and time of lambing on feed requirements. Pregnant sheep, that are already eating more (and thus producing more heat), need a relatively smaller increase in feed intake to maintain body temperature in cold weather following shearing.

The effect of time of shearing on feed is also felt with the way cull and cast-for-age (CFA) sheep are sold off a farm. Cull and CFA stock are commonly sold before feed becomes limiting (late summer in southern Australia) and it is preferable to maximise their return by shearing before sale. Shearing times later than cull sale time force the producer to either prematurely shear cull sheep (reducing fleece value) or hold stock over until shearing, placing extra strain on feed resources at an uncertain time of the year.

Disease and mortality risks

The length of fleece affects its wetting and drying properties. Approximately six months wool growth is still easy to wet but dries slowly (Raadsma 1988). If shearing time results in such a length of fleece during wet but warmer times of the year, the fleece is prone to developing fleece rot. Although fleece rot usually causes only a minor reduction in fleece quality (Abbott 2002), it is the major risk factor for the development of body strike (Bottomley 1979). Although flystrike can be prevented or controlled chemically, a shearing time that necessitates extra chemical treatments does not help the industry's goal of reducing pesticide residues in wool.

Hypothermia/cold exposure

Devastating losses of recently shorn sheep can occur then they are exposed to cold, wet and windy weather. For example, it has been estimated that nearly one million sheep die within 14 days of shearing each year (Hutchinson 1968). Sheep are at greatest risk of hypothermia during the fortnight after shearing and especially in the first 3 days after shearing (Geytenbeek 1962; Hutchinson 1968). The risk of off-shears mortality is greatly increased if a cold storm occurs during warmer months, because sheep are not adapted to the cold at these times of year.

Sheep respond to cold stress by mobilising available body fat reserves (Holmes et al. 1992) and sheep on a falling plane of nutrition are particularly susceptible to dying (Hutchinson & McRae 1969). A shearing time combining non-cold-adapted sheep, the risk of cold storms and light body condition carries a particular risk of off-shears losses.

Newborn lambs: A common reason given by farmers for choosing a pre-lamb winter shearing is the belief that it encourages ewes to seek shelter, thus protecting their newborn lambs from dying of hypothermia. Studies have definitely shown that the provision of *abundant* shelter improves lamb survival. However shearing ewes prior to lambing does not improve lamb survival further (Alexander et al. 1980). A pre-lamb winter shearing does increase ewe feed requirements, putting additional nutritional pressure on ewes at a critical time. Increasing ewe feed requirements may also reduce potential enterprise stocking rate and profitability, as discussed above.

Reproduction

Shearing ewes prevents them exhibiting oestrus signs (and therefore not mate) for up to two weeks (MacKenzie, Thwaites & Edey 1975; Fernandez Abella et al. 1996). Ovarian activity and ovulation rates appear to be unaffected and subsequent mating occurs successfully.

4.2 Frequency of shearing

Frequency of shearing (how often sheep are shorn during the year) obviously affects the length of the wool staple. In Australia, shearing is generally carried out once per year. However, recent breeding for increased fleece weight has resulted in sheep that produce a longer staple with once yearly shearing than in the past. Wool processors generally prefer staple length to be between 60 and 90 millimetres. In an attempt to meet market requirements, some producers have altered shearing frequency, such as shearing three times every two years. Because, as discussed above, so many wool traits vary annually (especially SS, POB, VM and yield), non-annual shearing can make control of these factors difficult (Graham 2003). Agriculture NSW is currently conducting a trial assessing the implications of this practice.

If young sheep are being kept to enter the adult mob, their shearing must be timed to 'line them up' with the adult mob's shearing time. Timing of lamb/weaner shearing can also dramatically affect the value of fleece produced from young sheep. Wool from young sheep is finer than adults (Corbett 1979) and therefore potentially valuable where market premiums for fine wool exist. The same staple length preferences apply to wool from sheep of all ages. Shearing young sheep before their wool reaches the critical 60mm attracts substantial price penalties. If weaner shearing can be appropriately delayed, the value of their wool can be maximised, making a substantial contribution to the value of their lifetime wool production.

