
Available from Deakin Research Online

http://hdl.handle.net/10536/DRO/DU:30065838

Reproduced with the kind permission of the copyright owner

Copyright: 2002, RIRDC
Extent and source of short and cotted mohair

A report for the Rural Industries Research and Development Corporation

by B. A. McGregor

August 2002
Foreword

Mohair is a rare natural fibre, renowned for its lustre. The commercial Australia mohair industry is based on Angora goats imported during the nineteenth century and newer genetics released from quarantine in the early 1990s. Since the mid-1970s, Australian mohair has primarily been exported for processing. During the late 1990s, the mohair industry identified a growing problem with the production of short and cotted mohair.

The key areas that were investigated in this report were:
- The extent and impact of short and cotted mohair based on production and marketing data;
- The views and experience of mohair producers and selling brokers;
- The direct impact of short and cotted mohair production on financial returns of two producers;
- A review of the biological and management issues related to these problems and on the experience of the wool industry;
- A proposed work plan was developed.

This project was part funded from industry revenue that is matched by funds provided by the Federal Government. The majority of the funding was provided by the Specialised Rural Industries Program of the Victorian Department of Natural Resources and Environment.

This report, a new addition to RIRDC’s diverse range of over 800 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:

- downloads at www.rirdc.gov.au/reports/Index.htm
- purchases at www.rirdc.gov.au/eshop

Simon Hearn
Managing Director
Rural Industries Research and Development Corporation
Acknowledgments

This project could not have been completed without the financial support of the Rural Industries Research and Development Corporation, and the Specialised Rural Industries Program of the Victorian Department of Natural Resources and Environment.

I am greatly indebted to the National Mohair Pool P/L., Australian Mohair Marketing Organisation Ltd., and Australian Mohair Trading P/L. for access to their records and their willing participation in this project. I thank Mohair Australia and the Australian Goat Report (Mrs. D. Cunningham) for their assistance in distributing the survey to their readers.

I also thank the mohair producers who agreed to frankly discuss their views and experience and to those who offered their farm records to assist this project.

Mr Kym Butler, biometrician at the Victorian Institute of Animal Science is thanked for his assistance in analysing the mohair marketing data.

About the author

As a Senior Research Scientist, Dr. Bruce McGregor has specialised in improving the production and quality of speciality animal fibres and goat meat. He has been directly involved in the development of the mohair, cashmere, and alpaca industries with research, on-farm development and extension programs aimed at overcoming constraints to the development of viable industries. He has published over 280 research, technical and advisory articles on these subjects. Bruce has studied cashmere producing regions of Asia, alpaca producing regions of South America, and mohair producing regions in several countries. Appointed Head of the Fibre Quality Department, Victorian Institute of Animal Science, in 1995, his work included managing research programs into Higher Quality Export Fine Wool, Minimising Chemical Residues in Wool and Fibre Testing Services. Bruce is also a member of the Editorial Advisory Board of the international scientific research journal Small Ruminant Research. He is a past president of the Victorian Branch of the Australian Society of Animal Production. In 1996 he received the Gold Award for a scientific paper at the 6th International Conference on Goats, Beijing.
# Contents

**Foreword** .................................................................................................................................... iii

**Acknowledgments** ...................................................................................................................... iv

**About the author** ...................................................................................................................... iv

**Contents** ..................................................................................................................................... v

**Executive Summary** ................................................................................................................... vi

1 **Introduction** ........................................................................................................................... 1
   1.1 Background.......................................................................................................................... 1
   1.2 Project Objectives ............................................................................................................. 2
   1.3 Project Methodology ........................................................................................................ 2

2 **Extent and impact of short and cotted mohair production** ................................................ 4
   2.1 Analysis of mohair market .................................................................................................. 4
   2.3 Feedback from mohair selling brokers .............................................................................. 6

3 **Experience of mohair producers – outcomes of survey** .................................................... 12
   3.1 Characterising the respondents ....................................................................................... 12
   3.2 Experience of short and cotted mohair............................................................................ 19
   3.3 Methods producers have used to reduce short and cotted mohair ..................................... 22
   3.4 “Trade-offs” identified by producers .............................................................................. 27

