Producing and marketing quality mohair

A report for the Rural Industries Research and Development Corporation

By B.A. McGregor

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Foreword

This report provides significantly increased knowledge on mohair quality by focusing on the major attributes that determine mohair quality and undertaking experiments to further examine what producers can do to manipulate mohair quality.

This report provides:

- New market information to increase producers’ knowledge of the importance of certain attributes of mohair in determining mohair quality.
- New data on the response of modern Australian Angora goats to supplementary feeding and different shearing strategies and methods of fleece evaluation.
- A summary of the main methods that producers can use to manipulate mohair quality.
- Evidence of improved capability in mohair producers following workshops in regions where mohair quality was compromised by a high incidence of short and cotted mohair.

The report will be a useful resource for existing and new entrants to mohair production and those wishing to study mohair production.

This project was part funded from industry revenue that are matched by funds provided by the Australian Government and part funded by the Victorian Department of Primary Industries.

This report, an addition to RIRDC’s diverse range of over 1500 research publications, forms part of our Rare Natural Fibres R&D program, which aims to facilitate the development of new and established industries based on rare natural fibres.

Most of our publications are available for viewing, downloading or purchasing online through our website:

- purchases at www.rirdc.gov.au/eshop

Peter O’Brien
Managing Director
Rural Industries Research and Development Corporation
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Executive Summary

Introduction
There is little objective information on the production characteristics or the market evaluation of mohair produced by modern genotypes of Australian Angora goats. For the mohair industry to be attractive to investors it must increase returns to existing producers and provide current economic and production data. This project worked with mohair selling agents and producers to develop new information on the production of premium quality mohair.

What the report is about
This report provides:
• New market information to increase producers’ knowledge of the importance of certain attributes of mohair in determining mohair quality.
• New data on the response of modern Australian Angora goats to supplementary feeding and different shearing strategies and methods of fleece evaluation.
• A summary of the main methods that producers can use to manipulate mohair quality.
• Evidence of improved capability in mohair producers following workshops in regions where mohair quality was compromised by a high incidence of short and cotted mohair.

Who is the report targeted at?
The report will be useful for existing and new entrants to mohair production and those wishing to promote or study mohair production.

Background
An earlier RIRDC project DAV 192A quantified both the physical and financial impacts and the extent of poor quality mohair. That project also identified that many mohair producers were neither confident nor capable of managing their goats to produce premium mohair during the year, particularly with young goats during winter. Many producers receive sub-optimal prices for their finest kid mohair as it was short, cotted or entangled. The present project was established to undertake some of the recommendations of DAV 192A.

Aims/Objectives
Project DAV 209A “Increasing the capability of mohair producers to produce premium fibre” aimed to increase mohair producer’s knowledge and capability to produce premium fibre and to evaluate different supplementary feeding and mohair harvesting strategies. This type of work had been identified in the RIRDC Rare Natural Animal Fibre Research and Development Plan 1998-2003.

Methods Used
A detailed statistical analysis of factors affecting the market price of Australian mohair was completed. The results were published in the Australian Journal of Agricultural Research and an advisory bulletin produced and distributed to mohair producers by their mohair selling broker. Three field experiments that investigated the nutritional management of weaner kids during the winter half year were completed with commercial mohair producers. The impact of shearing month, shearing frequency and genotype on mohair production and quality of Australian Angora goats was examined in a two-year long experiment. Information was gained on the mohair quality of weaner goats during a study tour of South Africa. Research was conducted with modern Australian Angora goats to determine the sources and extent of variation in mohair quality between positions within the fleece, with the objective of identifying the most relevant and reliable sites for fleece evaluation. Training workshops were developed and conducted with producers in regions reporting problems with mohair quality.
Results/Key Findings

The size of discounts and premiums that relate to different quality attributes of mohair were quantified. The statistical model accounted for 98% of the variation in mohair price. This means that attributes not included at the time of mohair sale have no importance to mohair buyers and exporters in determining the market price of mohair. Of the attributes that producers can manipulate, mean fibre diameter was by far the most important accounting for 67% of the variation in price. Increasing mohair mean fibre diameter from 25 to 30 μm results in a 50% reduction in market value. A premium for superior style of mohair was identified for the first time and was substantial at 12%. There was an important interaction between style and fibre diameter indicating that producers should measure both before selecting sires. However, selling agents have stopped marketing superior style mohair, thus sending confusing messages to producers. The reasons for producers to properly husband young goats have been explained in terms of mohair market premiums. The market premiums for mohair length and other attributes were quantified with substantial discounts of 50% or more for short and cotted mohair.

The field trials evaluating the type of supplementary feeding and various periods of feeding weaned Angora goats provided variable results. It is possible for weaner Angora goats to gain live weight during the winter half year provided a sufficient level of feeding can be determined. In the trials conducted, a level of supplementary feeding of 350 g/d of lupin and barley grain over a four months period was required for significant gains. This level of feeding increased mohair production by 16%. The results suggest current industry feeding practices during winter have been sub-optimal.

Shearing practices were shown to affect all 16 objective and subjective attributes of mohair that were evaluated. Goat shorn less frequently grew less mohair that was more likely to be entangled in spring. In the shearing experiment, goats of Texan genotypes were more associated with this effect but the same problems were identified in South African genotypes during inspections of animals in South Africa.

Mohair producers and mohair selling agents in South Africa report that about 30% of kid mohair has problems with staple entanglement so the issue is not one of genotype per se but of the production system and all the husbandry practices including animal selection. No cases of cotted fibre were seen during the field trials and intensive shearing experiments but various levels of staple entanglement were detected. It appears that many producers do not understand the wool science underlying the production of mohair and how cotted fibre and entangled staples form and are differentiated. Information on these issues has been developed for producers.

The relationships between sampling sites demonstrated that mohair grown on the brisket and side of the neck should be removed during fibre classing and sold in coarser lines. This work also showed that mohair grown along the back was not coarser than the main body of the fleece, as was the case with the now superseded Australian
genotypes. This means mohair grown on the back should not be removed during classing. These recommendations differ from current industry classing advice.

Training workshops were developed and delivered in regions that had reported mohair quality issues. Producer feedback indicated that they valued the learning obtained during this project.

Implications for relevant stakeholders
This project has demonstrated that the mohair market is highly predictive and discriminating against coarse mohair. Improved nutrition and shearing practices can improve both the production and quality of harvested mohair from young weaned Angora goats. Mohair producers can use the materials developed during this project to improve their fleece quality, production, classing and sale. Mohair classing procedures should be modified to reduce the sale of coarser mohair with finer mohair.

Recommendations
On the basis of the findings in this report the following recommendations are made:
1. That existing and new objective information on the management of Angora goats and the marketing of mohair be brought together.
2. Mohair producers should increase their skills and knowledge of pasture production.
3. The best methods for evaluating mohair fleeces need to be identified.
4. Research should be conducted to improve the nutritional management of breeding flocks.
1. Introduction

1.1 Introduction
The RIRDC Rare Natural Animal Fibre Research and Development Plan 1998-2003 identified under the objective “To Improve Production Efficiencies” the following strategy:
Improve fibre quality by improved husbandry, clip preparation and reduction of short and cotted fleeces caused by genotype x environment considerations in the mohair industry.

This project aimed for the following outcomes:
• To increase mohair producers knowledge and capability to produce premium fibre; and
• To evaluate different supplementary feeding and mohair harvesting strategies.

A range of field experiments, analysis of mohair market reports and training workshops have been completed as described in this report. The following sections of this Chapter introduce the topics discussed in Chapters 2 to 6.

1.2 Defining mohair quality
Effective marketing, genetic improvement and training in the mohair industry requires accurate knowledge of the impact of attributes on the value of mohair. For the international textile industry that buys Australian mohair, only a small number of attributes affect the value of mohair. Chapter 2 discusses the outcomes of a detailed analysis of the factors affecting the price of Australian mohair. Chapter 2 also describes how the international mohair market evaluates mohair quality and the price and discounts that relate to different quality attributes. The results of this work have relevance to all mohair producers because most Australian mohair is purchased for export to international processors. Full details of the analyses of Australian mohair market information can be found elsewhere (McGregor and Butler 2004).

1.3 Nutrition management of weaner kids
There are many biological and management issues affecting the quality of mohair. A previous RIRDC project (DAV 192A, McGregor 2002) identified a number of practical and theoretical approaches that producers could apply to manipulate mohair quality. Previous RIRDC projects have determined the affects of different nutritional treatments on the production of grazing goats (McGregor 1985a,b), the impact on kid survival and skin follicle development (1995) and the methods for intensive feeding and drought management of goats (McGregor 2003, 2005a). Recently a compendium of growth rates of Australian goats was published and indicates that there is little information on the production of current genotypes of Australian Angora goats (McGregor 2005b).

Given the a lack of objective evidence regarding the impact on mohair quality of a number of common husbandry practices applied to modern Australian Angora goats, Chapter 3 investigates the following recommendation from McGregor (2002): improving nutritional management of weaner kids during the winter half year.

1.4 Effects of shearing frequency and genetic strain on mohair fleece growth and mohair quality attributes
The RIRDC Project DAV 192A “Optimising mohair harvesting strategies” (McGregor 2002) identified a number of practical and theoretical approaches that producers could apply to improve the quality of mohair. In particular the impact of variations in shearing strategies that producers use and the effects of different new genotypes of Angora goats were identified as being likely to have an impact.
These potential impacts arise as a consequence of different biological, environmental and management influences including:

1. As a consequence of a cessation of fibre growth during mid-winter, which occurs to a greater extent in Angora goats compared with Merino sheep. Thus many Angora goats exhibit a seasonal shedding of mohair fibres during early to mid spring. Fleeces that have shed fibres can exhibit matting and cotting (natural felting). Management must be developed to enable continuous mohair fibre growth.

2. As Angora goats are likely to be affected by the effects of cold stress throughout the year (McGregor 2002, Birrell 1989, Farrell and Corbett 1970) they expend considerable energy to maintain themselves. Restricted provision of energy and/or long periods of cold stress during the winter half year will exacerbate the seasonal depression in mohair growth. Consequently mohair production and fibre length will be reduced.

3. Mohair harvesting procedures must be correctly implemented to harvest fibre before any potential to cot in spring and to ensure it achieves B length classification to optimise price (Chapter 2). There is no information on the impact of shearing on mohair production and quality and very little available for sheep. In carpet wool sheep Reid and Sides (1984) evaluated the then current practice of shearing Elliotdale wethers in Tasmania each January and July. The July wool weights had been consistently lighter than those shorn in January, despite equal wool growth periods. As they noted, shearing at less than 12 months intervals in any speciality carpet wool breeds makes seasonal variation a more significant factor in the choice of shearing times. The wool growth pattern of Elliotdale wethers reflected the combined effects of photoperiod and nutritional management with wool growth in the spring and summer period being about twice that of the winter growth. The old Australian genotype of Angora goat showed a similar fluctuation (Stapleton 1978). Reid and Sides (1984) found that November and May shearings gave the most similar wool weight, with the combinations of July/January and March/September shearings having, respectively, increasingly more uneven shorn wool weights.

4. There needs to be a clear focus on breeding productive goats that grow long and fine mohair (McGregor and Butler 2004, Ferguson and McGregor 2005). There is also a potential trade off between different genotypes and the ideal form of mohair.

A survey of the experiences of Australian mohair producers with mohair quality problems revealed that they regarded genetic background as an important factor affecting propensity to cot (McGregor 2002). The survey responses indicate that those producers reporting the more serious impacts on mohair quality had, on average, a greater Texan genetic background in their Angora goats compared to those reporting less serious impacts who had a higher proportion of South African genetics. Many respondents reported that problems with short or cotted mohair diminished when they used increasing amounts of South African genetics.

The experiment described in Chapter 4 was designed to examine the impact of shearing timing, shearing frequency and genotype on mohair production and quality of Australian Angora goats. Information gained on the mohair quality of weaner goats during a study tour of South African is also provided.

1.5 Quality variation within mohair fleeces

The quality of mohair fleeces is assessed following shearing in the shearing shed and usually also by an agent, a buyer and perhaps an exporter. Fleeces are also assessed on live animals by breeders, animal buyers and during judging competitions. It is well understood that mohair varies across the body of Angora goats and that some animals appear more uniform than others. For example, most mohair producers understand that the mohair that grows on the brisket is coarser than that grown elsewhere on the body and classing guidelines in Australia have for many years advised producers to remove “strong necks” (actually meaning brisket).
However, few mohair producers actually know what the differences are between mohair grown on the brisket and mohair grown on the shoulder, mid back or rump. Where differences exist are they affected by the environment or the sex of the goat? To what extent are differences affected by the sire or genetic strain? Do the relationships between different sites within a fleece change with age of goat? What is the best site to use when sampling fleeces? Do sampling sites differ in their ability to detect different attributes of fleeces? These issues are important as they impact on the ability of producers to separate poorer mohair from premium quality mohair during fibre classing and in identifying and selecting superior sires and dams during breeding programs.

As a fleece consists of millions of fibres the assessment of the attributes of a fleece subjectively by eye is frequently unreliable as mohair fleeces show large variations in quality within the fleece. In addition, our eyes are limited in their ability to discern fibre diameter, the mean of other fibre attributes and the extent of naturally occurring contaminants. Mohair fleeces are also affected by environmental conditions, in particular humidity, but also by storage conditions. The same limitations that affect mohair fibre apply to other animal fibres.

It is generally accepted that the variation in the attributes within the fleece of animals is related to the following components:

1. Within a staple: Most of the variation in fibre diameter occurs between fibres within a staple. The difference between the fibre diameter of fibres growing from primary and secondary skin follicles in an mohair may be more than 20 µm. Many medullated fibres in mohair fleeces are more than 10 µm coarser than the mean fibre diameter.
2. Along the fibre: Changes occur in the fibre diameter, dust, grease and vegetable matter content as the fleece grows during the year. Nutritional changes, the effects of disease and reproduction all influence fibre diameter along the fibre.
3. Different positions within the fleece: Fibre diameter, incidence of medullated fibres, grease, dust and vegetable matter contaminants vary with the position in the fleece.
4. Differences between animals and between mobs: Within a herd of animals and between herds, animals, especially from different properties, will differ in their mean fibre diameter and level of grease and other contaminants.

The present research was conducted with modern Australian Angora goats to determine the sources and extent of variation in mohair quality between positions within the fleece, between sires, between properties and with different age groups with the objective of identifying the most relevant and most reliable sites for fleece evaluation and to identify if present classing practices are appropriate. This report is confined to the analysis of mean fibre diameter and staple length at twelve and eighteen months of age.

1.6 Engagement, training and evaluation
This project used a range of models for engagement and the main models were a mix of programmed learning, technology development and information access. Elements of group facilitation were also used early in the project. The main examples of technology development are provided in Chapter 3 although this approach was used in part of Chapter 5. Programmed learning was used on site during the experiment described in Chapter 4.

An important component of this project was to develop and conduct training workshops with producers in regions reporting problems with mohair quality. Chapter 6 briefly summarises this work. The main training needs as determined by a training needs analysis are provided. Chapter 6 also includes some examples of the training materials produced for training workshops. Evaluation of training events was conducted at workshops. As feedback from all the events was similar, details are provided from two events that used different approaches.
2. Defining mohair quality

2.1 Defining quality
Quality is usually defined as “fitness for purpose”. So the quality depends upon the intended use and the processing route for the product.

The quality of something can be defined in terms of three attributes: features, timeliness and cost. Quality mohair will have features that are desirable for textile products and may reduce the time and therefore cost needed for processing. The price ultimately depends on the demand for the end product.

In this article it is assumed that the market price reflects the quality of the mohair. In other words, the higher the commercial price or market value the higher the quality. Mohair that is not premium mohair will have a discounted price.

2.2 Mohair market information
2.2.1 Mohair prices
Market information was collected from two Australian mohair-selling agents for the four-year period 1998 to 2001. These agents tested mohair before sale using a range of IWTO wool industry tests. Sale date, mohair tests, subjective classing and the sale price were available for 557 sale lots comprising more than 650,000 kg.

2.2.2 Mohair objective tests
Mohair bale core samples were taken before sale and were tested for:
- Mean fibre diameter (MFD),
- Coefficient of variation of fibre diameter (CVD),
- Scoured yield, and
- Vegetable matter content (VM).

Australian mohair had an average MFD of 30.9 μm, CVD 29.1 %, VM 1.0 % and scoured yield 84.0%. Further details of statistical analysis are provided elsewhere.

2.2.3 Subjective mohair classing
Each agent assessed fibre length, mohair style and other attributes to form sale lines. Mohair length was classified into 5 classes:
- A, 12-16 cm;
- B, 10-12 cm;
- C, 7-10 cm;
- Overgrown (OG), > 16 cm; and
- AB (mixed AB length).

Kemp content was assessed as:
- Free or nearly free (FNF),
- Low (K),
- Moderate (KK), or
- High (KKK).

VM fault was assessed as:
- FNF, or
- Containing VM fault (V).
Style grades were applied as superior, average or poor, based on general appearance attributes including: staple character, style, tip and lock uniformity, fibre handle, uniformity of staple length, dust penetration and lustre. Poor style was applied to inferior mohair classified as K, KK or KKK. Style grades were not given to cotted, stained or OG mohair. Agents only separated mohair for superior style from 1998 until the second quarter in 2000.

2.3 Factors affecting mohair price
Greasy mohair price was affected by: selling period, selling agent, MFD, length, style, VM and fault line and interactions between these factors (Figure 2.1).

![Figure 2.1. The relative contribution to the variance in greasy mohair price accounted for by mean fibre diameter, vegetable matter, visual grades and selling period and agent combinations.](image)

No other factors were important. The final model accounted for 98% of the variation in greasy mohair price. Other factors combined could account for no more than 2% of the variation in price and must be regarded as being of little importance for commercial mohair buyers and processors. This is an important point for many mohair breeders are actively involved in the showing of Angora goats where small perceived differences in appearance have a large influence on outcome. However the market assessment of mohair quality and the prices paid by buyers indicate that only those factors shown in Figure 2.1 are important.

2.3.1 Mean fibre diameter
There was a very large price premium for MFD down to 25 μm (Figure 2.2). Terms involving MFD accounted for 59% of the variation in the price of mohair not accounted for by agent and period combinations (Figure 2.1).