Controlled trials have not found an increase in growth rate following lamb shearing (Tucker 1964; Donnelly 1991a), despite the common producer belief that shearing lambs makes them 'do' better. The effects of time of shearing on factors such as vegetable matter contamination (which McDonald (1981) points out is particularly important in lambs) and flystrike risk apply equally to young sheep as to adults.

4.3 Preparation for shearing

In order to produce a clip that is well classed and free of contaminants, both the wool producer and woolclasser have a number of functions to perform in preparation for shearing. These involve both preparing the sheep for shearing as well as the shearing shed.

Preparation of sheep

In order to prepare the sheep for shearing the following practices should be considered:

- Sheep should be drafted into mobs that present uniform fleece characteristics. (e.g., 3-5 year old ewes that have been grazed under similar conditions).
- Any sheep that may present dark fibre risk should be isolated into a separate mob.
- The mob shearing order should be established to facilitate clip preparation. Mobs that may present dark fibre risk should be shorn at the conclusion of shearing.
- Sheep should be visually inspected for stain. A pre shearing crutch should be considered to remove the risk of contamination from urine stain and dags.

In situations where On Farm Fibre Measurement (OFFM) is to be utilised to assist in clip preparation and where sheep have been tested prior to shearing, mobs should be drafted into micron categories. Where testing is to occur during shearing, consideration needs to be given to where the equipment will be placed within the shearing shed so as it will not negatively impact the work flow of shearing shed resulting in lower then acceptable clip preparation standards.

Post shearing issues need also be considered such lice treatments, coating, provision of shelter and extra nutritional requirements.

Preparation of the shearing shed

The Woolclasser is responsible for ensuring that the shearing shed has been prepared to an acceptable standard, to ensure that the Woolclasser can fulfil their responsibilities in accordance with the Code of Practice.

The Code of Practice (AWEX 2001) states attention must be given to the following items:

- Ensure that on inspection, the shed is clean, all potential contaminants are removed and there is adequate lighting and equipment, e.g. wool table etc.
- Items such as cans, clothing, bale hooks, wire, tools and cleaning rags must not be lying around the shed. There must be clearly identified areas for these articles away from the any wool handling area.
- Deep rubbish containers that cannot be tipped over must be available and positioned well away from wool preparation areas.
- Fodder baling twine (polypropylene) is a major problem to textile manufacturers. It must not be present in the yards or wool shed. Also it is important that baling twine is not in places around the shed where it may be accidentally tramped into wool handling areas, e.g. gate or door ties, dog leads etc.
- Polypropylene bags (e.g. fertiliser bags) or old High Density Polyethylene (HDPE) wool packs should not be present in the shed and must not be used as bins for oddments, etc. Cardboard boxes or hard plastic bins should be available for this purpose.

- Cigarette butts, especially filter tips, are a particular problem for textile manufacturers. There should be deep ashtrays, which cannot be tipped over, and located well away from any wool preparation areas. To avoid contamination, all wool preparation and handling areas within the shearing shed must be smoke free work areas.
- Ensure suitable space is available for all equipment that has to be stored in the shed (e.g. emery paper, Wool classer's stencil, shearers' handpieces, etc.), where it cannot contaminate the clip.
- Ensure Australian Wool Exchange Ltd approved packs are available for use.
- Brooms are to be in good condition with no loose bristles. Black bristled brooms are not to be used. Preferably paddles and sweeps should be available.

In dusty environments, consideration should be given to the watering of yards to reduce dust contamination.

Wool bins, butts and baskets should also all be clearly identified with the line of wool they are to hold before the commencement of shearing.