4 **Case studies - mohair producers** ........................................................................................ 28
   4.1 Market reports from producers ....................................................................................... 28
   4.2 Interviews with producers reporting serious problems ..................................................... 31

5 **Literature review** ................................................................................................................. 33
   5.1 Introduction....................................................................................................................... 33
   5.2 Biological issues .............................................................................................................. 33
   5.3 Management issues ....................................................................................................... 43

6 **Discussion and implications** ................................................................................................ 48
   6.1 Discussion....................................................................................................................... 48
   6.2 Implications ................................................................................................................... 51

7 **Recommendations** .............................................................................................................. 53

**References** ............................................................................................................................... 54

Appendix 1. Short and cotted mohair survey ................................................................................ 58
Executive Summary

Introduction
Mohair fibre length has important effects on the processing and quality of textiles. Historic data from South African and Australian mohair markets indicate that the price difference between short and long mohair can be 20 to 80%. It is in the interests of mohair producers, selling brokers and processors to maximise the financial returns from mohair production.

As a consequence, the RIRDC Rare Natural Animal Fibre Research and Development Plan 1998-2003 identified under Objective Four “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.

Neither the exact causes, the extent of the problems with short and cotted mohair nor the impact on the profitability of the Australian mohair industry have been defined.

Research Objectives and general approach
This RIRDC supported project (DAV 192A) was titled “Optimising mohair harvesting strategies”. The objectives were:
1. To identify the extent and impact of the short and cotted mohair problem in Australia; and
2. To identify issues related to causing the short and cotted mohair problem in Australia.

This project aimed to better identify the issues related to short and cotted mohair production in terms of impact, geographical spread, potential causes and potential solutions.

The following general process was outlined in the original submission and was carried out:
1. Market information for Australian mohair was collected from the major mohair selling brokers to determine the quantity of short and cotted mohair over the preceding four years;
2. Data from an associated project that analysed objective information on the attributes and price received for Australian mohair were obtained.
3. A survey was conducted, via industry newsletters, of Australian mohair producers seeking their views and experience of the problems. Data were analysed and graphed.
4. Selected mohair producers were interviewed and case study examples were documented;
5. Three mohair selling brokers were interviewed and their views and experience documented;
6. The published scientific and textile literature was reviewed and interpreted.

Analysis of mohair market
Production of short and cotted mohair has reduced industry income by 10%, amounting to over $1 million during the study period. By weight, short mohair represents about 13.5% of production and cotted mohair represents a further 7% of production. Short mohair refers to C length mohair, that has a staple length of less than 11 cm, and locks, whereas B length mohair generally has a staple length of 11 to 13 cm.

After adjustment for other factors including mean fibre diameter, vegetable matter etc, C length mohair is sold at a 45% discount to B length mohair and cotted mohair is discounted 37 to 91%.

Mohair brokers
All brokers reported significant effects of these products on their business and income. However, the brokers generally underestimated, by about 20%, the financial impact of selling short mohair compared to long mohair. Discussions revealed variation in the practices used for assessing mohair length. Brokers were aware of some of the options available to producers in their attempts to reduce the impact of short and cotted mohair on financial returns. All brokers stated that many producers prepared mohair poorly and they regarded cotted mohair as a sign that routine husbandry practices were not being carried out at the optimal time. The brokers suffered three impacts of short and cotted mohair: smaller lot sizes of preferred length mohair; increased costs of preparing mohair for sale; and reduced income from commission for the sale of lower valued mohair.
Mohair producers

Approximately 15% of mohair producers responded to the survey. The respondents appear to be a typical cross-section of Australian mohair producers. They reported that problems with short and cotted mohair exist in all States of Australia although the problem appears more concentrated in some districts, particularly in south-eastern Australia. Most of the respondents reported problems with short and cotted mohair, with 40% reporting problems in most or all years and only 10% reporting no problems in any year. The problem was regarded as moderate to serious by 55% of respondents. The data suggest that producers underestimate the financial impact of the problem. In one case study 40% of mohair output was affected and 21% of potential income was lost.