The MFD of mohair is the most important determinant of commercial value as it affects both the processing and textile performance of mohair, as is the case with wool. The decline in price at below 25 μm (Figure 2.2) may be explained by noting that most of the fibre below 24 μm was shorter AB and B length kid mohair discounted for various faults such as poorer style, length, kemp and VM. Agents indicated there was less competition for the smaller lots of this mohair and that this mohair was not passed in.

The baseline response shows the maximum price was reached at a MFD of 25 μm. The relative price declined to about 50% of the maximum at 30 μm and to a price of 10% of the maximum at 36 μm (Figure 2.3).
Figure 2.2 The baseline response of greasy mohair price to the mean fibre diameter, for a length of average style, without fault, 0.5% vegetable matter (FNF) and the 2\textsuperscript{nd} quarter of 1999.

Figure 2.3. The relative response of Australian greasy mohair prices to changes in mean fibre diameter after standardisation as in Figure 2.2. The maximum price has been held at 25 $\mu$m.

Demand for coarser mohair for use in tropical suiting material for Japanese markets declined during the 1980s following the development of cheaper alternative yarns using crossbred wools from New Zealand. Part of the reduced demand is based on the increased focus on comfort properties of textiles, in particular the perception of prickle in mohair fabrics. McGregor (1998b) briefly reviewed research undertaken on wool and the prickle or itch appears to be due to the fibre pricking the skin. Any fibres coarser than 30 $\mu$m can cause prickle sensations and when 5\% of fibres are greater than 30 $\mu$m most people regard textiles as being prickly. Given that about 45\% of current world production of mohair is coarser than 34 $\mu$m it is not surprising that the price for coarse mohair is depressed. In addition, demand for low MFD fibres is also related to the ability of modern of spinning machines to process finer mohair at greater speed and also to the greater demand for fabrics of lower mass per unit area.

Over the past 20 years there has been no progress in producing significant quantities of finer mohair. It would be expected that if significant quantities of finer mohair became available
then the price trends seen with wool and cashmere would prevail. This would result in the price discount curve moving towards finer fibre, so that the maximum price would be obtained at, say, 20 μm. Exporters pay more for finer mohair (Photo 2.1).

Photo 2.1. One of Australia’s leading mohair buyers and exporters, Mr Ian Laycock evaluating fleeces at the NAT mohair competition, Goulburn 2004.

2.3.2 Selling period and agent
Selling period and agent combinations accounted for 22% of the variation in mohair prices (Figure 2.1). The response of greasy mohair price to MFD differed greatly with period. In some selling periods the price was up to 200% or more than that shown in Figure 2.2. While the timing of sale does impact on price there was no selling season within a year that was better than another selling season.

It is not surprising that relativities between mohair fibre diameter change with time as seen with wool. These relativities are associated with changes in demand and textile uses of mohair. In addition, daily variation due to exchange rate fluctuations, as occurs with greasy wool price, also affect mohair prices. Mohair growers need to become aware of the likely changes in prices between sales and make better use of opportunities when mohair prices are high.

The analysis indicates that most of the time the agents prepared mohair similarly but where small differences occurred it appeared to be with the classification of off-type mohair. This may reflect the different types of off-type mohair received.
2.3.3 Mohair style

2.3.3.1 Discounts and premiums for mohair style

There were important statistically significant discounts and premiums for style grades (Table 2.1). The increase in the value of superior compared with poor style mohair was 43%. These discounts and premiums were consistent with time and MFD.

Table 2.1. Effect of style, within mainlines, on the price of Australian mohair sold during the period 1998 to 2001.

<table>
<thead>
<tr>
<th>Mohair Style</th>
<th>Price Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior</td>
<td>+12.5</td>
</tr>
<tr>
<td>Average</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>-21.9</td>
</tr>
</tbody>
</table>

These results emphasise the importance of good husbandry and genetic selection at low MFD to avoid the 20% discount seen with poor style mohair.

Style is believed to be correlated to more even fibre length distribution within the mohair fleece but the limited number of experiments have not clearly shown this to be the case (McGregor 1997). The premium for superior style mohair suggests that better genetic selection for style in fine mohair may be economic. However Australian mohair selling agents discontinued the superior style lines of mohair during the price boom of 2000 and 2001 as a premium given to style was not apparent. This analysis suggests otherwise, as the price differentials between superior and average and between average and poor styles were both significant and large.

2.3.3.2 Affect of style on mohair fibre diameter

Further analysis showed why agents and growers did not “see” an effective premium for style. In Australia, mohair classed as Fine Kid, Kid and Young Goat and of superior style had on average a greater MFD than similar mohair classed as having average style (Table 2.2).

Table 2.2. Effect of style grading within subjective fibre diameter classes on the actual measured mean fibre diameter (MFD) of sale lots. Bold value within subjective fibre diameter classes are statistically different.

<table>
<thead>
<tr>
<th>Subjective fibre diameter class</th>
<th>Style grading</th>
<th>Difference in MFD (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Superior style MFD (μm)</td>
<td>Average style MFD (μm)</td>
</tr>
<tr>
<td>Fine kid</td>
<td>24.8</td>
<td>23.7</td>
</tr>
<tr>
<td>Kid</td>
<td>27.4</td>
<td>25.5</td>
</tr>
<tr>
<td>Young goat</td>
<td>30.6</td>
<td>30.1</td>
</tr>
<tr>
<td>Fine hair</td>
<td>33.7</td>
<td>33.3</td>
</tr>
</tbody>
</table>

This finding influences the interpretation of the price information so that for mohair finer than 31 μm: a premium for style can be offset to a varying extent by a discount for higher MFD (Figure 2.3); and the visual assessment for superior style mohair is correlated with increasing MFD (Table 2.2).
Clearly producers should try to avoid penalties for reduced style that may arise with finer mohair production. In South Africa specifications for every goat tested mohair (EGT) include fibre diameter, staple length and style grade (Photos 2.2 and 2.3).

Photo 2.2. South African company Cape Mohair and Wool Ltd, specify that every goat tested fibre (EGT) must have a specified fibre diameter and length and be of superior style.

Photo 2.3. Cape Mohair and Wool Ltd, Mohair Manager, Mr. Pierre van der Vyver wants better specified mohair for commercial customers who pay premium prices for accepted fibre.

“We have customers who want better specified mohair”

Mr Pierre van der Vyver Mohair Manager Cape Mohair and Wool South Africa June 2004

These findings also emphasise the importance of evaluating potential mohair sires for MFD as well as the subjective evaluation of fleece style.
2.3.4 Length
There was a small price discount for B length mohair, and a substantial price discount for C length mohair (Figure 2.4).

Figure 2.4. Effect of length at 30 μm on the price of Australian mohair sold during the period 1998 to 2001.

Deviations due to length differ with time indicating greater and lesser discounts related to demand. B length mohair is closer to A length (zero) at all times whereas the price for C length is clearly dependent on demand.

The discounts for length were less at lower MFD (Figure 2.5). For example, the main discount for B length mohair was a reduction in price of 7% (Figure 2.4), but at 23 μm there was a premium for B length (Figure 2.5) resulting in the discount being negligible (-7% + ≈ 7% = 0%).

Figure 2.5. Greasy mohair price percentage deviations for B (■) and C (Δ) length mohair by mean fibre diameter, compared with the baseline A length deviation at 30 μm at any period. The discounts for length at a specific mean fibre diameter need to be combined with the discounts for length at 30 μm in Figure 2.4.
Mohair staple length determines the processing route for mohair in textiles. Long mohair is required for worsted processing as longer staples produce longer hauteur allowing greater spinning speeds and producing yarns with less irregularity, greater tenacity and extension and less hairiness than yarns made from shorter mohair. For woollen processing, C length mohair is desired although mohair noils and shorter mohair locks may also be used. Buying pressure for different mohair length categories will depend on whether the fashion trend is for worsted or woollen yarns. It is clear that the market generally favours longer mohair for worsted processing compared with mohair used for woollen processing.

It is more desirable to produce B length kid mohair than to risk producing A length or AB length kid mohair with VM fault. This indicates that management practices such as grazing, kidding, sire selection and shearing strategies need to be implemented to maximise the quantity of average to superior style A length mohair with low VM. It is clearly desirable to avoid producing C length mohair and face a 50% discount. Any practice that can result in potential C length mohair reaching B length would result in an effective doubling of greasy mohair price.

### 2.3.5 Kemp

Kemp fibres are short medullated fibres that usually grow from primary follicles. Kemp and other medullated fibres are undesirable in mohair as they detract from the finished fabric appearance and may add to perceived fabric evoked itch.

B length mohair with Kemp (K) was discounted 34% (Table 2.3) where as B length with no Kemp (Figure 2.4) was discounted only 7%. Presence of excessive Kemp in adult AB length mohair resulted in discounts of about 78%. Kemp is a greater problem in fine mohair than in adult mohair and the price will depend on the demand.

<table>
<thead>
<tr>
<th>Length and fault group</th>
<th>Deviation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A length Kemp K FNF</td>
<td>- 28</td>
</tr>
<tr>
<td>B length Kemp K FNF</td>
<td>- 34</td>
</tr>
<tr>
<td>Cotted or Heavy cott FNF</td>
<td>- 37, - 91</td>
</tr>
<tr>
<td>Fine Hair AB length V</td>
<td>- 51</td>
</tr>
<tr>
<td>Overgrown FNF</td>
<td>- 56</td>
</tr>
<tr>
<td>Light stain FNF</td>
<td>- 70</td>
</tr>
<tr>
<td>AB length Kemp KKK FNF</td>
<td>- 78</td>
</tr>
<tr>
<td>Kemp KKK FNF</td>
<td>- 87</td>
</tr>
</tbody>
</table>

### 2.3.6 Vegetable Matter

While the effect of VM can in some situations be large, the overall picture is that it contributes only a small percentage (less than 2%) of the overall variation in greasy mohair price (Figure 2.1). This is partly a result of mohair not being produced in the worst VM areas.

Large discounts (40 to 80%) occur for mohair with more than 2% VM at all MFD (Figure 2.6). While the discount was always large, the level of discount for VM increased substantially, as mohair became finer. For example vegetable matter in AB fine hair mohair resulted in a 51% discount. The data also suggests that finer mohair has greater VM probably due to on-farm reasons.

Vegetable matter contamination (amount and type) affects scouring, top making, yarn and cloth. Processing to remove VM produces lower quality textiles with shorter fibre length (as a result of greater fibre breakages), yellowing and reduced lustre after carbonising and residual VM causing defects in appearance and handle.
Figure 2.6. Greasy mohair price percentage deviations for vegetable matter by mean fibre diameter, compared with 0.5% vegetable matter (-); 23 μm (○), 25 μm (■), 27.5 μm (△), 30 μm (σ), 32.5 μm (□), 35 μm (λ), 37.5 μm (+). The values plotted for 35 and 37.5 μm have been cut off at 1% VM as there was no lots with VM > 1%.

2.3.7 Effect of time and MFD on fault lines
The overall picture for length and fault discounts was for these discounts to be relatively consistent over time. The discounts for mohair faults were much greater at lower MFD (Figure 2.7) and were proportionally less serious when the mohair MFD was high and the changes in discount with MFD were proportionally greater the more serious the fault.

Figure 2.7. Greasy mohair price percentage deviations for fault lines by mean fibre diameter, compared with the baseline A length fault deviation at 30 μm at any period. The discounts need to be combined with discounts in Figure 2.4 and Table 2.3. Faults that had a reasonable number of data points; FNF A length K (○), FNF B length K (□), FNF AB length KKK (σ), FNF Overgrown (×), FNF light stain (△).
2.3.8 Other attributes of mohair sale lots

There was no observed effect of sale lot size, CVD or clean wool content.

2.3.8.1 CVD

CVD of sale lots varied from 24 - 41%. In this analysis, the lack of response to CVD is due to much of the variation being accounted for within length, kemp and other faults.

While CVD was related to MFD of the sale lot, MFD accounted for only 1.7% of the variation in CVD. Over a 20 \( \mu \text{m} \) range in mohair MFD the CVD increased only 2% units. However, differences in length accounted for 2.8% units in CVD and the presence of kemp, cotts or stain a further 3 to 9% units in CVD.

If buyers are having difficulty in incorporating changes in CVD into their mohair valuations they may need provision of the spinning fineness parameter that incorporates MFD and CVD into a single attribute. The current range in CVD of Australian mohair is equivalent to a variation in processing performance = 3 \( \mu \text{m} \) change in MFD.

2.3.8.2 Scoured yield of mohair

Scoured yield (SY) estimates the proportion of clean mohair in the greasy material, which is critical to the processor of wool yet there is no evidence that this measurement is adding to the explanation of greasy mohair price as would be expected. Given that the range in SY of tested lots was 74 - 92% it is surprising that the SY provided at sale was not related to the greasy price of mohair.

Buyers reported that they assume an average of 85% scoured yield for mohair. As the price reported to producers is the greasy price, the price signals are not clear unless buyers value natural contaminants such as soil and grease to the same extent as clean mohair. If mohair prices were reported on clean fibre content the price would be 8 to 35% higher (mean increase 19%) compared with the reported greasy mohair price.

2.4 What this means for producers

MFD is more important in affecting mohair prices than in the past. As MFD affects almost 60% of the remaining variation in price producers should:

- Use bucks known to produce mohair < 30 \( \mu \text{m} \)
- Cull goats that exhibit excessive MFD ‘blowout’
- When selecting for superior style mohair use MFD tests to avoid correlated increases in MFD
- Maintain high levels of nutrition for breeding does.

Producers should adjust shearing and crutching times and grazing practices with:

- Priority given to goats growing the finest and highest value mohair such as kids and yearling; and focus on
- Producing A or B length mohair with < 1% VM and free of kemp, stain and cots.

Producers cannot do anything about the variation in mohair prices caused by year and sale time affects. Other factors have little importance and must be regarded as being of little importance for commercial mohair buyers and processors.
A note about using the information

The price for any mohair, at any time during the study period, can be calculated by determining the relevant baseline value, and then accumulating relevant deviations from the tables and graphs.

For example, fibre selling for AU$20/kg in the baseline response may also have selling period discounts of 5%, premiums for style of 20% and discounts for VM of 35% providing the outcome:

\[
\text{Price} = 20 \times \frac{(100-5)}{100} \times \frac{(100+20)}{100} \times \frac{(100-35)}{100} \\
= $14.80 as the predicted sale price.
\]

Note: these deviations from the baseline do not add up, the deviations multiply.

Further information to determine the historic price for the periods and type of mohair studied is contained in the reference.

References

Full details of this work can be sourced from:


An advisory Agriculture Note is also available:

3. Investigations into the nutrition management of weaner kids

3.1. Background
Angora kids are normally born in spring and weaned either in summer at 12 to 16 weeks of age or weaned around first shearing in early autumn (McGregor 2002). This means that weaner goats have grazing conditions that are declining in either pasture quality or pasture availability or both. Many producers report that their weaners do not grow quickly. As the weaners are shorn in autumn they face the cold winter period with little natural protection. It is likely they suffer cold stress during the entire winter period (McGregor 2002). Weaner goats also endure other potentially serious challenges including internal parasitism and social dislocation based upon weaning and separation from mothers.

Thus weaner goats are expected to grow and potentially double in live weight during their first six months but are faced with adverse nutritional and environmental conditions. It is during the two years that Angora goats produce their finest and most valuable fleeces. Reduced mohair production, suppressed future reproduction, health issues and increased mortality of weaners will substantially impact on the financial returns from Angora goats.

The following section summarises the findings of three field experiments where young Angora goats were provided with a range of different nutritional treatments in order to gather further information on their production responses.

3.2. Effect of short periods of supplementary feeding in winter
3.2.1 Materials and Methods
3.2.1.1 Location and environmental conditions
Animals were grazed on a farm in southern New South Wales (37°00’34”S, 149°36’39”E, altitude 191 m ASL) and managed by producers with 30 years experience. The site had an easterly aspect and soils are based on weathered granite. The property had shade and shelter provided by native vegetation and hills. Fresh water was provided in all paddocks. Daily rainfall records were taken on site and long-term average rainfall for the site was available.

3.2.1.2 Animals
Angora weaners born September 2002 and shorn in February 2003 (does n = 45, wethers n = 35). Within sex, weaners were allocation to treatment based on stratified live weight.

3.2.1.3 Design
There were five treatments each with 16 replicates:
  - Two level of supplementary feeding x Two periods of supplementary feeding + Control. Replication: 16 individual kids allotted to each treatment based on sex and live weight.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Grazing only</td>
</tr>
<tr>
<td>Supplementary feeding Level 1</td>
<td>Grazing plus 115 g/d whole barley grain</td>
</tr>
<tr>
<td>Supplementary feeding Level 2</td>
<td>Grazing plus 230 g/d whole barley grain</td>
</tr>
<tr>
<td>Feeding Period 1</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Feeding Period 2</td>
<td>8 weeks</td>
</tr>
</tbody>
</table>
3.2.1.4 Feeding
The feeding level was based on Huston’s (1994) research with Angora goats on rangelands in Texas where supplementary feeding of 10 g/kg$^{0.75}$/d provided the maximum level of feed intake. This translates to a level of supplementary feeding of about 100 g/d of grain for a 21 kg doe. As this property was hilly and the goats were expected to grow it was decided to provide supplementary feeding at a rate 15% above that suggested by Huston (1994).

The feeding regime was based on the survey responses of producers who claimed benefits for feeding only during the last month of the growing period before spring shearing (McGregor 2002). Therefore feeding for the short period began on 29 July, one month before shearing and for the longer period feeding was designed to begin near the winter solstice (shortest day) and began 1 July 2003.

3.2.1.5 Management
All goats were weighed prior to the first feeding and at intervals of approximately two weeks until shearing on 27 August 2004. Animals were also weighed two and 13 weeks after shearing. Body condition scores were recorded at weighing.

All goats were fed individually in pens (Photo 3.1). The procedure was that all goats were moved into a covered shed where 18 individual pens were positioned. All goats for one treatment were then individually penned and fed their grain in a metal feed bin. When the grain had been eaten the goats were placed in a holding yard and not released back to grazing until all feeding had been completed. The control group was kept shedded until all grain had been fed. Any residues were collected and weighed. Feeding concluded on 26 August. Grain was introduced gradually following best practice recommendations (McGregor 1998a, 2002) and crushed limestone added at the rate of 1.5%. Grain was sampled during the feeding period and a bulked sample tested at FeedTest.