State based Occupational Health and Safety Acts legislate that employers must provide healthy and safe work environment. This requires that the wool producer, prior to shearing, inspect the shed to identify and rectify any potential hazards. These may include:

- Ensuring access to workstations such as grinders, shearing plant and wool presses is appropriate to prevent injuries.
- Ensuring sheep pens, races and gates don't expose workers to injuries through sharp edges, protrusions and splinters that may increase the risk of receiving cuts and embedded objects in the skin.
- Ensuring the shearing board is not worn or grooved increasing resistance to drag when handling sheep. This increases the effort required by shearers and the risk of back injury. Protruding nails, loose and slippery boards also add to the strain required to manoeuvre sheep and increase the potential for injury.
- Ensuring that the let-go area is not obstructed which can place significant strain on the shearer, and increase the risk of back injury. Additionally, the placement of let-go doors or chutes in areas that funnel prevailing cold winds can increase muscle fatigue. Glare filtering through the let-go area also increases the risk of cuts to shearers and sheep.
- Ensuring that the wool room has sufficient space to enable the wool to be safely and effectively processed. The risk of a range of injuries due to collision with fellow workers and contact with shed machinery can be influenced by the amount of space available. In addition, working on small wool tables that are not designed for the size of current fleeces can result in back strain. Uneven floor surfaces increase the risk of trips, slips and falls, while sharp edges and protrusions used to support wool packs or on wool bins, pose a risk of cuts and puncture wounds to those working in this area.
- Ensuring that if there is not a separate eating area outside the woolshed, a designated area for all breaks should be set aside. The size of this area should be adequate for all workers, with adequate facilities provided. Cleaning of the eating area should be completed daily.
- Ensuring that appropriate toilet facilities enhance overall hygiene and limit the transmission of disease in the shed. An adequate number of facilities should be provided for both male and female employees.

Furthermore, it is imperative that every person involved in the shearing operation is fully aware of his or her responsibilities. This will involve the producer ensuring that staffing agreements are in place with individuals and / or contractors. This is particularly important as shearing is the cumulation of 12 months clip preparation where several aspects of the clip's quality can be enhanced or reduced by the process of shearing and preparation. For example, poor shearing quality can increase the percentage of locks and reduce staple length, and poor clip preparation can reduce the value of main lines.

Lecture 2: Alternative shearing practices

Ben Swain and Angus Campbell

Learning objectives

On completion of Lecture 2 you should have an understanding of:

alternative shearing practice developments

Key terms and concepts

Shearing, Bioclip, ShearExpress, robotic shearing

Introduction to lecture 2

This lecture describes the alternative shearing practices of Bioclip, ShearExpress and Robotic shearing that have been researched, developed or commercialised over recent years.

4.4 Bioclip

The Bioclip process, developed by CSIRO, the Woolmark Company and Bioclip Pty Ltd, is an alternative to mechanical shearing that utilises a sheep hormone to induce a break in the wool which allows the fleece to be harvested.

At this stage, Bioclip has been commercially released specifically for the use of harvesting lambs wool. In the 2002/03 year, approximately 200,000 lambs were harvested using the Bioclip process.

4.5 How bioclip works

Bioclip involves an injection of a synthesised version of the sheep hormone 'epidermal growth factor' (EGF). EGF is one of a number of factors that bind the epidermal growth factor receptor, which is found one the cells of developing and mature sheep wool follicles, as well as sweat and sebaceous glands.

An injection of exogenous EGF causes rapid but short-lived simultaneous regression of wool follicles in the sheep. The follicles enter a catagen-like – cell shedding from the dermal papilla slows and stops, although the wool follicles do not enter telogen. The wool fibre narrows and a break occurs when all cell shedding pauses. The break in the wool fibre occurs at this point.

Normal growth of a new wool fibre commences once EGF levels return to normal, 36-48 hours post-injection. A new fibre reaches the surface of the skin approximately 14 days after injection. The fleece is harvested 28 days after treatment.

The level of follicle shutdown (and hence the success of fleece shedding) depends on the dose rate of EGF and varies from sheep to sheep. A sufficiently large dose of EGF must be given to eliminate this variation, and so a net must be used to hold the fleece on the sheep until all follicles have successfully shed their fibres and all sheep are ready to be harvested on day 28.

Table 4.3 The Bioclip lamb harvesting cycle.
Source: Bioclip Pty Ltd (2006).

Day 1	Lambs are placed in the Bioclip 'Netting Cradle' Lambs are vaccinated with the Bioclip Protein and netted in the cradle Drenching and vaccination can also be carried out Approximately 2000 lambs can be netted per day using 4 people
Day 7	Wool break reaches the skin
Day 10	All lambs show signs of wool break
Day 28	Lambs wool is harvested

Figure 4.6 Bioclip 'Netting Cradle". Photograph supplied courtesy of Bioclip Pty Ltd.