The survey responses indicate that those producers reporting the more serious impacts 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 were aware of the common methods to reduce short and cotted mohair. The most common methods used to reduce short and cotted mohair were genetics, nutrition, shearing, husbandry and provision of shelter. The following trade-offs were identified: no method works in isolation; longer mohair may have a coarser mean fibre diameter; and costs of supplementary feeding are greater than the benefits.

Literature review

There are many biological and management issues affecting short and cotted mohair production. The review identifies a number of practical and theoretical approaches that producers could apply to reduce the impact of short and cotted mohair. These are summarised in the implications.

Implications

Some of the major implications from this study are:

1. The mohair textile processing industry giving a strong message that short and cotted mohair are inferior products that are heavily discounted in the market.
2. If the current approach to mohair production continues, about 20% of Australia's mohair will be short and cotted costing the Australian industry about 10% of total income.
3. Producers of short and cotted mohair are very interested in eliminating the production of these products and generally understand the financial impacts on their enterprise.
4. As a consequence of the cessation of fibre growth, many Angora goats exhibit a seasonal shedding of mohair fibres during early to mid spring (September). These shed fibres show up as cross fibres in the staple. Fleeces that have shed fibres can exhibit matting and cotting (natural felting).
5. Management procedures must be developed that enable continuous mohair fibre growth.
6. Environmental influences on mohair production are large. This implies that some districts may be less suited to mohair production.
7. As Angora goats are likely to be affected by the effects of cold stress throughout the year, they expend considerable energy to maintain themselves. Restricted provision of energy and/or long periods of cold stress will exacerbate the seasonal depression in mohair growth. Consequently mohair production and fibre length will be reduced.
8. The provision of adequate shelter for Angora goats in cold districts must be treated as a high priority.
9. Angora goats grazing in colder regions of southern Australia and in mountainous regions are likely to need additional energy provision particularly during the winter half year.
10. Nutritional management skills of mohair producers need to be improved.
11. There needs to be a clear focus on breeding productive goats that grow long and fine mohair.
12. There is a trade off between different genotypes and the ideal form of mohair.
13. Selection of mohair sires should take into account winter mohair production.
14. Producers need objective information about the impact of staple characteristics such as style, character, tip shape and length, upon classed assessed length and upon processed fibre length.
15. Mohair harvesting procedures must be correctly implemented to harvest fibre before it cots in spring and to ensure it achieves B length classification.
16. There is a continuing role for mohair discussion groups. In the past this role has been provided by regional groups within Mohair Australia. The producer survey indicated that many producers now have no other known mohair producer within 50 km. This lack of contact with other producers is reflected in the findings of the survey.

17. There is a clear need for continuing training in a range of subjects covered in this report. Subjects requiring training include: fleece preparation, harvesting and breeding strategies, nutrition and energy supplementation and evaluation of suitable sires.

**Recommendations**

On the basis of the findings the following recommendations are made:

1. That the findings be published and made available to mohair producers and brokers.
2. Extension material and messages for mohair producers be revised to reflect the findings of this study.
3. That focussed learning and evaluation trials be undertaken with mohair producer groups with the priority to reduce the incidence of short and cotted mohair produced by goats growing fine mohair.
4. The acceptable variance in mohair staple length for different mohair length classes should be quantified.
5. Different shearing strategies for mohair should be evaluated.
6. The current potential limits for producing long fine mohair should be determined.
1 Introduction

1.1 Background

1.1.1 Fibre length and textile attributes
Mohair fibre length has important affects on the processing and quality of textiles. In worsted processing, length is regarded as being second in importance to diameter as far as fibre quality is concerned. Reducing the length of mohair reduces the potential spinning speed and therefore increases the overhead costs for the yarn. Reducing staple length reduces the length of the combed top. In worsted yarns, increasing fibre length improves tensile properties, reduces short-term irregularity, reduces yarn faults and generally reduces yarn hairiness. In fabrics, increasing fibre length generally reduces the propensity for pill formation, improves abrasion resistance in knitwear, and improves bursting strength of knitwear. Increasing fibre length variation increases yarn and fabric faults (Hunter 1980, 1993, Turpie 1985).