At shearing, fleeces were individually weighed to the nearest 1 g. Stained fleece was separated at shearing and weighed to the nearest 1 g. Mid side samples were taken and tested for clean washing yield, mean fibre diameter, fibre diameter variation, fibre curvature and medullated fibre content. Staple length was determined on three staples from the mid side site. Clean fleece weight was determined as: total greasy fleece weight kg x clean washing yield %.

Photo 3.1. Weaner goats were individually penned three times each week and fed their designated ration. The goats rapidly learned the feeding routine.
3.2.1.5 Statistical analysis
Data were analysed using Genstat (Genstat Committee 2002) with a treatment structure of Sex*(Control/Level*Period). In this symbolic notation, ‘*’ represents all combinations for multi-level factors and multiplication for quantitative variates (i.e. crossing) and ‘/’ represents the levels of one factor being defined only within the level of another factor (i.e. nesting).

Pre-experimental data available for use as covariates in the analysis included: Genetic strain background (% Texan, % South African, % Australian); birth type (single, twin); first fleece weight (March). The only covariate that was significant was %Texan in the analysis of mean fibre diameter.

3.2.2 Results
3.2.2.1 Rainfall
The monthly totals and long-term average rainfall at the site are given in Table 3.1.

Table 3.1. Monthly rainfall data (mm) and long term mean monthly rainfall at the experimental site (37°00’34”S, 149°36’39”E, altitude 191 m)

<table>
<thead>
<tr>
<th>Month</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>Long term mean¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>39</td>
<td>19</td>
<td>45.5</td>
<td>59.0</td>
</tr>
<tr>
<td>February</td>
<td>201</td>
<td>102</td>
<td>45</td>
<td>70.5</td>
</tr>
<tr>
<td>March</td>
<td>7</td>
<td>99.5</td>
<td>47.5</td>
<td>74.4</td>
</tr>
<tr>
<td>April</td>
<td>110</td>
<td>48.5</td>
<td>39</td>
<td>92.4</td>
</tr>
<tr>
<td>May</td>
<td>35</td>
<td>47</td>
<td>31.5</td>
<td>59.7</td>
</tr>
<tr>
<td>June</td>
<td>24</td>
<td>16</td>
<td>8</td>
<td>50.8</td>
</tr>
<tr>
<td>July</td>
<td>9</td>
<td>31.5</td>
<td>29</td>
<td>68.6</td>
</tr>
<tr>
<td>August</td>
<td>5</td>
<td>56</td>
<td>19.5³</td>
<td>49.0</td>
</tr>
<tr>
<td>September</td>
<td>22</td>
<td>14</td>
<td>86</td>
<td>56.7</td>
</tr>
<tr>
<td>October</td>
<td>38</td>
<td>66</td>
<td>110</td>
<td>71.5</td>
</tr>
<tr>
<td>November</td>
<td>61</td>
<td>76</td>
<td>89</td>
<td>100.1</td>
</tr>
<tr>
<td>December</td>
<td>7</td>
<td>108</td>
<td>152</td>
<td>80.0</td>
</tr>
</tbody>
</table>

Annual mean 558² 683.5 702 832.6

¹ Records for period 1982-2005 excluding 1984; ² Third lowest annual total; ³ 18 mm rain to 23 August when experiment concluded.

3.2.2.2 Feed
For barley grain, the dry matter content was 87.8% and chemical composition (g/kg DM) was: CP 86; ADF 68; predicted DM digestibility (%DMD) 83.9; and predicted ME 12.4 MJ/kg DM.

3.2.2.3 Live weight
The mean (± sd) live weight of the goats at the start of the experiments was 20.4 (± 2.9) kg. Live weight change of all treatments during the feeding period is shown in Figure 3.1. There was no treatment effect in the change in live weight over the experimental period with the control goats gaining 0.44 kg, other treatments gaining 0.65 kg (sed 0.41; P value 0.60). Most of these live weight changes can be accounted for by fleece growth during the period of feeding.
Figure 3.1. Change in the mean live weight of Angora weaners grazed on pasture (control) or grazed on pasture and fed barley grain supplements at two different levels for 1 or 2 months during winter.

3.2.2.4 Mohair production and quality
Mohair production was not affected by treatment averaging 2.12 kg greasy or 1.81 kg clean (Table 3.2). Treatment did not affect mohair clean washing yield. Any level of supplementation did affect the weight of stained mohair with the control goats producing significantly less stained mohair (Table 3.2). On average, the control goats had mohair with longer staple length than other treatments. The data also suggested that high levels of feeding produced shorter mohair (Table 3.2).

Table 3.2. Effect of supplementary feeding at two levels and for two time periods on mohair production, mohair clean washing yield and mohair staple length.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Greasy fleece weight kg</th>
<th>Clean washing yield %</th>
<th>Clean fleece weight kg</th>
<th>Weight of stain g</th>
<th>Staple length cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.11</td>
<td>85.2</td>
<td>1.80</td>
<td>280</td>
<td>16.4</td>
</tr>
<tr>
<td>Feeding Level 1</td>
<td>2.14</td>
<td>85.5</td>
<td>1.83</td>
<td>428</td>
<td>16.5</td>
</tr>
<tr>
<td>Feeding Level 2</td>
<td>2.09</td>
<td>86.1</td>
<td>1.80</td>
<td>425</td>
<td>15.8</td>
</tr>
<tr>
<td>Period 1</td>
<td>2.18</td>
<td>85.7</td>
<td>1.87</td>
<td>418</td>
<td>16.3</td>
</tr>
<tr>
<td>Period 2</td>
<td>2.06</td>
<td>85.9</td>
<td>1.76</td>
<td>435</td>
<td>16.0</td>
</tr>
<tr>
<td>sed-control with others</td>
<td>0.077</td>
<td>1.15</td>
<td>0.067</td>
<td>53</td>
<td>0.38</td>
</tr>
<tr>
<td>P value-control with others</td>
<td>0.96</td>
<td>0.62</td>
<td>0.78</td>
<td><strong>0.007</strong></td>
<td><strong>0.03</strong></td>
</tr>
<tr>
<td>sed-control with fl or period</td>
<td>0.084</td>
<td>1.25</td>
<td>0.073</td>
<td>58</td>
<td>0.41</td>
</tr>
<tr>
<td>P value-fl &amp; period</td>
<td>0.069</td>
<td>1.02</td>
<td>0.060</td>
<td>47</td>
<td>0.34</td>
</tr>
<tr>
<td>P value-period</td>
<td>0.49</td>
<td>0.53</td>
<td>0.58</td>
<td>0.95</td>
<td>0.054</td>
</tr>
</tbody>
</table>

*fl; feed level

There was a sex effect on staple length with mohair from does being longer than that grown by wethers: does 16.5 cm, wethers 15.9 cm; sed 0.25; P value 0.03.
Mohair mean fibre diameter and spinning fineness was not affected by treatment averaging 26.1 μm (Table 3.3). Supplementary feeding reduced fibre diameter variability with both the SD and CV of fibre diameter being higher in unfed control goats compared with other treatments (Table 3.3).

**Table 3.3. Effect of supplementary feeding at two levels and for two time periods on mohair fibre diameter, fibre diameter variability and spinning fineness.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean fibre diameter μm</th>
<th>Fibre diameter SD μm</th>
<th>Fibre diameter CV %</th>
<th>Spinning fineness μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>26.4</td>
<td>6.56</td>
<td>25.1</td>
<td>26.5</td>
</tr>
<tr>
<td>Feeding Level 1</td>
<td>26.1</td>
<td>6.09</td>
<td>23.4</td>
<td>26.0</td>
</tr>
<tr>
<td>Feeding Level 2</td>
<td>25.9</td>
<td>5.88</td>
<td>22.4</td>
<td>26.0</td>
</tr>
<tr>
<td>Period 1</td>
<td>26.3</td>
<td>6.15</td>
<td>23.3</td>
<td>26.3</td>
</tr>
<tr>
<td>Period 2</td>
<td>25.8</td>
<td>5.82</td>
<td>22.4</td>
<td>25.7</td>
</tr>
</tbody>
</table>

\*sedcontrol with others 0.45 0.217 0.90 0.47
\*P valuecontrol with others 0.50 0.01 0.01 0.33
\*sedcontrol within fl or period 0.50 0.238 0.99 0.51
\*P valuefl 0.41 0.194 0.80 0.42
\*P valueperiod 0.58 0.29 0.23 0.98
\*P valueperiod 0.24 0.10 0.25 0.15

**Table 3.4. Effect of supplementary feeding at two levels and for two time periods on the incidence of medullated fibre, mohair fibre curvature and fibre curvature variability.**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Medullated fibre %</th>
<th>Medullated fibre % w/w</th>
<th>Fibre curvature Degree/mm</th>
<th>Fibre curvature SD Degree/mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.80</td>
<td>1.93</td>
<td>15.6</td>
<td>15.4</td>
</tr>
<tr>
<td>Feeding Level 1</td>
<td>0.80</td>
<td>1.76</td>
<td>15.2</td>
<td>13.9</td>
</tr>
<tr>
<td>Feeding Level 2</td>
<td>0.74</td>
<td>1.76</td>
<td>15.0</td>
<td>14.2</td>
</tr>
<tr>
<td>Period 1</td>
<td>0.77</td>
<td>1.69</td>
<td>14.9</td>
<td>13.8</td>
</tr>
<tr>
<td>Period 2</td>
<td>0.76</td>
<td>1.84</td>
<td>15.5</td>
<td>14.3</td>
</tr>
<tr>
<td>sedcontrol with others</td>
<td>0.101</td>
<td>0.218</td>
<td>0.48</td>
<td>0.61</td>
</tr>
<tr>
<td>P valuecontrol with others</td>
<td>0.770</td>
<td>0.43</td>
<td>0.39</td>
<td>0.03</td>
</tr>
<tr>
<td>sedcontrol within fl or period</td>
<td>0.110</td>
<td>0.233</td>
<td>0.52</td>
<td>0.67</td>
</tr>
<tr>
<td>P valuefl</td>
<td>0.90</td>
<td>0.190</td>
<td>0.43</td>
<td>0.55</td>
</tr>
<tr>
<td>P valueperiod</td>
<td>0.49</td>
<td>0.99</td>
<td>0.91</td>
<td>0.68</td>
</tr>
<tr>
<td>P valueperiod</td>
<td>0.90</td>
<td>0.42</td>
<td>0.21</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Table 3.5. Effect of supplementary feeding at two levels and for two time periods on greasy fleece weight and other attributes of mohair.**

<table>
<thead>
<tr>
<th>Mean fibre diameter μm</th>
<th>Fibre diameter SD μm</th>
<th>Fibre diameter CV %</th>
<th>Spinning fineness μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>26.4</td>
<td>6.56</td>
<td>25.1</td>
</tr>
<tr>
<td>Feeding Level 1</td>
<td>26.1</td>
<td>6.09</td>
<td>23.4</td>
</tr>
<tr>
<td>Feeding Level 2</td>
<td>25.9</td>
<td>5.88</td>
<td>22.4</td>
</tr>
<tr>
<td>Period 1</td>
<td>26.3</td>
<td>6.15</td>
<td>23.3</td>
</tr>
<tr>
<td>Period 2</td>
<td>25.8</td>
<td>5.82</td>
<td>22.4</td>
</tr>
</tbody>
</table>

\*Yield level \*Values adjusted after use of covariate

There was an effect of sex on mean fibre diameter after adjustment for the covariate with does producing coarser mohair: does 27.4 μm, wethers 24.4 μm; sed 1.06; P value 0.014.

There was no effect of treatment on the incidence of medullated fibres or on mean fibre curvature (Table 3.4). Control goats did have more variable fibre curvature than supplementary fed goats (Table 3.4).

Given the lack of treatment response for mohair production, all the data were pooled and analysed by multiple regression. There was a significant relationship between greasy fleece weight and other attributes of mohair (Table 3.5). Regression constants indicated that:

- for each 1 μm increase in mean fibre diameter, greasy fleece weight increased 70 g;
- for each 1 kg increase in pre-shearing live weight greasy fleece weight increased 33 g;
- wethers grew 122 g more greasy fleece than does; and
- for each 1 cm increase in staple length greasy fleece weight increased 3.9 g.
Table 3.5. Regression constants, correlation coefficient and probability ($P$) for relationships between greasy fleece weight (g) and mean fibre diameter ($\mu$m), Sex (wether, doe), staple length (cm) and pre-shearing live weight (kg) (Pooled data, $n = 78$)

<table>
<thead>
<tr>
<th>Dependant variate</th>
<th>Fitted parameters</th>
<th>Estimate</th>
<th>se</th>
<th>RSD</th>
<th>R</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greasy fleece weight</td>
<td>Constant (doe)</td>
<td>-1081</td>
<td>463</td>
<td>216</td>
<td>0.66</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Mean fibre diameter</td>
<td>69.6</td>
<td>15.1</td>
<td>1.6 x 10^{-5}</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pre-shearing live weight</td>
<td>32.6</td>
<td>9.04</td>
<td></td>
<td></td>
<td>0.00057</td>
</tr>
<tr>
<td></td>
<td>Sex (wether)</td>
<td>121.8</td>
<td>56</td>
<td></td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Staple length</td>
<td>3.9</td>
<td>1.98</td>
<td></td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

3.2.3 Discussion
There were limited effects of supplementary feeding and the most important impact was negative with an increased quantity of stained mohair. Beneficial effects from supplementary feeding were small and of little commercial significance (see Chapter 2). As there were no effects of feeding level or feeding period, all the impacts both positive and negative could be obtained from the shortest feeding period at the lowest level of feeding.

Under the conditions of this experiment there was no evidence that supplementary feeding provided any economic or production benefit. If nutrition was to impact on mohair production or quality it would need to be applied for longer periods and/or at a greater level perhaps via different feed sources than evaluated in the present experiment.

3.3 Effect of longer periods of supplementary feeding in winter and use of protein supplements

3.3.1 Introduction
Based on the results of the 2003 experiment it was decided to evaluate:
1. longer periods of supplementary feeding;
2. supplementary feeding at a greater level of energy provision; and
3. the feeding of sweet lupins as a source of higher levels of protein.

For comparative purposes there were two treatments that replicated the treatments applied in 2003. This experiment was conducted at the same location as the 2003 experiment. Rainfall data is provided in Table 3.1

3.3.2 Materials and Methods
3.3.2.1 Animals
Angora weaners born September 2003 and shorn 16 February 2004 (does $n = 48$, wethers $n = 30$). The experimental goats were grazed with 22 goats that were not part of this experiment.

3.3.2.2 Design
There were six treatments each with 13 replicates each of one animal. Within sex, animals were blocked on live weight into blocks of 6. From each block animals were randomly allocated to a treatment.

Unfortunately this experiment began under conditions of worsening drought and the proposed treatment design was adjusted to accommodate these conditions. Thus the Control needed to be fed to maintain live weight and the Drought feeding treatment was moved to an adjoining paddock with the non-experimental goats to ensure sufficient pasture remained for the other treatments. Effectively the Control and Drought treatments were similar but grazed in different paddocks.
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Grazing only until 4th June, then grazing plus barley fed at 230 g/d until shearing</td>
</tr>
<tr>
<td>Drought feeding</td>
<td>Grazing in different paddock and fed barley grain at 230 g/d for 4 months from May until shearing</td>
</tr>
<tr>
<td>Barley 1</td>
<td>Whole barley grain fed at the rate 230 g/d for 2 months before shearing in late August (same as L2P2 in 2003)</td>
</tr>
<tr>
<td>Barley 2</td>
<td>Whole barley fed at 230 g/d for 2 months from May</td>
</tr>
<tr>
<td>Lupins 1</td>
<td>Whole lupins and barley fed at the rate of 350 g/d for 2 months from May</td>
</tr>
<tr>
<td>Lupins 2</td>
<td>Whole lupins and barley fed at the rate of 350 g/d for 4 months from May until shearing</td>
</tr>
</tbody>
</table>

3.3.2.3 Feeding
The key feeding dates were:
- 19th May 2004, feeding began for Barley 2, Lupins 1 and Lupins 2 and Drought feeding.
- 6th July 2004, feeding for Barley 2 and Lupins 1 finished and feeding for Barley 1 began.
- 22nd August 2004, feeding finished for Barley 1, Drought and Lupins 2 treatments.

For Lupins 1 and Lupins 2 treatments, lupins and barley were fed as a 50/50 mix. All grain was measured to the nearest 5 g.

3.3.2.4 Management
All goats were fed individually in pens except for the Drought treatment which was group fed at pasture. The procedure was that every two days all goats were moved into a covered shed where individual pens were positioned. All goats for one treatment were given a different colour mark on their heads that enabled rapid drafting. Each treatment was then individually penned and fed their grain in a metal feed bin. When the grain had been eaten the goats were placed in a holding yard and not released back to grazing until all feeding had been completed. The control group remained yarded until all grain had been fed. Any grain residues were collected and weighed. Grain was introduced gradually following best practice recommendations (McGregor 1998) and crushed limestone added at the rate of 1.5%.

Introduction of whole lupins was slow and rejection of whole lupins by some goats resulted in a higher proportion of barley being fed during the introduction period. Goats were provided with free access to a multi mineral block (Furneys Trace Mineral Block, Dubbo) at all times.

All kids were given an anti-lice treatment following their first shearing on 16th February 2004. Goats were drenched twice, on 3rd June and 19th August 2004 and crutched and wigged on 17th June 2004.

All goats were weighed on 6th May for treatment allocation and at intervals of approximately 4 weeks until shearing on 23rd August 2004 and then at approximately two and twelve weeks after shearing. Herbage availability and composition were visually estimated at the start, when feeding changed and at shearing. Grains were sampled during the feeding period and a bulked sample tested at FeedTest.

Fleece measurements as described earlier were conducted with the addition of an estimate of mohair mid side staple strength obtained using the OFDA2000. Grazing behaviour at pasture following grain feeding on 31st May was observed using binoculars at three and seven hours after feeding.
3.3.2.5 **Statistical analysis**
Data were analysed using Genstat Release 7.2 (Genstat Committee 2002). As preliminary analysis showed that only the Lupin 2 treatment differed from the control, the treatment structure was amended. The final analysis used the treatment structure (Lupin 2/Treatment). In this symbolic notation, ‘/’ represents the levels of one factor being defined only within the level of another factor (i.e. nesting). Pre-experimental data available for use as covariates in the analysis included: Genetic strain background (% Texan, % South African, % Australian); live weight at weaning in January. No covariates were significant in the analysis.