Figure 4.7 Netted lamb. Photograph supplied courtesy of Bioclip Pty Ltd.

Figure 4.8 Freshly harvested lamb. Photograph supplied courtesy of Bioclip Pty Ltd.

4.6 Benefits of bioclip

Bioclip offers some advantages throughout the wool processing pipeline, including:

- Improved animal health (Bioclip 2001)
  - elimination of skin cuts from shearing, including pizzle and teat damage
  - reduced handling of sheep
- Increased wool quality and value
  - no second cuts / locks
  - no skin pieces
  - increase staple length
  - no mechanical damage to fibre
  - a reduction in hair and kemp fibres

Trials have reported that the Bioclip skirting process is more efficient than conventional harvesting. Both adult and lambs wool are skirted with the base of the staple rather then the tip towards the wool handler. This can result in a lower proportion of pieces being removed allowing more valuable fleece wool to be included in the main line.

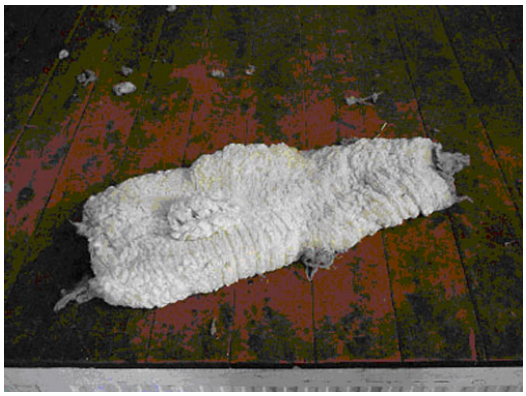

Figure 4.9 Harvested fleece. Photograph supplied courtesy of Bioclip Pty Ltd.

4. Disadvantages of bioclip

- Significant development of suitable nets to hold the fleece on prior to harvesting has been required. The original nets were poor fitting and as a result they had a tendency to move around the body after the wool had separated from the sheep. In some cases this caused the wool to become cotted. Improvements in design have largely removed this problem and speeded sheep throughput during the netting process.
- The original nets were designed with a square of 18mm. This allowed the wool to come through the nets whilst on the sheep and made it difficult to remove the wool from the nets, particularly in areas of high VM contamination. Nets currently in use have squares of 2-4mm, which is claimed to prevent this problem occurring.
- The current design of the net does not cover the legs of the sheep. Subsequently the leg wool is lost in the paddock. This is the primary reason that only lambs up to 7 months old are currently being harvested using this method, as to loose leg wool from adult sheep would significantly reduce grower returns. Development is currently underway to resolve this problem so as the Bioclip process can be used to harvest wool from adult sheep.
- EGF is also associated with an increased rate of abortion in ewes (Nixon & Moore 1998) – another reason why it is not currently used in adult sheep.

4.8 Robotic shearing

Investigations into the technical feasibility of robotic shearing or automated mechanical shearing (AMS) began in the early 1970s by the engineering departments of the Universities of Western Australia (UWA), Melbourne and Adelaide.

UWA was successful in designing and building a detailed AMS. The Shear magic robot and SLAMP (simplified loading and manipulation platform) formed the basis of this success.

The work continued through until 1993 by which time it was shown that the shearing of a whole sheep using a robot was possible. Although, perhaps slower and more expensively then conventional shearing. At this time, the Australian wool industry entered into a long period of financial hardship. As a result neither the funds not the confidence to continue the development were available. Work has never recommenced as more practical and efficient alternatives have been developed.

Figure 4.10 The Shear magic robot and SLAMP. Source: Warr (1993).

Summary

As you can see, there are many factors for and against the choice of any one shearing time. Little research has comprehensively examined the effect of time of shearing in a commercial setting. Staple strength, vegetable matter, winter nutritional requirements and animal health (flystrike risk & exposure) are arguably the most important factors to be considered when choosing a time of shearing. Producers can relatively easily observe the effects of wool quality by shearing several groups of similarly managed sheep at different times and observing differences in objectively measured wool characteristics (Butler, Gibson et al. 1994). This should be repeated over several years before a decision to change the entire farm's time of shearing.