1.1.2 Historic market premiums for mohair length
Markets pay premium prices for the finest mohair of suitable length for processing. Raw staple length affects the price received for mohair. An analysis of the South African mohair prices between 1970 and 1980 (van der Westhuysen 1982) demonstrated that mohair prices were discounted by 10% if they were shorter than 7.5 cm, and for a very small component of production, a premium of 10% was paid for fibre longer than 15 cm. This analysis is now of limited value in the current Australian market.

In recent years in Australia, it has been possible to achieve price increases of between 20 and 80% for fine kid fibre by ensuring that this fibre was of the maximum accepted length (A length). Any kid or young goat mohair classed as cotted is very heavily discounted and this fibre sells for at a considerable discount to adult mohair prices. However there has not been a comprehensive statistical analysis of the price received for different types of Australian mohair using objectively measured fibre attributes.

1.1.3 Justification for investigation
It is in the interests of mohair producers, selling brokers and processors to maximise the financial returns from mohair production. As a consequence, the RIRDC Rare Natural Animal Fibre Research and Development Plan 1998-2003 identified under Objective Four “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.

Neither the exact causes nor the extent of the problems with short and cotted mohair nor the impact on the profitability of the Australian mohair industry have been defined.

1.1.4 Current industry practices
Mohair is harvested twice annually. Ideally the harvested mohair will be a suitable length to achieve A length classification. Australian mohair is sold by experienced brokers who sort the fibre into a number of grades. These grades include fibre diameter and length classifications along with other categories. It is possible that both harvesting strategies and selling/classing strategies of producers have not been optimised. This may be partially explained by some aspects of industry development.
While the Mohair industry has existed in Australia since the 19th Century there was significant expansion of the industry between 1970 – 1990, when mohair producing goats were:

- introduced to many environments where there was little knowledge of their management requirements;
- purchased by new entrants to agriculture; and
- bred with a large range of mohair genotypes.

Since 1990, genotypes from southern Africa and Texas have been crossbred with the existing Australian genotypes.

Despite a considerable period of improvement in the management and genetics of mohair producing goats, problems have continued with the production of short and cotted mohair.

The industry is currently valued at $3 to $3.5 million annually with considerable scope for expansion. Expansion is based on the demand for fine mohair and the demise of two former large producers of mohair, USA and Turkey. World production is currently at a 30 year low.

1.2 Project Objectives
This RIRDC supported project (DAV 192A) was titled “Optimising mohair harvesting strategies”. The objectives were:

1. To identify the extent and impact of the short and cotted mohair problem in Australia; and
2. To identify issues related to causing the short and cotted mohair problem in Australia.

This project aims to better identify the issues related to short and cotted mohair production in terms of impact, geographical spread, potential causes and potential solutions.

1.3 Project Methodology
1.3.1 Introduction
The following general process was outlined in the original submission and was carried out:

1. Market information for Australian mohair was collected from the major mohair selling brokers to determine the quantity of short and cotted mohair;
2. Objective information on the attributes and price received for Australian mohair was collected from the two largest mohair selling brokers;
3. A survey was conducted, via industry newsletters, of Australian mohair producers;
4. Selected mohair producers were interviewed;
5. Three mohair selling brokers were interviewed;
6. The published scientific and textile literature was reviewed.

1.3.2 Mohair market analysis
1.3.2.1 Quantity
Market details of price, product descriptions, objective tests, lot sizes, selling broker, selling date and other attributes for all mohair sold during the years 1998, 1999, 2000 and 2001, until November, were collected. The data were analysed to determine the quantity of mohair in different length and fault lines.

1.3.2.2 Price
An associated project has completed a full statistical analysis of the market data and these results will be published elsewhere. Data relevant to this project are provided for the impact of classed length category and of cotted lines upon the price received. The baseline response for this analysis is “A length mohair of average character, 0.5% vegetable matter for the 2nd Quarter selling period in 1999”. This date represents typical values for the data set and has a complete set of length and fault classes with objective test data. Results are presented as discounts (deviations) relative to the baseline mohair price. The total financial impact on industry returns is estimated by multiplying the percentage of fibre sold as short or cotted mohair by the estimated discounts.
1.3.3 Producer and broker surveys and case studies

1.3.3.1 Producer survey
A survey was prepared and trialed on mohair producers present at the August 2001 meeting of the Victorian Division of Mohair Australia. A revised survey (Appendix 1) was sent to all members of Mohair Australia, as an insert to the mailing of their Journal in August 2001. The survey was also sent as an insert in the mailing for most of the subscribers to the Australian Goat Report in September 2001. The data from completed surveys were entered onto a database. For clarification, some details were checked with some respondents. The data were analysed and graphed.