3.3.3 Results

3.3.3.1 **Herbage availability**
Herbage availability throughout the period averaged about 300 kg DM/ha of green pasture, mostly native grasses and 1000 kg DM/ha of dead grass. Approximately half of the dead grass had been killed by frosts.

3.3.3.2 **Rations**
For barley grain, and lupin grain respectively the dry matter content was 89.3% and 91.7% and chemical composition (g/kg DM) was: CP 80, 317; ADF 52, not measured; predicted DM digestibility (%DMD) 84.2, 83.8; and predicted ME 12.4, 13.1 MJ/kg DM.

3.3.3.3 **Grazing behaviour**
Three hours after grain feeding (1300 hr) 54% of goats were resting and 46% grazing. Of those grazing only 6 of the 46 had been grain fed in the morning. Seven hours after grain feeding (1700 hr) 94% of goats were grazing and of the six resting three had been fed.

3.3.3.4 **Live weight**
The mean (± sd) live weight of the goats at the start of the experiments was 17.8 (± 2.8) kg.
Live weight change of treatments during the feeding period is shown in Figure 3.2. As there was no statistical difference between the Control and the Drought feeding treatments, their live weights have been pooled and graphed. There were no treatments effect on live weight in June (day 22) but by day 48 there were significant differences, with Lupin 2 heavier than all other treatments combined (P = 4.7 x 10^{-5}) and Lupin 1 was heavier than Barley 1, Control and Drought fed goats. By day 93 (end of experiment) Lupin 2 were significantly heavier than other treatments (P = 3.1 x 10^{-5}) and Barley 1 and Lupin 1 were marginally heavier than the Control and Drought fed goats (P < 0.06). Lupin 2 goats were heavier than other goats on 2 Sept (P = 2.9 x 10^{-5}) but by 11 November there was no difference between treatments.

![Figure 3.2. Change in mean live weight of Angora weaners grazed on pasture (control) or fed barley or lupin grain supplements at different levels for 2 or 4 months in winter.](image-url)
3.3.3.4 Mohair production and quality

Both greasy and clean mohair production of the Lupin 2 treatment was significantly higher than other treatments with production 0.24 kg or 16% greater (Table 3.6). Treatment did not affect mohair clean washing yield, staple length or staple strength (Table 3.6).

Table 3.6. Effect of supplementary feeding barley or lupin grain at two levels and for two time periods on mohair production, washing yield, staple length and strength.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Greasy fleece weight kg</th>
<th>Clean washing yield %</th>
<th>Clean fleece weight kg</th>
<th>Staple length cm</th>
<th>Staple strength N/ktex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lupins 2</td>
<td>1.70</td>
<td>76.1</td>
<td>1.29</td>
<td>14.6</td>
<td>40.4</td>
</tr>
<tr>
<td>Other treatments</td>
<td>1.46</td>
<td>76.6</td>
<td>1.12</td>
<td>14.2</td>
<td>41.7</td>
</tr>
<tr>
<td>sed L2 - other treatments</td>
<td>0.046</td>
<td>1.19</td>
<td>0.029</td>
<td>0.43</td>
<td>1.43</td>
</tr>
<tr>
<td>P value L2 - other treatments</td>
<td>1.9 x 10^{-6}</td>
<td>0.65</td>
<td>3.2 x 10^{-7}</td>
<td>0.42</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Within other treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Greasy fleece weight kg</th>
<th>Clean washing yield %</th>
<th>Clean fleece weight kg</th>
<th>Staple length cm</th>
<th>Staple strength N/ktex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>1.47</td>
<td>76.1</td>
<td>1.13</td>
<td>14.0</td>
<td>40.8</td>
</tr>
<tr>
<td>Drought feeding</td>
<td>1.48</td>
<td>76.6</td>
<td>1.13</td>
<td>14.3</td>
<td>43.3</td>
</tr>
<tr>
<td>Barley 1</td>
<td>1.39</td>
<td>76.9</td>
<td>1.07</td>
<td>14.3</td>
<td>40.7</td>
</tr>
<tr>
<td>Barley 2</td>
<td>1.44</td>
<td>76.2</td>
<td>1.09</td>
<td>14.1</td>
<td>42.8</td>
</tr>
<tr>
<td>Lupins 1</td>
<td>1.50</td>
<td>77.3</td>
<td>1.15</td>
<td>14.4</td>
<td>40.9</td>
</tr>
<tr>
<td>sed all treatments</td>
<td>0.060</td>
<td>1.19</td>
<td>0.038</td>
<td>0.56</td>
<td>1.85</td>
</tr>
<tr>
<td>P value all treatments</td>
<td>0.44</td>
<td>0.94</td>
<td>0.16</td>
<td>0.94</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Lupin 2 fed goats produced mohair that was coarser than mohair produced by other treatments (Table 3.7). There were no other treatment effects on mohair fibre diameter or fibre diameter variability (Table 3.7).

Table 3.7. Effect of supplementary feeding barley or lupin grain at two levels and for two time periods on mohair fibre diameter and fibre diameter variability.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean fibre diameter μm</th>
<th>Fibre diameter SD μm</th>
<th>Fibre diameter CV %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lupins 2</td>
<td>23.8</td>
<td>5.79</td>
<td>24.4</td>
</tr>
<tr>
<td>Other treatments</td>
<td>22.5</td>
<td>5.59</td>
<td>25.0</td>
</tr>
<tr>
<td>sed L2 - other treatments</td>
<td>0.57</td>
<td>0.244</td>
<td>1.00</td>
</tr>
<tr>
<td>P value L2 - other treatments</td>
<td>0.028</td>
<td>0.42</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Within other treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean fibre diameter μm</th>
<th>Fibre diameter SD μm</th>
<th>Fibre diameter CV %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>22.3</td>
<td>5.52</td>
<td>24.8</td>
</tr>
<tr>
<td>Drought feeding</td>
<td>22.7</td>
<td>5.47</td>
<td>24.2</td>
</tr>
<tr>
<td>Barley 1</td>
<td>22.1</td>
<td>5.99</td>
<td>27.1</td>
</tr>
<tr>
<td>Barley 2</td>
<td>22.7</td>
<td>5.53</td>
<td>24.5</td>
</tr>
<tr>
<td>Lupins 1</td>
<td>22.6</td>
<td>5.46</td>
<td>24.2</td>
</tr>
<tr>
<td>sed all treatments</td>
<td>0.57</td>
<td>0.316</td>
<td>1.29</td>
</tr>
<tr>
<td>P value all treatments</td>
<td>0.91</td>
<td>0.41</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Lupin 2 fed goats produced mohair that contained a higher incidence of medullated fibre and which had a marginally lower fibre curvature than mohair produced in other treatments (Table 3.8). There were no other treatment effects on the incidence of medullated fibre or fibre curvature or curvature variability (Table 3.8).
Table 3.8. Effect of supplementary feeding barley or lupin grain at two levels and for two time periods on the incidence of medullated fibre, mohair fibre curvature and fibre curvature variability.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Medullated fibre %number</th>
<th>Medullated fibre % w/w</th>
<th>Fibre curvature Degree/mm</th>
<th>Fibre curvature SD Degree/mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lupins 2</td>
<td>0.534</td>
<td>1.32</td>
<td>15.9</td>
<td>17.2</td>
</tr>
<tr>
<td>Other treatments</td>
<td>0.406</td>
<td>1.08</td>
<td>17.1</td>
<td>18.5</td>
</tr>
<tr>
<td>sedL2 - other treatments</td>
<td>0.0578</td>
<td>0.152</td>
<td>0.70</td>
<td>0.86</td>
</tr>
<tr>
<td>P valueL2 - other treatments</td>
<td>0.03</td>
<td>0.12</td>
<td>0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>Within other treatments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>0.429</td>
<td>1.27</td>
<td>17.6</td>
<td>17.6</td>
</tr>
<tr>
<td>Drought feeding</td>
<td>0.429</td>
<td>1.05</td>
<td>17.4</td>
<td>18.4</td>
</tr>
<tr>
<td>Barley 1</td>
<td>0.371</td>
<td>10.9</td>
<td>16.6</td>
<td>19.6</td>
</tr>
<tr>
<td>Barley 2</td>
<td>0.441</td>
<td>1.17</td>
<td>16.7</td>
<td>18.4</td>
</tr>
<tr>
<td>Lupins 1</td>
<td>0.360</td>
<td>0.83</td>
<td>17.2</td>
<td>18.8</td>
</tr>
<tr>
<td>sedall treatments</td>
<td>0.0746</td>
<td>0.196</td>
<td>0.90</td>
<td>1.11</td>
</tr>
<tr>
<td>P valueall treatments</td>
<td>0.73</td>
<td>0.25</td>
<td>0.74</td>
<td>0.52</td>
</tr>
</tbody>
</table>

When all the data for greasy fleece weight were pooled and analysed by multiple regression there was a significant relationship between greasy fleece weight and other attributes of mohair (Table 3.9). Regression constants indicated that:

- for each 1 μm increase in mean fibre diameter, greasy fleece weight increased 32 g;
- for each 1 kg increase in pre-shearing live weight greasy fleece weight increased 28 g;
- for each 1 % increase in clean washing yield greasy fleece weight decreased 20 g.

Sex, staple length, genetic background and fibre curvature not significant, P > 0.15.

Table 3.9. Regression constants, correlation coefficient and probability (P) for relationships between greasy fleece weight (g) and mean fibre diameter (μm), washing yield (%) pre-shearing live weight (kg) (Pooled data, n = 70).

<table>
<thead>
<tr>
<th>Dependant variate</th>
<th>Fitted parameters</th>
<th>Estimate</th>
<th>se</th>
<th>RSD</th>
<th>R</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greasy fleece weight</td>
<td>Constant</td>
<td>1772</td>
<td>390</td>
<td>135</td>
<td>0.77</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Mean fibre diameter</td>
<td>32.1</td>
<td>8.66</td>
<td></td>
<td></td>
<td>0.00043</td>
</tr>
<tr>
<td></td>
<td>Pre-shearing live weight</td>
<td>27.9</td>
<td>5.43</td>
<td></td>
<td></td>
<td>2.7 x 10^-6</td>
</tr>
<tr>
<td></td>
<td>Clean washing yield</td>
<td>-20.23</td>
<td>4.47</td>
<td></td>
<td></td>
<td>2.5 x 10^-5</td>
</tr>
</tbody>
</table>

3.3.4 Discussion
The limited observations of the grazing behaviour of these goats suggest that the goats substituted grain for grazing. In other words, goats that received supplementary grain spent less time grazing compared with goats that were not supplementary fed. This does not necessarily mean that they ate less pasture as their rate of eating could have been higher but on the balance of probabilities it is likely that supplemented goats ate less pasture although their total intake is likely to have been higher.

Supplementation with lupins increased the live weight of goats during winter. Goats fed lupins and barley at 350 g/d for four months gained weight in a linear fashion throughout the entire winter period demonstrating that Angora goat weaners can grow during winter if their requirements for growth are satisfied. This live weight response to a high level of lupin feeding during winter is similar to that described for Australian cashmere goats (McGregor
in a situation where goats that only grazed or who were fed poor quality hay only maintained live weight. Feeding barley at 230 g/d for short periods only marginally influenced live weight in the July to August period.

The impact of supplementary feeding lupins and barley at 350 g/d for four months was a 16% increase in mohair production that was almost totally a result of the 1.3 μm increase in mean fibre diameter. This increase in mean fibre diameter increased mohair cross-sectional area by 11.9% and along with the small change in staple length of 2.8% (see Tables 3.6 and 3.7) accounted for most of the increase in fleece weight. There was a small non-commercial change in the incidence of medullated fibre, probably associated with the increase in the mean fibre diameter.

Feeding small amounts of barley or changing the timing of barley feeding was no different to the drought feeding and control treatments, which is not surprising as they effectively received the same quantity of grain feeding. Unfortunately the drought conditions limited the ability to examine other variations in feeding.

In practice, these findings reinforce previous research with Australian Angora goats and with Merino sheep that show an increase in fleece growth can be obtained if feed intake is increased during the winter half year. The best way to achieve this outcome is to increase green pasture availability. Mohair producers should evaluate their current pasture management systems, particularly fertilizer practices, grazing management and pasture species in an effort to optimise their grazing resources, as pasture is usually the cheapest and easiest form of feeding grazing animals in Australia. Associated with this broad approach would be improved training for mohair producers in pasture management by attendance at Prograze courses.

In addition, the management of internal parasite infections in weaned goats also needs to be optimised. Internal parasite infections are widespread on sheep and goat properties in southern Australia and can cause large economic losses.

3.4 Response to supplementary feeding during winter
A field example of the response to the supplementary feeding of Angora goats during winter is provided. This example was obtained during the current project using modern Australian Angora wether goats. There is no ability to obtain replication or a non-grain fed control treatment.

The goats were losing live weight during late autumn and into early winter in response to the lack pasture (Figure 3.3). Green pasture availability was low (less than 400 kg DM/ha) between April and mid July and only increased substantially from mid-August. Grain feeding was introduced gradually in April and increased after assessment and weighing in early June when it was apparent that the goats were still loosing weight. Note that the live weight includes fleece weight so the actual fleece-free body weight would have declined slightly between May and June. The amount of grain fed was increased to approximately half maintenance energy requirements equal to 200 g/d (150 g/d barley and 50 g/d lupins). The goats began gaining live weight and by late August, when spring pasture growth was apparent, grain feeding was phased out over a two weeks with no negative affect on live weight gain.
Figure 3.3. Live weight change (mean ± s.e.) during winter of Angora wethers grazing annual pasture and then fed about half maintenance levels of supplementary grain.
4. Impact of shearing frequency and genetic strain on mohair fleece growth and mohair quality attributes

4.1 Materials and methods

4.1.1 Location and environmental conditions
Animals were grazed on annual temperate pastures at the Department of Primary Industry, Attwood, Victoria (37°40’S, 144°53’E, altitude 135 m). The soils are based on weathered granite. Fresh water was provided in all paddocks. Shelter was available in the form of covered and enclosed shedding that was always accessible and could accommodate all goats. Daily rainfall records were available from a Bureau of Meteorology station located 2.5 km to the west of the site with records taken hourly and and long-term average rainfall data available since 1970.

4.1.2 Animals
Angora wethers born in September 2002 at Horsham Victoria, as part of the RIRDC Project DAV 191A ‘Developing a model for progeny testing mohair sires’, were purchased. These goats were the progeny of 11 sires that were evaluated during that project and detailed records of sire line, birth weight, birth type, live weight gain, fleece growth and fleece quality were available. Following shearing in February 2004, the goats were transported to Attwood.

4.1.3 Design
There were 21 treatments each with four or eight replicates:

- 7 Shearing treatments x 3 Genetic strains of Angora goat x 12 or 24 replicates of individual goats.

The Shearing treatments were:

- Three treatments of six month shearing intervals each with different months of shearing: February-August, April-October and June-December;
- Two treatments each of 12 months shearing intervals each with different months of shearing: August-August, September-September;
- One treatment of 3 month shearing interval (Often treatment); and
- One treatment with a seven-month winter shearing interval, February-September.

Genetic strain was based on sire line as follows:

- South African: Sires 100% South African bloodline;
- Texan: Sires 100% Texan bloodline; and
- Mixed: Sires 50% South African and 37.5 to 50% Texan and 0 to 12.5% Australian.

The replicates were allotted as follows: from each block of eight animals with similar initial live weight and of the same genetic strain, two were randomly allocated to the Often treatment and one was randomly allocated to each of the other treatments by using Genstat (Genstat Committee 2002). Each treatment had 3 South African, 4 Texan and 5 Mixed strain goats giving a total of 12 replicates per treatment except for the Often treatment which had double these numbers. The total number of wethers used was 96.
4.1.4 Management
Goats were grazed on improved annual pasture at near the recommended stocking rate. The grazing area was divided into six similar sized 2 ha paddocks and the goats were moved into an new paddock every week or more frequently when conditions required a change. During the first year the season was affected by drought and supplementary feeding was provided for several months to maintain live weight according to the recommendations for drought feeding goats (McGregor 2003, 2005). A Fosforlic Mineralised Stock Block (Ridley AgriProducts Pty. Ltd.) with the following content was always available: Minimum content Ca 4.9%; P 1%; S 2%; Cu 600 mg/kg; Co 60 mg/kg; I 60 mg/kg; Zn 1000 mg/kg; Fe+2 1100 mg/kg; Se 5 mg/kg; based on NaCl 75 to 85%.

Goats were given a full crutching and wigging three months prior to any full shearing or every three months for the treatments shorn annually. As the goats in the Often treatment were shorn every three months they were not crutched. Goats were also vaccinated against Clostridia spp. annually and provided an effective antihelmintic to control internal parasites.

All goats were weighed to the nearest 0.2 kg every month and one day prior to any shearing. At weighing body condition score was also recorded. All goats were then fasted overnight prior to any shearing or crutching. Goats were returned to pasture together as one mob when shearing was completed.

4.1.5 Mohair evaluation
At crutching and shearing, fleeces, pieces, bellies and locks and samples were weighed to the nearest 1 g. Mid side samples were taken at shearing and placed into a plastic bag with identifier and stored.

In the laboratory a range of objective and subjective evaluations were completed on the mid side sample prior to testing the sample (Table 4.1, Photos 4.1 to 4.3). Three staples from the mid side sample were randomly chosen and assessed in the following order: staple definition, tippiness, style, character, entanglement, staple length. The assessed length was not the longest fibres in the staple tip but was subjectively determined with the aim of measuring to the point where most of the fibres were present before any significant narrowing of the staple near the tip.