Time of shearing affects many different wool production factors, including staple strength, position of break, vegetable matter, fibre diameter, greasy and clean fleece weight and yield. It also affects and animal management issues such as risk of flystrike, hypothermia/cold exposure and nutritional requirements. All these issues, and the relative risk to enterprise profitability and animal health and welfare, that a change in shearing time presents to each factor, need to be weighed up when determining shearing time.

Traditionally shearing has been carried out once per year. With the development of sheep breeding techniques that are leading to longer fibres, some producers are opting to shear more frequently. Current research is being carried out on this practice to determine its economic viability.

Preparation for shearing in terms of both sheep and shearing shed preparation is an important component of clip preparation. Both the wool producer and woolclasser have responsibilities to ensure that shearing is carried out in an environment that leads to the highest possible level of clip preparation possible.

There have been no major changes to the shearing industry since the introduction of mechanically driven shears in 1887. Over the past decade, new and improved methods of wool harvesting have gained momentum. This momentum has largely been driven by the increase in traditional shearing costs and the expectation that shearing costs will continue to increase.
The Bioclip process and ShearExpress both offer real and possible alternatives to traditional shearing practices and will be further commercialised over the next five years. Benefits from either system will not only result in potential decreases in cost of production, but may also deliver benefits in wool processing

References

Abbott, K. A. 1991, The effect of stocking rate on farm profitability, in: *Veterinarians and the Environment: Proc. of Australian Sheep Veterinary Society*, Donnelly, J. B. (ed.), Australian Veterinary Association, Darling Harbour, New South Wales, p. 10.

Abbott, K. A. 2002, *Sheep Health and Production*, Veterinary Information and Education Network, University of Sydney, Sydney.

Adams, N. R., Oldham, C., Suiter, R. and Wilson, G. (eds) 2000, *Managing Wool Production for Quality and Profit*, Premium Quality Wool Cooperative Research Centre, Perth.

Alexander, G., Lynch, J. J., Mottershead, B. E. and Donnelly, J. B. 1980, Reduction in lamb mortality by means of grass wind-breaks: Results of a five-year study, in: *Proc. of Australian Society of Animal Production,* Mackintosh, J. B. (ed.), vol. 13, p. 329.

Arnold, G.W., Charlick, A.J. and Eley, J.R., 1984. Effects of shearing time and time of lambing on wool growth and processing characteristics, Australian Journal of Experimental Agriculture and Animal Husbandry, vol 24 (126), p. 337.

AWEX, data from the 2000/01, 2001/02 and 2002/03 seasons, Australian Wool Exchange.

Bioclip, 2001, *Wool Processing Benefits*, Bioclip Fact Sheet No. 7, Bioclip Pty. Ltd.

Black, J.L. and Bottomley, G.A., 1980. Effects of shearing and lamb dates on the predicted pasture requirements of sheep in two Tasmanian locations. Australian Journal of Experimental Agriculture and Animal Husbandry, vol 20, pp. 654-661.

Bottomley, G. A. and Hudson, J. M. 1976, Winter shearing does have a major disadvantage, *Tasmanian Journal of Agriculture,* vol. 47(2), p. 95.

Bottomley, G.A., 1979. Weather conditions and wool growth. Physiological Limitations to wool growth, eds J.L. Black and P.J. Reis, Armidale. University of New England publishing unit, pp 115-126.

Butler, L. G., Gibson, W. R. and Head, G. M. 1994, The effect of age, shearing date and reproduction on seasonal wool growth patterns, staple strength and position of break, in: *Proc. of Australian Society of Animal Production*, Masters, D. G. and Allen, J. G. (eds), Perth Print Brokers, Perth, p. 269.

Corbett, J. L. 1979, Variation in wool growth with physiological state. Physiological limitations to wool growth, J. L. Black and P. J. Reis. eds.) Armidale, University of New England publishing unit, p. 79.

Court, J. 1991, *Sheep industry crisis - meeting the challenge* Department of Agriculture, Victoria, p. 16.11.

Court, J. and Lawless, J., 1995. Improved wool returns from clip marketing analysis 1991-1994 Agriculture Victoria, Melbourne.