1.3.3.2 Broker survey and visits
A modified and expanded version of the producer survey was developed and sent to the three largest mohair-selling brokers. These brokers were visited in November 2001. During these visits, the details of their responses to the survey were checked and discussed in some detail. Inspections were made of short and cotted mohair and the techniques used in preparing short and cotted mohair prior to sale were demonstrated and discussed. Information collected has been summarised. In presenting the responses from the three brokers, their identity has been kept confidential. The references made to Brokers A, B and C are not static as these identifiers are randomly altered in each section.

1.3.3.3 Producer visits and case studies
Based on the responses to the producer survey, five visits were arranged to producers in the worst affected area of southern New South Wales. During these visits, the responses of the producer to the survey were discussed in great detail. Two producers willingly offered to provide the details of their mohair sales from recent years. Data from these mohair sale invoices have been analysed and is presented as case studies. The estimated lost value of selling C length mohair compared to the actual price received for B length mohair and the lost value of selling cotted mohair compared to selling BYG mohair have been calculated.

1.3.4 Literature review
Research databases have been searched in an attempt to find scientific and other publications on the subject. Databases searched include Agricola, World Textile Abstracts, Australian Bibliography of Agriculture and CAB Abstracts. Few articles were found. The review expands on a recent advisory article on the topic by including data available from previous research from RIRDC funded projects, information from a recent review on mohair growth, that summarises relevant work of other scientists, and other articles considered relevant to the topic. This review does not claim to be exhaustive. It does review biological issues and management practices that are considered to be appropriate in understanding potential impacts upon or solutions to the issues under consideration.
2 Extent and impact of short and cotted mohair production

2.1 Analysis of mohair market

2.1.1 Market volume

2.1.1.1 Volume by length class

The percentage of mohair sold by different length categories or as cotted mohair is summarised in Table 2.1. The total volume of mohair sold during the period exceeded 1,000,000 kg.

Mohair classed as A, AB and B length represented 65.1% of all mohair sold during the period under examination. Mohair sold as C length represented 13.0% of the total mohair weight sold during the period. Kid mohair represented 16.6% and young goat (YG) mohair contributed 21.6% of all the C length mohair sold during this period. The total of inferior length mohair sold (C length, locks and overgrown) was 13.6% of sales.

Table 2.1. The percentage, by weight sold, of Australian mohair according to length category or as cotted fault based on data provided by the two largest mohair selling broker over four years

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A length</td>
<td>27.6</td>
<td>20.9</td>
<td>20.4</td>
<td>20.3</td>
<td>22.3</td>
</tr>
<tr>
<td>AB length</td>
<td>9.8</td>
<td>11.4</td>
<td>10.6</td>
<td>10.2</td>
<td>10.5</td>
</tr>
<tr>
<td>B length</td>
<td>30.8</td>
<td>31.0</td>
<td>32.0</td>
<td>35.5</td>
<td>32.3</td>
</tr>
<tr>
<td>C length</td>
<td>11.5</td>
<td>13.0</td>
<td>14.2</td>
<td>13.3</td>
<td>13.0</td>
</tr>
<tr>
<td>Locks</td>
<td>0.6</td>
<td>0.5</td>
<td>0.4</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Overgrown</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>Cott Soft</td>
<td>6.1</td>
<td>6.1</td>
<td>5.4</td>
<td>4.6</td>
<td>5.6</td>
</tr>
<tr>
<td>Cott Hard</td>
<td>1.0</td>
<td>2.6</td>
<td>1.5</td>
<td>1.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Cott Vegetable Matter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td>Other mohair classes</td>
<td>12.6</td>
<td>14.5</td>
<td>15.5</td>
<td>14.4</td>
<td>14.1</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

1 Total for the period as mohair from these classes is often held over until the following year

2.1.1.2 Volume by cotted fault class

Cotted mohair represented 7.2% of the total amount of mohair sold during the period examined with over 75% of cotted mohair classified as soft (Table 2.1).