Following laboratory evaluation, the mid side samples were tested for clean washing yield, and mean fibre diameter, fibre diameter variation, fibre curvature and medullated fibre content using the OFDA100. Clean fleece weight was determined as: total greasy fleece weight kg x clean washing yield %.
Table 4.1 Table of traits assessed during the shearing experiment

<table>
<thead>
<tr>
<th>Trait</th>
<th>Measurement or score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live weight</td>
<td>To the nearest 0.2 kg using electronic scales</td>
<td>Goats removed from pasture at 9 am and weighed.</td>
</tr>
<tr>
<td>Body condition score</td>
<td>Scored from 1 to 5 with intermediate scores: eg. 2+ = 2.3; 3+ = 2.7</td>
<td>Palpating lumbar vertebra using industry practice (see McGregor 2005).</td>
</tr>
<tr>
<td>Greasy fleece weight</td>
<td>To nearest g using electronic scales</td>
<td>The entire fleece weighed following shearing or crutching.</td>
</tr>
</tbody>
</table>
| Staple definition   | 5; well defined staple from base to tip, free separate staples  
                      4; some cross fibres  
                      3; lots of cross fibres holding the base of staples together  
                      2; bases of staples merge into larger clumps  
                      1; no clear staples, large mass | For the definition or clarity of the staple formation as viewed from the underside (cut side). The presence of cross fibres is seen by slowly uplifting the edge of the fleece. In fleeces with free staples (score 5) the fleece falls apart whereas score 1 the fleece is a large mass where no individual staple can be seen. Examples shown in Photo 4.3. |
| Tippedness          | Range from 5; blocky tip, to 1; long thin tip. | The degree of staple length uniformity based on the blockiness of the staple tip. Examples shown in Photo 4.1. |
| Style               | Count to nearest 0.5 | Mean of three mid-side staples of the number of twists along the staple.                                                                     |
| Character           | Count to nearest 0.5 | Mean of three mid-side staples of the number of crimps (waves) along the staple.                                                             |
| Entanglement        | 5; long free fibres easily separated as no adhesions  
                      4; some adhesions between fibres  
                      3; some effort to separate fibres as many adhesions  
                      2; many adhesions, staple fibres entangled, shortening of staple  
                      1; very entangled and shortened staple, overcrimping evident | The degree of staple fibre entanglement and adhesions. Very entangled staples (often called scratchy or spongy staples) are very shortened due to cross fibre adhesions. Examples shown in Photo 4.2. |
| Staple length       | To nearest 0.5 cm | Staples removed from mid side sample. Staple fibres straightened by removal of crimps, twists and adhesions. Stretched along ruler. Judgment as to where majority of fibres end. |
| Cottedness          | 1 to 5  
                      1 = very cotted; 5 = no cotts | The presence of actual cotted fibre in the fleece. |

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Photo 4.1. Examples of different tippiness scores in mohair showing the variation in the appearance of the staple.

Photo 4.2. Examples of different entanglement scores in mohair showing the variation in the appearance of the staple.
Photo 4.3. Examples of mohair illustrating different staple definition scores.

Staple definition score 4. Some cross fibres can be seen joining different staples.

Staple definition score 2. Many cross fibres have resulted in the bases of adjoining staples merging into large aggregations with the result that the individual staples cannot be seen.

Staple definition score 1. There are so many cross fibres and all the staples have aggregated and joined together that the fleece is effectively one large mass. When the fleece is picked up no staples fall out.
4.1.6 Statistical analysis
Fleece-free live weights were determined by subtracting the estimated greasy fleece weight from the recorded live weight assuming that fleece growth rate followed the pattern exhibited by the Often shorn treatment. In other words if the mohair growth rate was low in winter for the Often treatment then a similar proportion of the total annual greasy fleece growth was assumed to apply in other treatments. Fleece-free live weights are more reliable for analysis as they overcome the differences in live weight resulting from annual harvests where for example a 4 kg fleece is removed compared with harvesting a 1 kg fleece every three months.

For most variates the values analysed were the sum of the values determined during the period of analysis eg greasy fleece weights, staple length, character, style. For some variates the average measurement was determined by averaging the values determined during the time period eg fleece-free live weight, body condition score. For fibre diameter attributes the weighted average was determined eg the value at any one shearing was multiplied by the greasy fleece weight and the sum of these was dividing by the sum of greasy fleece weights for the period under analysis.

Measurements relating to the whole period of February 2004 to February 2006 were analysed using analysis of variance of the form presented in Table 4.2. Covariates were selected according to whether they substantially reduced the residual variation in the animal stratum, from measurements taken prior to the allocation of animals to this experiment. Inference is restricted to responses to different shearing regimes, and to differences between genetic strain in these responses, because some of the covariates differ between breeds. Thus breed main effects are confounded with covariates. The total number of shearings during this period varied from 3 to 8.

Measurements relating to the period spring 2004 shearing to spring 2005 shearing were analysed using analogous analyses of variance, but with the June-December shearing treatment excluded from the analysis and with total number of shearings replaced by number of shearings per year. This analysis was undertaken to more clearly identify the effects of shearing within a year as the number of shearings was either 1, 2 or 4.

Table 4.2. Analysis of variance terms and degrees of freedom (d.f.) for measurements relating to the two-year period from February 2004 to February 2006.

<table>
<thead>
<tr>
<th>Terms</th>
<th>d.f.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Block Stratum</strong></td>
<td></td>
</tr>
<tr>
<td>Genetic strain</td>
<td>2</td>
</tr>
<tr>
<td>Covariates</td>
<td>0-3</td>
</tr>
<tr>
<td>Residual</td>
<td>6-9</td>
</tr>
<tr>
<td><strong>Animal Stratum</strong></td>
<td></td>
</tr>
<tr>
<td>Shearings (total over experiment)</td>
<td>3</td>
</tr>
<tr>
<td>Linear</td>
<td>1</td>
</tr>
<tr>
<td>Deviations</td>
<td>2</td>
</tr>
<tr>
<td>Genetic strain . Shearings</td>
<td>6</td>
</tr>
<tr>
<td>Breed . linear</td>
<td>2</td>
</tr>
<tr>
<td>Deviations</td>
<td>4</td>
</tr>
<tr>
<td>Time of shearing (within same number of shearings)</td>
<td>3</td>
</tr>
<tr>
<td>Genetic strain . Time of shearing</td>
<td>6</td>
</tr>
<tr>
<td>Covariates</td>
<td>0-3</td>
</tr>
<tr>
<td>Residual</td>
<td>63-66</td>
</tr>
</tbody>
</table>
4.2 Results

4.2.1 Rainfall

The monthly totals and long-term average rainfall at the site are given in Table 4.3.

Table 4.3. Monthly rainfall and long term mean monthly rainfall recorded at the Melbourne International Airport, 2.5 km west of the experimental site (37°40'S, 144°51'E) during the period of the experiment.

<table>
<thead>
<tr>
<th>Month</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>Long term mean¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>23.4</td>
<td>50.6</td>
<td>43.6</td>
<td></td>
</tr>
<tr>
<td>February</td>
<td>200.6</td>
<td>58.6</td>
<td>39.4</td>
<td></td>
</tr>
<tr>
<td>March</td>
<td>20.2</td>
<td>6.6</td>
<td>37.8</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>49.0</td>
<td>26.0</td>
<td>46.8</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>18.2</td>
<td>8.0</td>
<td>42.1</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>24.2</td>
<td>31.0</td>
<td>39.6</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>27.8</td>
<td>21.0</td>
<td>36.7</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>69.4</td>
<td>57.6</td>
<td>46.5</td>
<td></td>
</tr>
<tr>
<td>September</td>
<td>47.8</td>
<td>39.4</td>
<td>48.4</td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>45.2</td>
<td>69.0</td>
<td>57.7</td>
<td></td>
</tr>
<tr>
<td>November</td>
<td>113.0</td>
<td>64.6</td>
<td>57.8</td>
<td></td>
</tr>
<tr>
<td>December</td>
<td>59.2</td>
<td>48.0</td>
<td>47.4</td>
<td></td>
</tr>
<tr>
<td>Annual mean</td>
<td></td>
<td></td>
<td></td>
<td>543.8</td>
</tr>
</tbody>
</table>

¹ For the period from 1970 when records began until the end of 2004

4.2.2 Live weight and body condition score

The changes in live weight are shown in Figures 4.1 and 4.2. No affect of shearing treatment or of genetic strain were detected on average or final fleece-free live weight (Table 4.4, 4.5).
Figure 4.1. The mean live weight of Angora goats in the different shearing treatments at different ages. Live weight includes any fleece present at the time of weighing. The treatment s.e.d. is plotted with the treatment shorn four times per year.

Figure 4.2. The change in live weight of three genetic strains of Angora goats. The s.e.d. is plotted with mixed strain treatment.

Changes in body condition score are shown in Figures 4.3 and 4.4. No affect of shearing treatment or of genetic strain were detected on average or final body condition score (Table 4.4, 4.5).
Figure 4.3. The mean body condition score of Angora goats in the different shearing treatments at different ages. The treatment s.e.d. is plotted with the treatment shorn four times per year.

Figure 4.4. The change in body condition score of three genetic strains of Angora goats. The s.e.d. is plotted with mixed strain treatment.
4.2.3 Mohair production and quality

The mean, s.d., and range for average live weight and for mohair attributes for goats in the treatments shorn twice each year are provided in Table 4.4. These values are the average production at each shearing. Thus the average annual greasy mohair production was 4.86 kg, and average clean fleece production was 4.20 kg.

Table 4.4. Mean, standard deviation and range in average live weight and for the measured attributes at each shearing, of mohair produced by goats in treatments shorn twice annually (n=48).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average live weight (kg)</td>
<td>34.1</td>
<td>4.19</td>
<td>23.8</td>
<td>44.3</td>
</tr>
<tr>
<td>Greasy fleece weight (kg)</td>
<td>2.43</td>
<td>0.331</td>
<td>1.88</td>
<td>3.13</td>
</tr>
<tr>
<td>Clean washing yield (%w/w)</td>
<td>86.6</td>
<td>3.95</td>
<td>77.1</td>
<td>94.6</td>
</tr>
<tr>
<td>Clean fleece weight (kg)</td>
<td>2.10</td>
<td>0.268</td>
<td>1.55</td>
<td>2.62</td>
</tr>
<tr>
<td>Staple length (cm)</td>
<td>13.8</td>
<td>0.77</td>
<td>11.9</td>
<td>15.8</td>
</tr>
<tr>
<td>Staple definition</td>
<td>3.5</td>
<td>0.44</td>
<td>2.75</td>
<td>4.6</td>
</tr>
<tr>
<td>Style</td>
<td>0.6</td>
<td>0.31</td>
<td>0.13</td>
<td>1.25</td>
</tr>
<tr>
<td>Character</td>
<td>11.5</td>
<td>1.99</td>
<td>7.75</td>
<td>16.25</td>
</tr>
<tr>
<td>Tippiness</td>
<td>2.7</td>
<td>0.74</td>
<td>1.0</td>
<td>4.25</td>
</tr>
<tr>
<td>Entanglement</td>
<td>3.6</td>
<td>0.63</td>
<td>2.25</td>
<td>4.50</td>
</tr>
<tr>
<td>Mean fibre diameter (MFD, µm)</td>
<td>31.5</td>
<td>2.61</td>
<td>26.4</td>
<td>37.6</td>
</tr>
<tr>
<td>Fibre diameter coefficient of variation (%)</td>
<td>24.8</td>
<td>3.56</td>
<td>17.7</td>
<td>31.3</td>
</tr>
<tr>
<td>Fibre curvature (degree/mm)</td>
<td>13.1</td>
<td>2.21</td>
<td>9.6</td>
<td>18.5</td>
</tr>
<tr>
<td>Medullated fibre incidence (% number)</td>
<td>1.53</td>
<td>0.506</td>
<td>0.61</td>
<td>2.89</td>
</tr>
</tbody>
</table>

4.2.3.1 Shearing frequency effects

Increasing the frequency of shearing affected almost every measured attribute of mohair (Tables 4.5, 4.6). Increasing the frequency of shearing resulted in linear changes in most fleece attributes with deviations from linear changes detected for several attributes.

There was little evidence of meaningful differences between shearing regimes within the same number of shearings for the two-year analyses (Table 4.7), with affects detected for only fibre diameter coefficient of variation, number of medullated fibres and staple tip. Other variates such as mean fibre diameter were not affected. There was little evidence of meaningful differences between shearing regimes within the same number of shearings per year for the one-year spring to spring analyses.

Tippiness scores in the present experiment were the lowest in the April/October shearing treatment during the shearing in October (Table 4.7). This occurred in both years of observation caused by the presence of fibres migrating out of the fleece and in one case forming pills on the surface of the fleece (Photo 4.5).
There was only one fleece that received a cottedness score less than five. This goat was in shearing treatment April-October and was of mixed genetics. This individual October shorn fleece exhibited many loose short fibres but the fibres were free and not cotted.

While tippiness score showed a linear decline with increased shearing frequency over a one year period, there was a significant deviation from this linear response (Table 4.6). In fact tippiness score was highest with one shearing per year and any increase in shearing frequency significantly reduced tippiness and it did not decline further with increased shearing within a year (Table 4.8). Over the two year period there was no significant affect of shearing frequency on tippiness (Table 4.5) and the average values are shown in Table 4.9.

Table 4.8. Effect of number of shearings per year on average tippiness score from spring 2004 to spring 2005

<table>
<thead>
<tr>
<th>Number of shearings per year</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tippiness score</td>
<td>4.0</td>
<td>2.8</td>
<td>2.8</td>
<td>0.19 - 0.21</td>
</tr>
</tbody>
</table>

Table 4.9. Effect of number of shearings on average tippiness score from February 2004 to February 2006

<table>
<thead>
<tr>
<th>Number of shearings</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>8</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tippiness score</td>
<td>3.1</td>
<td>2.9</td>
<td>2.7</td>
<td>2.9</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Average entanglement score showed a linear increase as shearing frequency increased both with in one year and over the two year period (Tables 4.5, 4.6). However there was a significant deviation from linear within one year (Tables 4.6, 4.10) with the main effect being that entanglement did not change much when shearing frequency increased from 1 to 2 per year but increased significantly with four shearings per year.
Table 4.5. The linear changes in attribute measurements for each extra shearings over a two-year period between February 2004 and 2006 following adjustment for covariates. Covariate(s) which were used are shown along with the P value. Bold values significant at less than 0.05.

<table>
<thead>
<tr>
<th>Attribute (unit of measurement)</th>
<th>Linear change per extra shearing</th>
<th>s.e.</th>
<th>P value</th>
<th>Covariate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Linear response</td>
<td>Deviation from linear</td>
</tr>
<tr>
<td>Final fleece-free live weight (kg)</td>
<td>-0.1</td>
<td>0.20</td>
<td>0.468</td>
<td>0.885</td>
</tr>
<tr>
<td>Av fleece-free live weight (kg)</td>
<td>-0.11</td>
<td>0.091</td>
<td>0.186</td>
<td>0.724</td>
</tr>
<tr>
<td>Final condition score</td>
<td>0.04</td>
<td>0.036</td>
<td>0.222</td>
<td>0.177</td>
</tr>
<tr>
<td>Av condition score</td>
<td>0.00</td>
<td>0.017</td>
<td>0.885</td>
<td>0.183</td>
</tr>
<tr>
<td>Greasy fleece weight (g)</td>
<td>121</td>
<td>41.6</td>
<td><strong>0.0055</strong></td>
<td>0.306</td>
</tr>
<tr>
<td>Clean washing yield (%)</td>
<td>0.2</td>
<td>0.12</td>
<td>0.178</td>
<td><strong>0.043</strong></td>
</tr>
<tr>
<td>Clean fleece weight (g)</td>
<td>124</td>
<td>35.5</td>
<td><strong>8.4 x 10^{-4}</strong></td>
<td>0.865</td>
</tr>
<tr>
<td>Total Staple length (cm)</td>
<td>0.82</td>
<td>0.169</td>
<td><strong>9.7 x 10^{-6}</strong></td>
<td>0.204</td>
</tr>
<tr>
<td>Av Mean fibre diameter (μm)</td>
<td>0.21</td>
<td>0.077</td>
<td><strong>0.0072</strong></td>
<td>0.221</td>
</tr>
<tr>
<td>Av Fibre diameter coefficient of variation (%)</td>
<td>0.33</td>
<td>0.107</td>
<td><strong>0.0031</strong></td>
<td>0.698</td>
</tr>
<tr>
<td>Av FC (degree/mm)</td>
<td>-0.17</td>
<td>0.071</td>
<td><strong>0.041</strong></td>
<td>0.704</td>
</tr>
<tr>
<td>Total character</td>
<td>-1.4</td>
<td>0.31</td>
<td><strong>4.1 x 10^{-5}</strong></td>
<td>0.221</td>
</tr>
<tr>
<td>Total style</td>
<td>0.26</td>
<td>0.066</td>
<td><strong>2.4 x 10^{-4}</strong></td>
<td>0.684</td>
</tr>
<tr>
<td>Av Staple definition</td>
<td>0.11</td>
<td>0.020</td>
<td><strong>8.6 x 10^{-7}</strong></td>
<td>0.187</td>
</tr>
<tr>
<td>Av Entanglement</td>
<td>0.31</td>
<td>0.024</td>
<td><strong>8.7 x 10^{-19}</strong></td>
<td>0.288</td>
</tr>
<tr>
<td>Av Tippiness score</td>
<td>-0.04</td>
<td>0.032</td>
<td>0.271</td>
<td>0.159</td>
</tr>
</tbody>
</table>
Table 4.6. The linear changes in attribute measurements for each extra shearing over a one year period between spring 2004 and spring 2005 following adjustment for covariates. Covariate(s) which were used are shown along with the P value. Bold P values significant at less than 0.05, italic P value significance between 0.05 and 0.1.