Donnelly, F.B., 1991a. Shearing Merino sheep with significantly less than twelve months wool growth - some field experiences. Wool Technology and Sheep Breeding, vol 39 (1), pp 40-42.

Doyle, P.T. and Thompson, A.N., 1992. Grazing management for tine sound wool. In Management for Wool Quality in Mediterranean Environments, eds P.T. Doyle, J.A. Fortune and N.R. Adams, Perth, W.A. Department of Agriculture.

Elvidge, D. G. and Coop, I. E. 1974, Effect of shearing on feed requirements of sheep, *New Zealand Journal of Experimental Agriculture,* vol. 2(4), p. 397.

Fernandez Abella, D., Rodriguez Palma, R., Saldanha, S., Surraco, L. and Villegas, N. 1996, Effects of season of shearing on the fertility of ewes mated early and on wool growth on natural basalt soil pasture, *Produccion Ovina,* vol. 9, p. 63.

Geytenbeek, P. E. 1962, A survey of post-shearing losses, *Proc. of the Australian Society of Animal Production,* Hutchinson, K. J. (ed.), Ramsay, Ware Publishing Pty Ltd, vol. 4, p. 185.

Gilmour, R. et al. 1979 Effect of shearing time and location on vegetable matter components in the New South Wales woolclip, *Australian Journal of Experimental Agriculture and Animal Husbandry,* vol. 19 (101), p. 684.

Graham, P. 2003, in: *e-Sheep forum: advancing individual animal management*, Australian Sheep Industry CRC, Armidale, p. 12.

Holmes, C. W., Kamil, K. A., Parker, W. J., Mackenzie, D. D. S., Purchas, G. and Kidd, R. 1992, in: *Proc. of New Zealand Society of Animal Production*, Vol. 52, p. 199.

Hutchinson, J. C. D. 1968, 'Deaths of sheep after shearing.' *Australian Journal of Experimental Agriculture and Animal Husbandry,* vol. 8(33), p. 393.

Hutchinson, J. C. D. and McRae, B. H. 1969, Some factors associated with the behaviour and survival of newly shorn sheep, *Australian Journal of Agricultural Research,* vol. 20(3), p. 513.

Irving, R. F. 1991, Factors which influence the selection of a time for shearing on a property in Gippsland, Master of Veterinary Studies Thesis, University of Melbourne, Melbourne

Lightfoot, R. J. 1967, The effects of shearing time and stocking rate on wool production, *Journal of Agriculture of Western Australia,* vol. 8(2), pp. 90-98.

Mackenzie, A. J., Thwaites, C. J. and Edey, T. N. 1975, Oestrus, ovarian and adrenal response of the ewe to fasting and cold stress, *Australian Journal of Agricultural Research,* vol. 26(3), p. 545.

McDonald, J. W. 1981, Grass seed infestation, in: *Refresher Course on Sheep August 10-14, 1981 (Proc. No. 58)*, Hungerford, T. G. (ed.), University of Sydney, Post-Graduate Committee in Veterinary Science, Sydney, p. 113.

Morley, F. H. W. 1983, Date of joining, in: *Proceedings. No. 67: Sheep Production and Preventative Medicine*, Hungerford, T. G. (ed.), University of Sydney Post-Graduate Foundation in Veterinary Science, pp. 83, 95.

Nixon, A.J. and G.P.M. Moore 1998, Growth factors and their role in wool growth: a review, *Proceedings of the New Zealand Society of Animal Production,* vol. 58, p. 303.

Oldham, C.M., 2000c. The importance of staple strength to wool profit. In Managing Wool Production for Quality and Profit, eds N.R. Adams, C.M. Oldham, R.J. Suiter and G.M. Wilson. Cooperative Research Centre for Premium Quality Wool, p59, Perth.

Pricemaker 2003, Premium and discount schedule for staple length Australian Wool Innovation.

Raadsma, H. W. 1988, Flystrike, in: *Proc. No. 110: Sheep Health and Production*, Hungerford, T. G. (ed.), University of Sydney Post-graduate Committee in Veterinary Science, Sydney, p. 317.