2.1.2 Market price

2.1.2.1 Price by length class

The mean deviations for the effects of different mohair length relative to the baseline of A length fleece, average character, 0.5% vegetable matter (VM), using prices from the 2nd quarter of 1999 are shown in Table 2.2. Locks were excluded from this analysis as no objective measurement data were available.

Following adjustment for other objective measurements, B length mohair sold at a price 6% lower than that of A length mohair (Table 2.2). Compared to A length mohair, C length mohair sold at a price 48% lower. Compared to B length mohair, C length mohair sold at a price 45% lower. Overgrown mohair was discounted by 56%.
The analysis detected an interaction between the length and the mean fibre diameter on the discount. Relative to the values given in Table 2.2, the discount of B and C length mohair was less at lower mean fibre diameters (25 to 28 µm) and the discount was greater at mean fibre diameters above 30 µm. The magnitude, in percentage term, of these interactions between length and mean fibre diameter, was greater in C length mohair compared to B length mohair.

Table 2.2. The percentage deviation in the price of mohair of different length classes and for cotted mohair, based on an analysis of mohair sales during the four year period 1998 to 2001 where objective testing data was available. The deviations are relative to A length mohair of average character with 0.5% VM, using prices from the 2nd Quarter 1999

<table>
<thead>
<tr>
<th>Mohair class</th>
<th>Mean deviation, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A length</td>
<td>0</td>
</tr>
<tr>
<td>B length</td>
<td>-6</td>
</tr>
<tr>
<td>C length</td>
<td>-48</td>
</tr>
<tr>
<td>Overgrown</td>
<td>-56</td>
</tr>
<tr>
<td>Cott soft</td>
<td>-37</td>
</tr>
<tr>
<td>Cott hard</td>
<td>-91</td>
</tr>
</tbody>
</table>

* Data only available for one Broker

2.1.2.2 Price by cotted fault class
The mean deviation for the effect of cotting on mohair price is given in Table 2.2. Mohair sold as soft cots was discounted by 37%. Hard cotted mohair was discounted much more severely achieving a 91% discount relative to the baseline mohair.

2.1.3 Estimated financial impact on industry
By multiplying the percentage of the market classified as short or as cotted mohair by the percentage discount, an estimate can be made of the total financial impact of short and cotted mohair (Table 2.3). For this analysis, locks have been included in the amount of C length mohair and the comparison is made with B length mohair.

The industry wide financial impact on the sale of greasy mohair from the production of short and cotted mohair is estimated as 10%. If the average price of mohair is assumed to be $10/kg and as the sales during the period under study exceeded 1 million kg, then the estimated cost of short and cotted mohair exceeded $1,000,000.

Table 2.3. Estimated impact of short and cotted mohair on the potential total financial returns from the sale of mohair using discounts from the 2nd Quarter of 1999. The figures represent the potential increase in financial returns if these fault classes were sold as B length mohair of average character with 0.5% vegetable matter

<table>
<thead>
<tr>
<th>Mohair class</th>
<th>Potential increase in total financial returns %</th>
</tr>
</thead>
<tbody>
<tr>
<td>C length and locks</td>
<td>6.5</td>
</tr>
<tr>
<td>Cott soft</td>
<td>2.1</td>
</tr>
<tr>
<td>Cott hard</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10.0</strong></td>
</tr>
</tbody>
</table>
2.3 Feedback from mohair selling brokers

2.3.1 Response to survey

2.3.1.1 Seriousness of problem

All brokers reported that the problems of short and cotted mohair occurred in most or all years. The two largest brokers regarded these problems as moderate and the smaller broker regarded the problems as minor.

The brokers indicated that short and cotted mohair represented the following approximate percentage of their throughput: 55%, 30% and 15%.