<table>
<thead>
<tr>
<th>Attribute (unit of measurement)</th>
<th>Linear change per extra shearing</th>
<th>s.e.</th>
<th>Linear response</th>
<th>Deviation from linear</th>
<th>Linear response differs with breed</th>
<th>Covariate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av fleece-free live weight (kg)</td>
<td>-0.26</td>
<td>0.173</td>
<td>0.127</td>
<td>0.287</td>
<td>0.485</td>
<td>Lwt start, LWtNov03</td>
</tr>
<tr>
<td>Av condition score</td>
<td>-0.01</td>
<td>0.030</td>
<td>0.659</td>
<td>0.162</td>
<td>0.764</td>
<td>Lwt start</td>
</tr>
<tr>
<td>Greasy fleece weight (g)</td>
<td>145</td>
<td>39.8</td>
<td>4.7 x 10⁻⁴</td>
<td>0.490</td>
<td>0.179</td>
<td>GFwt3</td>
</tr>
<tr>
<td>Clean washing yield (%)</td>
<td>0.5</td>
<td>0.22</td>
<td>0.035</td>
<td>0.341</td>
<td>0.758</td>
<td>CWY3</td>
</tr>
<tr>
<td>Av clean fleece weight (g)</td>
<td>153</td>
<td>32.5</td>
<td>1.3 x 10⁻⁵</td>
<td>0.300</td>
<td>0.116</td>
<td>CFwt3</td>
</tr>
<tr>
<td>Total Staple length (cm)</td>
<td>0.60</td>
<td>0.149</td>
<td>0.00020</td>
<td>0.438</td>
<td>0.325</td>
<td>SL3</td>
</tr>
<tr>
<td>Av Mean fibre diameter (μm)</td>
<td>0.32</td>
<td>0.161</td>
<td>0.044</td>
<td>0.147</td>
<td>0.218</td>
<td>MFD2, MFD3</td>
</tr>
<tr>
<td>Av CVD (%)</td>
<td>0.68</td>
<td>0.209</td>
<td>0.0029</td>
<td>0.990</td>
<td>0.274</td>
<td>CV2, MFD3</td>
</tr>
<tr>
<td>Av FC (degree/mm)</td>
<td>-0.30</td>
<td>0.144</td>
<td>0.064</td>
<td>0.582</td>
<td>0.171</td>
<td>FC3, CFwt3</td>
</tr>
<tr>
<td>Av medullated fibres (% number)</td>
<td>0.12</td>
<td>0.044</td>
<td>0.0025</td>
<td>0.787</td>
<td>0.738</td>
<td>Mednum2, FC3</td>
</tr>
<tr>
<td>Total character</td>
<td>-1.4</td>
<td>0.26</td>
<td>1.2 x 10⁻⁶</td>
<td>0.160</td>
<td>0.910</td>
<td>CWY3</td>
</tr>
<tr>
<td>Total style</td>
<td>0.29</td>
<td>0.072</td>
<td>1.7 x 10⁻⁴</td>
<td>0.507</td>
<td>0.851</td>
<td></td>
</tr>
<tr>
<td>AvStaple definition</td>
<td>0.23</td>
<td>0.056</td>
<td>0.00019</td>
<td>0.147</td>
<td>0.111</td>
<td></td>
</tr>
<tr>
<td>Av Entanglement</td>
<td>0.59</td>
<td>0.043</td>
<td>2.0 x 10⁻¹⁴</td>
<td>0.019</td>
<td>0.079</td>
<td></td>
</tr>
<tr>
<td>Av Tippiness score</td>
<td>-0.33</td>
<td>0.069</td>
<td>1.4 x 10⁻⁵</td>
<td>4.3 x 10⁻⁴</td>
<td>0.370</td>
<td>MFD3</td>
</tr>
</tbody>
</table>
Table 4.7. The effects of season within two shearings per year on fleece attributes adjusted for covaritates. Bold P values significant at less than 0.05, italic P value significance between 0.05 and 0.1.

<table>
<thead>
<tr>
<th>Attribute and season</th>
<th>Months of shearing</th>
<th>s.e.d.</th>
<th>P value</th>
<th>Covariates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Feb-Aug</td>
<td>Feb-Sept</td>
<td>Apr-Oct</td>
<td></td>
</tr>
<tr>
<td>Mean fibre diameter Autumn (μm)</td>
<td>32.7</td>
<td>32.3</td>
<td>32.7</td>
<td>0.55</td>
</tr>
<tr>
<td>Mean fibre diameter Spring (μm)</td>
<td>32.4</td>
<td>30.5</td>
<td>31.4</td>
<td>0.80</td>
</tr>
<tr>
<td>Fibre diameter coefficient of variation Autumn (%)</td>
<td>24.6</td>
<td>25.2</td>
<td>21.7</td>
<td>1.02</td>
</tr>
<tr>
<td>Fibre diameter coefficient of variation Spring (%)</td>
<td>22.8</td>
<td>22.6</td>
<td>24.6</td>
<td>0.96</td>
</tr>
<tr>
<td>Medullated fibres Autumn (% number)</td>
<td>1.79</td>
<td>1.77</td>
<td>1.60</td>
<td>0.204</td>
</tr>
<tr>
<td>Medullated fibres Spring (% number)</td>
<td>1.40</td>
<td>1.04</td>
<td>1.52</td>
<td>0.180</td>
</tr>
<tr>
<td>Staple definition Autumn</td>
<td>3.7</td>
<td>3.8</td>
<td>3.7</td>
<td>0.23</td>
</tr>
<tr>
<td>Staple definition Spring</td>
<td>3.2</td>
<td>3.3</td>
<td>3.2</td>
<td>0.32</td>
</tr>
<tr>
<td>Entanglement Autumn</td>
<td>3.8</td>
<td>3.9</td>
<td>3.5</td>
<td>0.28</td>
</tr>
<tr>
<td>Entanglement Spring</td>
<td>2.8</td>
<td>3.1</td>
<td>2.9</td>
<td>0.31</td>
</tr>
<tr>
<td>Tippiness Autumn</td>
<td>2.8</td>
<td>3.0</td>
<td>2.8</td>
<td>0.38</td>
</tr>
<tr>
<td>Tippiness Spring</td>
<td>2.5</td>
<td>3.4</td>
<td>2.0</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Table 4.10. Effect of number of shearings per year on average entanglement score from spring 2004 to spring 2005 for different genetic strains of Angora goat

<table>
<thead>
<tr>
<th>Genetic strain</th>
<th>1</th>
<th>2</th>
<th>4</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texan</td>
<td>2.5</td>
<td>2.8</td>
<td>4.7</td>
<td>0.28-0.30</td>
</tr>
<tr>
<td>Mixed</td>
<td>3.6</td>
<td>3.5</td>
<td>4.8</td>
<td>0.25-0.27</td>
</tr>
<tr>
<td>South African</td>
<td>3.0</td>
<td>3.8</td>
<td>4.8</td>
<td>0.32-0.35</td>
</tr>
<tr>
<td>s.e.d.</td>
<td>0.29-0.33</td>
<td>0.23-0.27</td>
<td>0.29-0.33</td>
<td></td>
</tr>
</tbody>
</table>

4.2.3.3 Genetic strain effects
Only for staple entanglement did the linear response for extra shearings differ with genetic strain (Table 4.5, 4.11). When entanglement was evaluated over two years the response to genetic strain was significant at P = 0.016 and within one year the response was weaker (P = 0.079, Tables 4.6, 4.10). The deviation was caused by Texan strain goats having more staple entanglement (lower scores) at the lower shearing frequencies compared with the other strains but there being no differences in entanglement scores at the higher shearing frequencies.

Table 4.11. Effect of number of shearings on average entanglement score from February 2004 to February 2006 for different genetic strains of Angora goat.

<table>
<thead>
<tr>
<th>Genetic strain</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>8</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texan</td>
<td>2.6</td>
<td>3.0</td>
<td>3.7</td>
<td>4.6</td>
<td>0.23</td>
</tr>
<tr>
<td>Mixed</td>
<td>3.5</td>
<td>3.6</td>
<td>3.8</td>
<td>4.6</td>
<td>0.20</td>
</tr>
<tr>
<td>South African</td>
<td>3.1</td>
<td>3.6</td>
<td>4.1</td>
<td>4.6</td>
<td>0.26</td>
</tr>
<tr>
<td>s.e.d.</td>
<td>0.21-0.24</td>
<td>0.21-0.24</td>
<td>0.21-0.24</td>
<td>0.21-0.24</td>
<td></td>
</tr>
</tbody>
</table>

4.2.4 Seasonal changes in fibre growth and quality

4.2.4.1 Measurements from the Often shorn treatment
The seasonal changes in fibre growth rate, mean fibre diameter and staple length growth rate are shown in Figure 4.5. Fibre growth rate increased during the first nine months and then declined during the following winter before increasing. The main driver for this change appears to be mean fibre diameter with fibre length growth rates being relatively stable.

4.2.4.2 Effect of seven month shearing interval in winter on staple length
The effect on staple length and average greasy fleece weight of extending the winter shearing interval to seven months by reducing the summer shearing interval to five months can be seen in Table 4.12. Increasing the shearing interval during winter significantly increases staple length in spring and reduces the length at the summer shearing. The overall average staple length and average greasy fleece weight were not affected by this manipulation.
Figure 4.5. The seasonal changes in greasy and clean fibre growth rate, mean fibre diameter and fibre length growth for goats shorn every three months. The box plots show the median, upper and lower quartile, 5% and 95% limit (end of bars) and the mean of the upper and lower 5% (open circles) (n=22).

Table 4.12. The effect of extending the winter shearing interval to seven months on staple length at the spring and summer shearing, average staple length and greasy fleece weight.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Staple length (cm)</th>
<th>Average greasy fleece wt (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spring 04*</td>
<td>Feb 05*</td>
</tr>
<tr>
<td>February-August</td>
<td>13.0</td>
<td>15.2</td>
</tr>
<tr>
<td>February-September</td>
<td>14.5</td>
<td>13.0</td>
</tr>
<tr>
<td>s.e.d.</td>
<td>0.30</td>
<td>0.24</td>
</tr>
<tr>
<td>P-value</td>
<td>0.002</td>
<td>$3.5 \times 10^{-5}$</td>
</tr>
</tbody>
</table>

* Adjusted values after the use of significant covariate; staple length at 18 months of age
4.3 Discussion
It is clear that the frequency of shearing (fibre harvesting) affects the attributes of mohair. The direction of these effects were generally favourable and for most attributes the magnitude of the response was linear and of commercial importance. Only one attribute showed a deviation due to genetic strain affect and it is potentially of commercial importance to Australian producers.

4.3.1 Shearing frequency
This experiment compared shearing frequencies ranging from one to four per year and a range of monthly shearing patterns. In Australia, a shearing frequency of two per year is general industry practice in order to provide fleeces with staple lengths of 12 to 15 cm. One shearing per year is also commercially used in several countries including Lesotho, Argentina and for speciality production (wigs, dolls hair) in other countries. One shearing per year was more common in the 19th century. Presently the sale of overgrown mohair is penalised with large discounts (see Table 2.3).

The present research documents the many advantages in fleece production and quality that arise from increasing shearing frequency from once per year to two per year. These advantages increase further with shearing four times per year but the penalty of four shearings per year is the significantly reduced staple length of the harvested mohair making it impossible to achieve B length for sale lines. It may be possible to shear three times each year and still achieve B length mohair thus avoiding large market discounts for C length mohair and possibly avoiding crutching costs but such a practice is not being advocated at this time.

With two shearings per year the evidence is that February/September may be preferable over other combinations. This shearing combination had a spring fleece marginally finer with lower numbers of medullated fibre and a better tip appearance than other combinations without any correspondingly inferior fleece quality in autumn as seen in other shearing combinations. The April/October treatment, for example, had a lower fibre diameter CV in autumn but a higher fibre diameter CV in spring providing no net benefit compared with the other treatments (Table 4.7). In any case, differences in mohair fibre diameter CV currently have no commercial benefit (Chapter 2.4.8.1). The staple tips scores in the April/October treatment at the spring shearing were the lowest measured (Table 4.7) and such low tip scores may result in the fibre being down graded during classing.

Why would a greater shearing frequency result in increased mohair fleece weight? It is likely that the following mechanisms all operate to a greater or lesser degree:
1. Shearing stimulates a cold stress response increasing the metabolic rate resulting in increased feed intake as observed with sheep (Farrell and Corbett 1970, Birrell 1989).
2. Increased feed intake increases fibre growth rate.
3. With annually shorn animals there is more fibre loss from moultng and accumulated UV damage (discussed later in this section). With Australian Merino sheep it is estimated that the fibre harvested is about 10 to 15% less than that actually grown.

4.3.2 Genetic strain
4.3.2.1 Experimental results
The only affect detected due to genetic strain was in fleece entanglement. This occurred in Texan goats when shearing frequency was one or two per year (Table 4.10). As these shearing frequencies are commercial it is apparent that special attention should be paid to shearing times and that the shearing interval should not be allowed to increase in the winter half year past seven months. Given that there was no serious entanglement in the four shearings per year treatment it may be useful to investigate shearing Texan goats three times per year in order to reduce potential problems with entanglement. Whether such a practice is economical depends on shearing costs, the avoidance of any price penalties for fibre failing to reach B length and the price penalties for longer entangled fibre (if they exist) for leaving fibre to grow to six months.
4.3.2.2 South African experience

As part of this project a brief tour of the commercial mohair industry in South Africa was conducted. It was found that the problems reported with the entanglement of mohair from weaner goats on Australian farms also existed on South Africa farms (Photos 4.6, 4.7). The problem of entanglement was found in the first winter fleece. Interviews held with the mohair managers of the two leading mohair brokers and with two managers of large Angora goat herds gave surprisingly consistent responses. All four reported that entangled fibre represented 30 to 33% of the first winter consignment of fleeces from weaner goats.

I personally inspected several large flocks of Angora weaner goats on four different properties. In all flocks the smaller goats (the tail end) displayed a high incidence of entangled compressed fibre, particularly over the rump, back and flanks. As Photos 4.6, 4.7 show, the visual appearance on these South African goats is identical to that seen with affected weaner goats in Australia.

Entangled fibre is clearly not confined to one genotype of Angora goats. Australian producers need to select and feed their goats to avoid entangled fibre in weaner goats to avoid any market discounting.

4.3.3 Separating entangled from cotted mohair

Separating entangled mohair from cotted mohair is easy to do with a little training. While the definitions provided by mohair brokers are clear, as shown in Table 6.1, about 50% of surveyed mohair producers are not confident of accurately determining the length of mohair. An even higher proportion of surveyed mohair producers are unable to determine the financial impact of short mohair. Thus skill errors and misunderstandings are leading to a situation where entangled mohair is being mis-identified as short C length mohair or as cotted mohair both leading to financial penalties.
Entangled mohair appears to have a short staple length but mostly consists of long fibres. Close inspection shows that fibres within a staple of mohair have the appearance of bold flat over-crimped fibres mixed with straight fibres. This situation is illustrated in Figure 4.6. Essentially adhesions form between slower and faster growing fibres. The adhesions can be skin pieces (scurf or dandruff), wax, suint or mixtures of these products and dust. Once an adhesion has formed it results in the fibres that are growing faster forming exaggerated crimps as they buckle sideways. The faster growing fibres cannot pull or push the slower growing fibres out of the skin but this process will straighten the slower growing and now shorter fibres. The adhesions appear to fix in place the fibres within the staple formation somewhat like triangulation is used in the framework of modern buildings.

Usually these entangled staples have good lustre as most of the crimped fibres, while very curved, are parallel to each other. Indeed the straight fibres and adhesions ensure these crimped fibres stay parallel. It can take some force to break these adhesions.

![Figure 4.6. A stylised entangled mohair staple showing how fibres within a staple become entangled by forming adhesions with other crimped fibres and with straight fibres.](image)

To accurately determine the length of fibres within a staple it is necessary to disentangle the fibres by firmly holding the cut (shorn base) end of the fibres. Any adhesions need to be broken by gentle plucking of the fibres ensuring they are not pulled from the fingers holding the base of the staple. Once free of adhesions the fibres can be gently straightened. When this has been completed the “apparent” staple length is increased significantly.

To illustrate the result of this process a range of staples with differing entanglement scores (Table 4.1) were measured prior to straightening and following disentanglement and straightening (Table 4.12). The entangled raw staple length of mohair with an entanglement score of 1 was significantly shorter than staples with an entanglement score of 3 or above. There was no statistical difference between the disentangled staple lengths of the fibre with different entanglement scores. Consequently there was a large increase in the “apparent” staple length of entangled fibre when the adhesions were broken and the crimps were straightened.
Table 4.12. The mean (± s.d) increase in apparent staple length following disentanglement of fibre adhesions within mohair staples of differing entanglement scores (n = 30).

<table>
<thead>
<tr>
<th>Entanglement Score</th>
<th>Raw staple length (cm)</th>
<th>Disentangled staple length (cm)</th>
<th>Percentage increase in staple length#</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 and 4</td>
<td>10.8 ± 2.25b</td>
<td>11.7 ± 1.26</td>
<td>9.4 ± 12.48a</td>
</tr>
<tr>
<td>3</td>
<td>11.8 ± 3.29b</td>
<td>15.0 ± 4.05</td>
<td>28.6 ± 13.63b</td>
</tr>
<tr>
<td>2</td>
<td>9.6 ± 2.68ab</td>
<td>13.9 ± 3.75</td>
<td>46.2 ± 16.82c</td>
</tr>
<tr>
<td>1</td>
<td>7.7 ± 0.76a</td>
<td>12.6 ± 1.39</td>
<td>64.3 ± 19.30c</td>
</tr>
</tbody>
</table>

#; mean values with different superscripts differ P < 0.05 based on “T”test.

Research with wool (Goldsworthy and Lang 1954, Balasubramaniam and Whitely 1964, Nay and Williams 1969) has clearly demonstrated that the actual straight length of a fibre depends on its crimp form, with helical fibres being longer than sine fibres given the same initial crimped length. Wool fibres do not conform to any particular three-dimensional form although individual staples or consignments may do so. In Merino wool, the longer fibres had greater crimp depth and longer crimp chords and conversely the shorter fibres had smaller crimp depth and shorter crimp chords. They concluded “the shortest fibres have to conform, in the sense that they have to reduce their wave amplitude or straighten out in order to fit into the average crimp wave, and for the same reason the longest fibres have to increase their amplitude without increasing the wavelength.” This is exactly what was observed in the present study of entangled mohair.

As noted in the earlier study (McGregor 2002), some mohair producers report cotting of fibre when they actually have entangled fibre that can be easily straightened after scouring. Entangled fibre is not felted. Cotted fibre is felted and can only be separated with some degree of effort by pulling apart with the hands or if the cotts are hard, the fibre can only be separated by a powerful machine. The present experiment did not observe any cotting in the fleeces of wether goats. Mohair production from pregnant and lactating goats under greater physiological stress will be more likely to exhibit cotting when nutritional conditions are poor during winter, particularly if shearing is delayed after August.

4.3.4 Tippiness scores for mohair

What the data shows is that on average, staple tips had a more blocky appearance with one shearing per year and more tippy appearance with two or more shearings per year (Table 4.8). This result was not expected as current theory suggests that there is uneven fibre growth between individual mohair fibres which, when extended over an entire year, was expected to result in more tippy staples when compared with mohair harvested from two shearings per year.