Ralph, I. G. 1971, Tender wool can be avoided, *Journal of Agriculture of Western Australia,* vol. 12(9), p. 232.

Ritchie, A.J.M., I.G. Ralph, et al. 1992, The Accumulation of Vegetable Matter in Spring and Autumn Shorn Wool in Mediterranean Environment, *Proceedings of the Australian Society of Animal Production*, ed. J.Z. Foot, vol.19 p. 142.

Trials Evaluating Additional Measurement (TEAM) 1988, Report on trials evaluating additional measurements 1981-1988. Melbourne, Australian Wool Corporation.

Tucker 1964, Shearing carry-over lambs: Does it pay? *Agricultural Gazette of New South Wales,* vol. 75, p. 1318.

Warr, G.J., Gilmour, A.R. and Wilson, H.K., 1979. Effect of shearing time and location on vegetable matter components in the New South Wales woolclip. Australian Journal of Experimental Agriculture and Animal Husbandry, vol 19, pp. 684-688.

Warr, G. J. A. 1993, Effect of Shearing Time and Location on Vegetable Matter Components in the New South Wales Wool Clip, *Australian Journal of Experimental Agriculture*, vol. 19(101), p. 684.

Glossary of terms

B Double	A trailer pulled by a prime mover that consists of a full size trailer as well as a half sized trailer
Card	Continuous strand of opened and loosely assembled scoured wool fibres, together with variable amounts of vegetable matter. Its linear density is approximately constant and it is without twist
Code of Practice	Outlines the Clip Preparation standards that need to be met
CVH%	The statistical measure of the variability of Hauteur. It expresses the standard deviation as a percentage of the mean; the higher the CV, the greater the variability
Dermal Papilla	The base of the Follicle canal where mitosis takes place. Also called the follicle bulb
Dermatitis	A skin condition resulting in lumpy wool
Fibre Diameter	The thickness of individual fibres; it is customary to quote an average value (Mean Fibre Diameter or MFD) in micrometres
Hauteur	The average of the length-biased distribution of fibre length in a top. It is obtained by sorting a sample of the sliver into length classes and calculating the average of the number of fibres of each length class. Hauteur is usually regarded as a numerical average although this assumes no relationship between fibre length and fibre diameter
Hypothermia	Temperature below normal. Also known as cold stress
Micron	Commonly used name for the unit of measurement of fibre diameter, correctly termed a micrometre (µm)
Mitotic	The division of cells to form new cells
Noil	Short fibres removed during the combing process; it comprises second cuts, pieces of broken fibres, neps, and is contaminated by small pieces of vegetable matter
OFFM	On Farm Fibre Measurement
Position of Break	(POB) - an indication of where a staple breaks during extension, determined by comparing the masses of clean wool in the broken portions of the staple. It does not imply that a break exists in the staple
Second cut	Staple resulting from shearing an area on a sheep which has already been shorn. A second cut differs from a normal staple in that both ends are severed and no tip end is evident. In Staple Length measurement second cuts are considered as staples
Shearing	The act of harvesting the wool from the sheep
Shearing Shed	A building where shearing takes place
Staple Length	Length of a staple projected along its axis obtained by measuring the staple without stretching or disturbing the crimp of the fibres
Staple Strength	Maximum force required to rupture a staple per unit of average linear density
Tender Wool	Wool for which a significant proportion of staples exhibit a marked weakness, at corresponding points in all the fibre of the staples

Top	Sliver that forms part of the starting material for the worsted and certain other drawing systems, usually obtained by the process of combing, and characterised by the following properties: (a) A substantially parallel formation of the fibres, essentially free of vegetable matter. (b) The absence of fibres so short as to be uncontrolled in the preferred system of drawing. (c) A substantially homogeneous distribution throughout the sliver of fibres from each length group present
Vegetable Matter	Burrs (including hard heads), twigs, seeds, leaves and grasses present in wool
Woolclasser	The individual responsible for sorting the wool to meet Clip Preparation Standards
Yield	Amount of clean fibre, at a standard regain, that is expected to be produced when a delivery of raw wool is processed. The yield may be expressed both as a clean mass in kilograms and as a percentage of the mass of raw wool prior to processing