In Merino wool the blocky staple tips consist of wool wax, soil, suint and fragments of damaged wool caused by UV light, that together fix the individual fibres together in a sticky mass. These blocky staple tips help hold the staple in a state of strain as the base of the fibres are held fixed in the skin. According to Goldsworthy and Lang (1954), following an examination of a wide variety of fine and medium wools, the shorter fibres within a staple may be straighter, and the longer made more convolute, than the average, because of the adhesion of the majority of the fibres in the tip at an early stage in the season. They suggested that the staple form and fibre association may be affected by intermediate adhesions of fibres at intervals within the staple. In their method they developed an idealised view of seven different crimp and fibre length forms within staples, and illustrated these idealised forms, based on the following factors:
1. structural fibre crimps equal or variable;
2. fibre length equal or variable;
3. direction of original growth from the skin surface identical or different;
4. adhesion or non-adhesion of fibres at the staple tip.
These observations can be seen to fit with the description of mohair provided above (Chapter 4.3.3 and Figure 4.6) in that mohair does not have the adhesions at the staple tip but does have adhesions within the staple coinciding with the observations made in the present work with entangled mohair. Thus the issues facing some in the mohair industry are not dissimilar to that faced by some Merino wool producers in the early 1950s.

4.3.5 Mohair character or mohair staple crimp frequency
The character trait measured in the present work is the actual count of mohair staple crimp frequency (Table 4.8). The present experiment showed that character or total staple crimp frequency was at a maximum when goats were shorn once per year and crimp frequency declined as shearing frequency increased (Tables 4.5, 4.6). This observation may also fit the explanation provided by Goldsworthy and Lang (1954) for the uniformity of crimping in some wools. Goldsworthy and Lang (1954) observed that if wool fibres were adhered at the tip and the skin they would form more uniform crimp patterns compared with wools without adhesions.

To explain the present observations in mohair it is hypothesised that in the annual shearing treatment, the mohair fibres formed adhesions in the staple that were able to effectively fix the fibres and allow staple crimping to form whereas in the biannual shearing treatments the fleece required twice the time to form effective adhesions consequent upon twice the shearing frequency and so there was less time to form staple crimp. Clearly with four shearings per year there was even less time to form effective adhesions between fibres and so crimp frequency was still further reduced.

It is possible that more blocky staple tips in the annual shearing treatments could arise from two other causes:
1. There is more time for moulted, loose and broken fibres to migrate out of the fleece and be lost. Thus the staple tip looks more even at the time of shearing but at other times during the year the staple tip may not appear so blocky.
2. There is more cumulative UV light damage to the staple tip and the ends of longer fibres have more time to break and be lost, leaving more uniformly blocky staple tips.

Both of these mechanisms would result in less harvested fleece and may in part explain why annually shorn fleeces were lighter. The first mechanism may also explain why the number of medullated fibres is lower compared with more frequent shearings.

4.3.6 Fibre growth rhythm
The amplitude (A) of the photoperiodic rhythm of wool growth rate is defined as: \( A = (H-L)/[(H+L)/2] \); where H is the maximum rate of wool growth and L is the minimum rate of wool growth (Hutchinson and Wodzicka-Tomaszewska 1961). A diagram of a theoretical rhythm is shown in Chapter 6.2.3.

The present study cannot define the photoperiodic rhythm but the data can be used to estimate the actual fibre growth rhythm. Using the formula above and the clean fibre growth rate data for the often shorn treatment (Section 4.2.4, Figure 4.5) the growth rhythm was determined as 47% for the period November 2004 to August 2005 and 39.5% for August 2005 to February 2006. The numbers indicate the winter depression in fibre growth rate that occurs in modern Angora goats.

There was a significant multiple linear regression between this fibre growth rhythm data and a number of measurements of fleece quality and live weight (Table 4.13). Both average live weight and total staple length growth were associated with increased fibre growth amplitude and average fibre curvature and total style measurements were associated with reduced fibre growth rhythm data. While total style measurements had a lower statistical significance the attribute has been retained as it is regarded as import by industry and the regression in Table 4.13 provides quantification of its impact.
Table 4.13. Regression constants, correlation coefficient and probability ($P$) for relationships between the amplitude of clean fibre growth (%) and the following measurements over the period March 2004 to February 2006: average live weight, total staple length, average fibre curvature and total style using data from only the often shorn treatment.

<table>
<thead>
<tr>
<th>Dependant variate</th>
<th>Fitted parameters</th>
<th>Estimate</th>
<th>se</th>
<th>RSD</th>
<th>R</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amplitude clean fibre growth</td>
<td>Constant</td>
<td>-84.6</td>
<td>32.9</td>
<td>6.28</td>
<td>0.78</td>
<td>0.00037</td>
</tr>
<tr>
<td></td>
<td>Average live weight</td>
<td>1.42</td>
<td>0.318</td>
<td>0.002</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total staple length</td>
<td>1.90</td>
<td>0.496</td>
<td>0.007</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average fibre curvature</td>
<td>-2.03</td>
<td>0.963</td>
<td>0.018</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total style</td>
<td>-2.5</td>
<td>1.26</td>
<td>0.065</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The potential impact on clean fibre growth rate amplitude over the range in observed attribute values were:
- Average live weight range 25 to 45 kg; impact on amplitude values $+28\%$.
- Total staple length range 50 to 66 cm; impact on amplitude values $+30\%$.
- Average fibre curvature range 10 to 16 degrees/mm; impact on amplitude $-12\%$.
- Total style range 0 to 6.5; impact on amplitude $-16\%$.

4.3.7 Absolute level of fibre growth
These Angora goats produced an annual clean fleece equivalent to 12.3\% of their mean live weight (4.20 kg/34.1 kg). This fibre growth was equal to 297.6 g clean mohair/kg$^{0.75}$ or 0.82 g/kg$^{0.75}$/day.

4.4 Conclusion
Fleece quality is affected by shearing practices. Goats that are shorn less frequently grow less mohair that is more likely to be entangled in spring and discounted in the market place (Photo 4.8).

Photo 4.8. Goats that are shorn less frequently grow less mohair that is more likely to be entangled in spring and discounted in the market place.
5. Quality variation within mohair fleeces

5.1 Methods and materials

5.1.1 Source of animals
Australian Angoras from two herds with pedigree breeding records were used:
1. Angora goats (n = 221) born in September 2002 at Horsham Victoria, in the RIRDC Project DAV 191A ‘Developing a model for progeny testing mohair sires’ (Ferguson and McGregor 2005).
2. Angora goats born in September 2002 used in the supplementary feeding experiment described in Chapter 3.2 (n = 80).

There were common sires between these sites and animals were sampled at twelve months of age in the same year.

5.1.2 Sampling sites
Mohair staples were taken from nine sites across the body of the Angora goats (Table 5.1, Figure 5.1). Some of these sites were used by CSIRO in their study of Merino sheep (Turner et al. 1953).

Table 5.1. Sampling sites and their location

<table>
<thead>
<tr>
<th>Site name</th>
<th>Site location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid side</td>
<td>Centred on 3rd last rib midway between mid-line of back and mid-line of belly (CSIRO).</td>
</tr>
<tr>
<td>Belly</td>
<td>50 mm above the mid-line of the belly, below the MS site. Behind the sternum and away from the bare area of skin near the front leg (modified from CSIRO).</td>
</tr>
<tr>
<td>Brisket</td>
<td>On the anterior aspect of the neck below the muzzle and at a point level with the MS site (ie half way between the muzzle and a point between the front legs on the sternum).</td>
</tr>
<tr>
<td>Hind flank</td>
<td>Mid way between the hip and hock sites.</td>
</tr>
<tr>
<td>Hip</td>
<td>Over the point of the hip bone (CSIRO).</td>
</tr>
<tr>
<td>Hock</td>
<td>Posterior aspect of the hind leg above the hock. (CSIRO).</td>
</tr>
<tr>
<td>Mid back</td>
<td>50 mm below the mid-line of the back above the mid side site.</td>
</tr>
<tr>
<td>Neck</td>
<td>Half-way between the point of the jaw and the shoulder blade (ie on the side of the neck).</td>
</tr>
<tr>
<td>Shoulder</td>
<td>Over the point of the shoulder blade.</td>
</tr>
</tbody>
</table>

5.1.3 Sampling methods
On the day prior to shearing, animals were restrained on a table on their left side by two operators. The ear tag number was identified. Two further operators carefully located a single staple at four or five of the designated locations. The staple was cut at skin level using sharp scissors. A fifth technician assisted in ensuring that the correct sample was placed in an envelope identified with the correct tag number and sampling site.
5.1.4 Testing methods
Samples were placed in a standard fibre-testing laboratory and conditioned for more than 48 hrs. Testing of animals was in a random order. Generally for each animal the site samples were measured in a random order before the next animal samples were tested. With the Burragate samples all the mid side samples were measured first. The stretched staple length was measured using a ruler to the nearest 0.5 cm. The staple was then tested using the OFDA2000 to determine mean fibre diameter (μm), fibre diameter coefficient of variation (CVD, %) and fibre curvature (degree/mm).

5.1.5 Statistical analysis
Data were analysed by a multiple regression approach, using a restricted maximum likelihood (REML) algorithm, to determine the relationships between a measured attribute at a specific age and the other factors and variables. The best predictive model was developed with terms being added or rejected on the basis of Wald tests. Some terms were transformed and interactions between terms were calculated. Full details of the analysis are too long to be included in this report and will be made available when the scientific papers are published. For each Site the Animal with Sire effect was confounded with the measurement error.

For analyses at twelve months of age data from two properties was available but at eighteen months of age data was only available from one property. A technique error was detected during data analysis of the Burragate mid side sample staple length and this data has been deleted. Terminology is described in Payne (2005) and abbreviations provided in Table 5.2.

Table 5.2. Definitions of abbreviations used in model formula.

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Farm origin</td>
</tr>
<tr>
<td>Sex</td>
<td>Sex of animal (doe, wether)</td>
</tr>
<tr>
<td>Sire</td>
<td>Sire of animal</td>
</tr>
<tr>
<td>Site</td>
<td>Location of sample on the body of animal (Table 5.1)</td>
</tr>
<tr>
<td>MFD</td>
<td>Mean fibre diameter (μm)</td>
</tr>
<tr>
<td>SL</td>
<td>Staple length (cm)</td>
</tr>
<tr>
<td>2 or 3</td>
<td>Sampling age (2 = 12 months of age, 3 = 18 months of age)</td>
</tr>
</tbody>
</table>
5.2 Results
5.2.1 Mean fibre diameter

5.2.1.1 MFD2
The model used log transformation with the following effects:
Fixed effects: Property*Sex*Site
Random effects: For each site, Sire + Animal within Sire

The average mid side mean fibre diameter at 12 months of age was: Horsham does 21.9 µm, Horsham wethers 21.9 µm, Burragate does 26.6 µm, Burragate wethers 25.7 µm. The percentage deviation in mean fibre diameter of each site compared with the mid side site are shown in Figure 5.2.

5.2.1.2 MFD3
The model used log transformation with the following effects:
Fixed effects: Sex*Site
Random effects: For each site, Sire + Animal within Sire

The average mid side mean fibre diameter at 12 months of age was: Horsham does 27.7 µm, Horsham wethers 27.3 µm. The percentage deviation in mean fibre diameter of each site compared with the mid side site are shown in Figure 5.3.

Figure 5.2. The differences in mean fibre diameter at 12 months of age at different sites from that at the mid side site for does and wethers in two herds (measurements in µm).

5.2.1.2 MFD3
The model used log transformation with the following effects:
Fixed effects: Sex*Site
Random effects: For each site, Sire + Animal within Sire

The average mid side mean fibre diameter at 12 months of age was: Horsham does 27.7 µm, Horsham wethers 27.3 µm. The percentage deviation in mean fibre diameter of each site compared with the mid side site are shown in Figure 5.3.
Figure 5.3. The differences in mean fibre diameter at 18 months of age at different sites from that at the mid side site for does and wethers in two herds (measurements in μm).

5.2.2 Staple length

5.2.2.1 SL2

The model used had no transformation with the following effects:

Fixed effects: Property*Sex*Site
Random effects: (An overall Sire effect) + (an Animal within Sire effect for each Site).

The average mid side staple length at 12 months of age was for Horsham does 12.3 cm and for Horsham wethers 11.9 cm. At Burragate the average shoulder staple length was for does 13.3 cm, Burragate wethers 12.3 cm. The differences in staple length between the sites are shown in Figure 5.4.

Figure 5.4. The differences in staple length at 12 months of age at different sites from that at the mid side site or shoulder for does and wethers at two locations. All measurements in cm.

The neck site looked to be the best site for staple length assessment as it had low variation and was well correlated with most of the main body of the fleece. The correlation between sire effects for the
different sites was 1.00 (by the construction of the model) indicating that selection for increased staple length at one site would give equal responses at all sites.

5.2.2.2 SL3
The model used had no transformation with the following effects:
Fixed effects: Site
Random effects: (An overall Sire effect) + (an Animal within Sire effect for each Site).

The average mid side staple length at 18 months of age at Horsham was 11.8 cm. The differences in staple length between different sites and the mid side site are shown in Figure 5.5.

Figure 5.5. The differences in staple length at 18 months of age at different sites from that at the mid side site. All measurements in cm.

5.3 Discussion
While the extent of quality variations within the fleece of Merino sheep have been well studied they are not well documented in Angora goats. The few studies of variation in mohair attributes across the fleece have restricted analysis of the data to quantifying the magnitude of differences, usually between a limited number of sites, with little attention paid to the sources of variation or to the relationship between different sites. In addition, over the past 15 years, Australia mohair producers have been incorporating new genetic material from South Africa and Texas into their herds and so the relevance and reliability of earlier studies on variation within mohair fleeces needs to be evaluated.

5.3.1 Variation in fleece attributes
There are large variations in the attributes of Australian mohair fleeces between sites across the body. There are also important differences between sires and with property in the variation between sites. There was more variability between sites than between sires.

At Horsham, for mean fibre diameter at 12 months of age the general pattern was for the mid back, hip and hip sites to be finer and the neck, brisket, belly and hock sites to be coarser than the mid side site, which was the finest site. The neck was 20% coarser which equalled 4.6 μm or one and a half classing grades coarser than the mid side site. At Burragate, the mid side site was not the finest site and the fleeces were more even from neck to hock. The brisket was 11% coarser which equalled 2.6 μm or one classing grade coarser than the mid side site. For the third shearing at Horsham the mean fibre diameter was more even between the sites but the brisket, neck and belly were still the coarser sites. While the brisket was only 16% coarser than the mid side site this was still equal to 4.4 μm or one and a half classing grades coarser than the mid side site.

The general pattern was that the sites from the back half of the body were shorter than the sites from the front half of the body (neck, shoulder, brisket, belly). For staple length at both ages, the shortest site was the hock while the mid back, hip and hind flank, all areas of higher sunlight (UV) exposure were shorter than the mid side or shoulder. The bellies were shorter at Burragate than at Horsham,
probably due to differences in abrasion as Horsham was a flat site with relatively little pasture owing to drought conditions while Burragate is hilly and had areas of rougher pasture.

5.3.2 Value of mid side site for fleece sampling
Since 1947, the accepted method for testing sheep wool has been to take a mid side sample (Turner et al. 1953). In sheep, the theory behind using a mid side sample is that a mid side sample test result is close to the mean of both the top to underside and the front to rear variation found in a fleece. For this to be true the mid side sample has to be either mini-cored or testing after carding. The mid side site is also convenient to use for sampling because it can be easily located during shearing and can even be shorn without removing the entire fleece. This advantage is also true for other sites prior to shearing.

The results of this work with Angora goats show that the mid side site tends to be finer than the mean of all the other sites at the second shearing but coarser at the third shearing. At Horsham, the mid side site was about 8.8% finer at the second shearing and 4% finer at the third shearing than the mean of the other sites while at Burragate it was about 1.5% coarser at the second shearing. However if the brisket is omitted from these calculations, as it is currently suggested that this fibre be removed from the rest of the fleece during classing, then the differences between the mid side and other sites are substantially reduced at Horsham.

For staple length, the mid side site was slightly longer than the average of all the other sites but the differences were small and mainly due to the inclusion of the hock site, which is usually removed during classing. When the hock site was removed there was no difference between the mid side site and the average of the other sites. The neck site appears to be the best site for staple length assessment as it had low variation and was as well correlated with other sites as any other site.

In Angoras, during normal mid side sampling a 30 to 50 g sample is taken, not a staple as in this study. If the mid side sample is taken too low on the body it may include fibre that is really part of the belly and lead to errors in mean fibre diameter and staple length measurement. If errors are to be made during sampling it appears better to sample towards the mid back or the hip as these sites are closer to or not statistically different from the mid side site.

5.3.3 Implications for preparation of mohair for sale
The physical attributes of mohair fleeces vary considerably over the body. During the preparation of mohair for sale, the fleece is commonly divided into three major components:
1. Mainline fleece; the majority of most fleeces are classed into mainlines for sale. Usually this fibre is split into more than one mainline, sometimes for differences in staple length. The “neck”, the coarser fibre from the brisket but usually termed the neck, is removed and placed into a different mainline to most of the fleece.
2. Skirtings or pieces; usually the edges of the fleece including shorter fibre from the legs, breech and belly.
3. Contaminated and out sorts fibre; stains, vegetable matter contaminated and cotted fibre are removed and placed into their own separate line.

The sampling sites across the body used in the present study could be notionally placed into the fleece components listed above as follows:
1. Mainline fleece; mid side, mid back, pin bone, hind flank, shoulder, neck, brisket.
2. Skirtings or pieces; hock, belly.

The results of the present work indicate that:
- The brisket fibre must be removed and placed into a fibre diameter line one or two grades coarser than the main body of the fleece.
- On some properties the neck fibre should also be removed and placed into a fibre diameter line one grade coarser than the main body of the fleece.
- Belly and breech fibre (near the hock site) should also be removed as it will be of different fibre diameter and or staple length.
For staple length evaluations, the classer is better advised to place more value on the assessed length across the back and hind flank than the mid side site.

These observations are different to those of Stapleton (1996), who suggested that during clip preparation only the stronger neck (brisket) fibre and shorter fleece from the breech area may need to be separated from the main fleece.

Harmsworth and Day (1990) suggested that some Angora goats may produce coarse mohair down the centre of the back and that this should be carefully removed. This view is similar to the current classing guidelines of the Australian Mohair Marketing Organisation (Clancy 2005). Clancy (2005) highlights the attention required for mohair growing on the neck (meaning brisket) and back line:

“The fibre present in the neck portion of the fleece, as a general rule, tends to be stronger than the rest of the fleece and should be removed. Strong neck fibre is generally characterised by large broad flat or bold staples. The removal of this significantly stronger neck fibre, should improve the uniformity of the remaining body of the fleece by reducing the variation in micron and improve evenness of style and character. Neck fibre from the 2nd shearing onwards should be removed, as in the majority of cases this (is) warranted to maintain uniformity of micron.” “Another area of the fleece that may need attention is the back line. Some Angoras may have kempy or short compressed staples in this region. Consequently, if the fibre in the backline is significantly different to the majority of the body of the fleece in either kemp content or staple length, it should be removed.” [Note: the emphasis is provided by Clancy].

The present work on modern Australian Angora goats covering a range of genetic strains suggests that on average the recommendations provided by Harmsworth and Day (1990) and Clancy (2005) need revision. The variation between the mean fibre diameter of the mid side and the mid back sites was of no commercial significance or if anything the mid back was finer.

Williams (2001) reviewed Australian mohair classing standards but the review did not discuss the actual practice of classing the fleece.

5.3.4 Implications for animal selection

The data from the present project can be analysed further to provide significant information about the relationships between the sampling sites, the precision of sampling at each site and the preferred sampling sites for different mohair attributes. As these types of analyses were outside the scope of the present project the results are unavailable.
6. Training and evaluation

6.1 Development and delivery of training material

6.1.1 Training needs of mohair producers

A training needs analysis was conducted by surveying mohair producers at field days, mohair industry events in 2003. A summary of the feedback from producers is provided in Table 6.1.

Table 6.1. The percentage of surveyed mohair producers who responded that at that time they could not undertake a particular skill and needed training. Items in italics are issues examined in the research component of this project.

<table>
<thead>
<tr>
<th>Mohair production issue</th>
<th>Percentage of mohair producers who could not undertake skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>I know how to feed breeding does to minimise the amount of poor quality and short mohair</td>
<td>65</td>
</tr>
<tr>
<td>I know how to feed weaner goats to minimise the amount of poor quality and short mohair</td>
<td>59</td>
</tr>
<tr>
<td>I know why mohair growth is reduced during winter</td>
<td>59</td>
</tr>
<tr>
<td>I am confident that I can identify the best genetics to use in my area to breed long, fine, heavy fleeces</td>
<td>50</td>
</tr>
<tr>
<td>I know how to arrange mating to minimise the amount of poor quality and short mohair</td>
<td>53</td>
</tr>
<tr>
<td>I can confidently determine the length of mohair during classing</td>
<td>47</td>
</tr>
<tr>
<td>I can accurately class mohair for length</td>
<td>47</td>
</tr>
<tr>
<td>I can determine the impact of poor quality and short mohair on my financial returns</td>
<td>41</td>
</tr>
<tr>
<td>I know how to arrange shearing twice each year to minimise the amount of poor quality and short mohair</td>
<td>41</td>
</tr>
<tr>
<td>I know the correct stocking rate for my Angora goats</td>
<td>35</td>
</tr>
<tr>
<td>I know how to provide the right amount of shelter to my goats during wet weather and during windy weather</td>
<td>18</td>
</tr>
</tbody>
</table>

6.1.2 Training events

Training events included on-site farm field days, active participation in on-farm measurement, conduct of sampling, on-site workshops and workshop training events at locations where mohair producers would be motivated to attend and in association with regional groups of Mohair Australia.

Events were focussed in southern New South Wales (South Eastern Region of Mohair Australia) but were also held in Victoria and Western Australia. Training events were held in August 2003, November 2003, March 2004, August 2004, October 2004, March 2005, June 2005, October 2005, March 2006 and July 2006.
6.2 Examples of training materials
Extracts from workshop notes are provided. These notes were presented with significant discussion and interaction. The material illustrated in this section is focussed on a selection of the main training needs identified in Table 6.1, including financial implications flowing from a knowledge of mohair market discounts, improved nutrition management of breeding does, growth of mohair during winter and genetic selection.

6.2.1 Financial implications flowing from a knowledge of mohair market discounts

**Impact of mohair fibre diameter on fleece value**

- To grow the same value of fleece a goat producing coarser mohair has to grow a lot more mohair than a finer goat.
- The next graphs show how much extra mohair is required.

**The impact of things that you can manage on mohair prices**

- In some sales 38 μm mohair was valued at 300% the base line. That is, 3 times 7% or 21% of 25 μm mohair.
- In one year 4 kg of 25 μm mohair equals 16 kg of 33 μm mohair.

![Relative price of greasy mohair price at different mean fibre diameters based on A length average style mohair with 0.5% VM](image.png)

![Quantity of mohair at different fibre diameters to equal the value of 1 kg of 25 μm mohair](image.png)

![Impact of factors on mohair prices](image.png)
6.2.2 Improving nutritional management of breeding does

**Feed does properly during mid pregnancy and lactation**
- The most valuable fleeces come from kids whose does grew during mid pregnancy and lactation
- Nutrition affects the number of skin follicles that grow mohair
- These effects are life long
- Restricted feeding in lactation greatly reduces fleece value

**Impact of nutrition on fleece quality**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fleece weight</th>
<th>MFD</th>
<th>Staple length</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAL</td>
<td>2.49 kg</td>
<td>28.7 μm</td>
<td>14.1 cm</td>
<td>$47.01</td>
</tr>
<tr>
<td>CR</td>
<td>2.44 kg</td>
<td>30.2 μm</td>
<td>15.3 cm</td>
<td>$33.33</td>
</tr>
<tr>
<td>SR</td>
<td>2.67 kg</td>
<td>30.5 μm</td>
<td>15.4 cm</td>
<td>$33.94</td>
</tr>
<tr>
<td>CAL</td>
<td>2.55 kg</td>
<td>30.2 μm</td>
<td>14.9 cm</td>
<td>$42.63</td>
</tr>
</tbody>
</table>

**Financial benefit from feeding does**
Correct feeding of does provided
- $13 from improved feeding during lactation
- $4 from improved feeding during pregnancy in fleece value at the second and third shearing

Feeding costs money but it produces more valuable fleeces over the lifetime of goats.

**Stocking rates**
are described in
DSE’s: DRY SHEEP EQUIVALENTS

1 DSE = the energy required to maintain a non-breeding 45 kg Merino sheep for 1 year

**Breeding does - targets**
- Stocking rate = 2.5 DSE
- Condition score = 2+ to 3
- Supplementary feeding – 6 weeks before and 6 weeks after kidding
- Areas with wet winters - iodine drench
6.2.3 Mohair growth during winter

Nutrition during winter
- Pasture growth declines during cold weather
- Waterlogging or late pasture germination reduces winter pasture growth
- Pregnant goats have a high energy need for kid development
- Cold stress reduces energy available for mohair growth
- Must aim to maintain continuous mohair growth

Winter mohair growth
- Mohair growth is reduced during winter in response to the shorter length of day
- Some mohair producing skin follicles stop growing fibre
- When fibre growth re-starts it causes fibre shedding leading to cotting of fleece
- As goats age the number of inactive follicles increases in winter

Changes in day length affect the growth rate of mohair

In a “Normal year”
- Winter growth 42%
- Summer growth 58%

Common situation for 6 to 18 month old goats
Winter fleece 1.7 kg
Summer fleece 2.3 kg
Total fleece 4.0 kg

6.2.4 Genetic selection using EBVs

Select bucks that produce fine long mohair
- Producers identified that the strain of buck affected the seriousness of short and cotted mohair
- The real issue is to identify productive bucks using Estimated Breeding Values
- Buck selection should take into account winter growth

Generally longer mohair is coarser
EBVs for third fleece mean fibre diameter and staple length

Evaluation of progeny from bucks to estimate their breeding value (EBV) has occurred at Horsham

Some bucks produce progeny with mohair up to 5 μm finer or 1.5 cm longer than the progeny of other bucks
INTRODUCTION
Mohair is a luxury fibre grown by Angora goats that frequently sells for a substantial premium compared with superfine Merino wool. Analyses of mohair auction prices show that prices are based on rational decisions by buyers and processors. For mohair producers to obtain premium prices they need to focus their efforts on the critical factors that influence the production and quality of mohair.

WHAT PRODUCERS CAN DO TO PRODUCE PREMIUM MOHAIR

1. Feed does well during mid pregnancy and lactation
Mohair grows from skin follicles. Nutrition during mid pregnancy and early lactation affects the number of skin follicles that develop. These effects are life long.

The most valuable fleeces come from kids whose mothers grew during mid pregnancy and lactation. These kids have finer mohair over their lifetime. Restricted feeding in lactation greatly reduces fleece value.

2. Shear goats at the correct time
Shear to obtain B length mohair (10 - 12 cm) as C length mohair is discounted by 48%. Mohair grows less during winter so the interval between shearing may need to be increased for spring shearing.

Avoid fleece engagement or cotting by shearing does before kidding. Cotting can be avoided by good nutrition during winter to ensure mohair fibres keep growing. Reserve shearing well in advance.

3. Select bucks that are more profitable
Buck selection should take into account fibre diameter, fleece length and fleece weight. Super style mohair is often coarser so fleece test bucks before use.

Producers can determine the estimated breeding values (EBVs) of bucks and use this to select the best male to use.

Generally longer mohair is coarser (see red line on graph).

Some bucks produce kids with mohair 5 μm finer or 1.5 cm longer than kids from other bucks.

These differences can increase mohair returns by up to 50%.

4. Give kids & weaners priority
Kids produce the finest and most valuable mohair.

Kids are more susceptible to internal parasites, cold stress, nutritional setbacks and fleece contamination.

The highest discounts for stain, short length and faults such as vegetable matter occur for fine mohair.

Give kids and weaners priority nutrition, shelter and shearing to maximise your financial returns.

5. Use mohair broker feedback
Mohair brokers aim to optimise your and their financial returns by cost effective selling of mohair. Brokers are in contact with mohair buyers and exporters.

1. Take note of broker advice about preparing mohair for sale.
2. Carefully separate faulty and short mohair.
3. Minimise selling and classing costs.

Remember that mohair prices vary with year and selling period.

6. Cull goats with micron blow-out
Large increases in fibre diameter as goats age is called ‘micron blow-out’. Increased fibre diameter means discounts of up to 90% in price.

Some Angora goats have a blow-out of 20 μm.

Cull the worst goats and select bucks with more stable fibre diameter.

CONCLUSION
Mohair producers can maximise their financial returns by feeding goats correctly, selecting more profitable bucks and careful management of weaners, shearing and mohair preparation.
6.3 Methods used to gather feedback from workshops

6.3.1 Method 1
Information was gathered by use of post presentation evaluation sheet. Sheets at each workshop asked six to eight quantitative questions relating to the topics covered in the workshop that were rated on the following four-point scale:

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No useful information provided;</td>
</tr>
<tr>
<td>1</td>
<td>Some useful information provided;</td>
</tr>
<tr>
<td>2</td>
<td>A lot of useful information provided;</td>
</tr>
<tr>
<td>3</td>
<td>Significant amount of useful information provided.</td>
</tr>
</tbody>
</table>

These data allows a Level 1 Kirkpatrick assessment of the presentation. Responses to each question were collated and the percentage of responses for each rating was graphed.

The sheet also asked 4 qualitative questions about how people felt about the presentation. Comments that were inappropriately put in one section of the qualitative questionnaire have been moved to more appropriate sections. The last question asked for other comments.

6.3.2 Method 2
The target or dartboard method was used to gauge reactions. By using this method at the start and at the end of the workshop it allows participants to self evaluate the change in their knowledge and provides a means to assess perceived changes in knowledge.

This method was used at a workshop held in March 2005. The workshop was part of the National Angora Trophy (NATS) three-day event in Goulburn NSW. A one hour segment titled ‘Commercial Marketing and Production of Premium Quality Mohair’ was presented. Each person in attendance was provided five sticky dot labels and asked to place the dots in the segments of the target that they thought were the most important attributes of mohair in defining premium quality. The definition of premium quality mohair (see Chapter 2.2) was provided in an overhead slide projected onto a screen. Participants were allowed to put more than one dot in any segment. If participants were certain of their view they were to place the dots near or on the centre of the target but if they were uncertain they were to place the dots at the outside edge or in the middle. Photos of these targets were taken. Several persons in attendance declined to participate.
6.4 Results
6.4.1 Method 1
6.4.1.1 Quantitative survey

Usefulness of information on mohair growth during winter
Half (53%) of the audience gained a lot or a significant amount of useful information.

Usefulness of information on feeding goats to improve mohair length
Three quarters (75%) of the audience gained a lot or a significant amount of useful information.

Usefulness of information on determining the financial impact of poor quality and short mohair
More than half (59%) of the audience gained a lot or a significant amount of useful information.

Usefulness of information on the affect of mohair attributes on mohair price
A substantial majority (86%) of the audience gained a lot or a significant amount of useful information.
Usefulness of information on the nutrition of breeding does
Over three quarters (80%) of the audience gained a lot or a significant amount of useful information.

Usefulness of information on the importance and determination of stocking rate for farms
A substantial majority (93%) of the audience gained a lot or a significant amount of useful information.

6.4.1.2 Qualitative survey
Where producer’s questions answered?
Feedback from all workshop responses to the question “Did you feel your questions were answered today?” were combined. Of those who filled in a feedback form, 72% said yes and 11% did not provide an answer to this question. Of the respondents to this question, 80% said yes and 20% said sometimes.
6.4.2 Method 2
The photos of the targets are provided in Photo 6.1.

Photo 6.1. Photos of the targets used at the start and at the end of the workshop on premium quality mohair at the NATS Workshop, Goulburn NSW 2005.

The analysis of the placement of dots between sectors provided on the target is provided in Table 6.2. It is also clear from the targets in Photo 1 that participants became significantly more confident about the importance of the different attributes of mohair as the positioning of dots within sectors moved to cluster about the centre of the target.

Table 6.2. Participant feedback on the most important attributes of mohair in defining premium quality (highest commercial value) at a workshop at Goulburn NAT Angora Show March 2005 based on a placement between sectors of the dartboard (Photo 6.1).

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Number of responses</th>
<th>Percentage of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before talk</td>
<td>After talk</td>
</tr>
<tr>
<td>Length</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td>Style</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>Kemp</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Strain of Angora</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MFD</td>
<td>27</td>
<td>34</td>
</tr>
<tr>
<td>VM</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Stain, cott &amp; other</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Total responses</td>
<td>83</td>
<td>85</td>
</tr>
</tbody>
</table>
6.5 Discussion and conclusions
Mohair producers are able to categorise their skill gaps during training needs analyses. About half of mohair producers surveyed acknowledge a lack of important skills while others believe that they are skilled sufficiently.

Following workshops designed to improve the skills and knowledge of mohair producers about issues identified for this project to address or identified during the training needs analysis significant, the vast majority of responses indicated that the information was very useful. It appears that this project was successful in generating and delivering information of relevance, interest and use for mohair producers aiming to improve the production of premium quality mohair.

Photo 6.2. Following an on-farm participation day in New South Wales, publicity was provided via ABC Rural Radio. Left: Ms Keva Gocher, ABC reporter with Gay Denney and Ron Harris.

Photo 6.3. Principal investigator Dr. Bruce McGregor at the field day held in October 2004, Department of Primary Industries Centre, Attwood, Victoria.
7. Implications and recommendations

There is great scope for the Australian mohair industry to increase the production of quality mohair. Market signals are clear, predictable and a failure to produce higher quality mohair results in severe price discounts. The implications are that mohair producers must increase their knowledge of how modern technology can assist them to identify superior goats that produce greater financial returns. The information in this report can help producers quantify the impact of changes in genetic selection, supplementary feeding and other management variables such as shearing time and frequency. There is scope to improve the nutritional management of Angora goats, particularly weaner goats. There is still limited knowledge about the best pasture based production systems for Angoras in Australia.

The best methods for the sampling and evaluation of mohair fleeces need further clarification. The present work has made some progress but this work is very complex and needs to be developed further along with the outcomes of the evaluation of the Every Goat Tested (EGT) approach.

It appears that many existing mohair producers have a large range of learning needs. As the industry keeps attracting new participants, the requirement for accurate, up-to-date and scientifically defendable practices will continue for many years. There is a continuing need for existing and new information to be brought together and made accessible to the industry.

On the basis of the findings in this report the following recommendations are made:

1. That existing and new objective information on the management of Angora goats and the marketing of mohair be brought together
   The industry bodies such as Mohair Australia and the leading mohair selling brokers have a pivotal role as points of contact with existing and prospective mohair producers. These bodies need objective scientifically based information to provide a creditable professional approach to inquiries. Most mohair producers report after workshops that they greatly appreciate access to objective information. RIRDC has a key role in drawing the various players together.

2. Mohair producers increase their skills in pasture production
   Many mohair producers do not have any depth of knowledge or experience in improving pasture production. This is partly a consequence of the industry continuing to attract new people from outside agriculture or of the limited size of mohair farms where pasture improvement is not seen as a high priority. Irrespective of these reasons, pasture is generally the cheapest method of feeding goats. Pasture production during winter is usually limiting mohair production and probably affecting long-term mohair quality. Methods need to be found to facilitate skills acquisition in pasture production.

3. Identify the best methods for evaluating mohair fleeces
   Increasing emphasis on the needs to improve and optimise the financial returns from mohair production necessitates improved and more precise techniques for the evaluation of mohair fleeces. Further research and development of these techniques is necessary given the advent of new technology and the findings of the present project. Full analysis and publication of data relating to variation in fleece quality should be completed.

4. Research to improve the nutritional management of breeding flocks
   There is a continuing need to improve the nutritional management of pregnant and lactating does and their progeny during the first 12 months of life. It is apparent from the present work and experience in South Africa that weaner kids face a difficult first year. Livestock losses during the “time envelope” of pregnancy and up to one year of age will considerably reduce the ability of the mohair industry to expand and is likely to substantially undermine the economics and profitability of participants.
8. References