The brokers indicated that short or cotted mohair was a result of the following issues:

- In any given year, somewhere in Australia there is a drought so will always have some short mohair;
- More cotts and short in winter;
- Cotts are variable in amount and about half of the cotts depend on husbandry, particularly with beginners who follow poor practice;
- A lot of cotts are overlong indicating late shearing;
- Brokers lose commission as price of short and cotted mohair is much lower than better lines;
- Mohair from Launceston to Mackay falls into these categories;
- Currently more focus on knitwear markets and industry would see more of a discount if the market was focussed on worsted products;
- Significant amount of adult fibre is C length.

Photo 1. Dr. Doug Stapleton, National Mohair Pool P/L., Cudal, showing a bale of hard cotted mohair, that “can be avoided by following standard husbandry practices”.
2.3.1.2 How fibre length is determined

The brokers used different approaches in determining the length of mohair and different definitions for determining length class. The following summarises the responses from brokers.

Broker A. Experience is used to estimate the average length of fibres. The length measurements are not the maximum length but the average length of fibres. If in doubt, fibres are pulled out to straighten crimps. If mohair is boarder line for length and the staple has a blocky tip the mohair would be put up into the higher length class. If mohair was boarder line and had a tippy staple then the mohair would be down graded to a shorter length class.

Broker B. Visual assessment using a ruler or classing card as a guide. A number of staples (3 to 6) should be assessed if the fibre is close to a margin. Producers are supplied with a ruler. Reported that it is the actual fibre length that is important not the staple length. A stretched length may be 30 to 40% higher than the staple length. Thus some animals are more affected by visual assessment than other animals. When some fleeces are subjected to wet and cold conditions the style of the fleece is accentuated and the lock length is shortened.

Broker C. The system is based on a physical appraisal to estimate the average fibre length. A reasonable representative sample from different areas of the fleece is inspected. Staples may be drawn and held at their base but not pulled straight. If the mohair cannot be easily held then it is short mohair. If a farm lot is too diverse and lacks uniformity then the entire lot may be down graded to a shorter class.

The actual length categories used by the Australian Mohair Marketing Organisation (AMMO) and National Mohair Pools are shown in Table 2.4. Clancy (2000) clearly states that when evaluating the length of fleece types with obviously weak tips at least the top 1 to 2 cm should be disregarded as this weak fibre will break off during processing.

Table 2.4. The length requirements for mohair to be assigned to various length classes for the Australian Mohair Marketing Organisation (Clancy 2000) and the National Mohair Pools (Stapleton 2000)

<table>
<thead>
<tr>
<th>Length class</th>
<th>AMMO Fibre diameter class</th>
<th>NMP Fibre diameter class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Young goat and adult</td>
<td>Kid</td>
</tr>
<tr>
<td>A</td>
<td>13 - 16 cm</td>
<td>12 - 16 cm</td>
</tr>
<tr>
<td>B</td>
<td>11 - 13 cm</td>
<td>10 - 12 cm</td>
</tr>
<tr>
<td>C</td>
<td>6 - 11 cm</td>
<td>6 - 10 cm</td>
</tr>
<tr>
<td>Locks</td>
<td>0 - 7 cm</td>
<td>0 - 7 cm</td>
</tr>
<tr>
<td>Overgrown</td>
<td></td>
<td>Over 16 cm</td>
</tr>
</tbody>
</table>
2.3.1.3 How cotted mohair is defined
All brokers referred to the National Classing Standard. The process of classifying cotted mohair is subjective as described below.

**Soft cott**, lightly matted, underside has some felting, poor staple formation, long fibres become cross fibres leading to a staple being hard to separate. These fleeces hold together and take some effort to pull apart. The effort to pull apart the cott should be similar to that applied in a fibre opener in front of a scour. Affect all fleece types, have low VM. May end up in kempy mohair lines.

**Hard cott**, are cotts that are hard to commercially separate by machine and are impossible to separate by hand. Often hard cotts have no commercial value.

**No commercial value**, hard matted mohair that cannot be separated.

Cotts tend to be finer than fine hair mohair, in other words, cotts are more likely to be young goat cott in terms of fibre diameter.

Overgrown cotts cause problems as they do not open as well and are more likely to go into hard cotts. Overgrown cotts could wrap around the opening rollers and cause stoppages in works.

Cotting effectively reduces the processed length of the mohair, as in separating the fibres significant fibre breakage and significant fibre loss occurs.

Fibre suitable for classing into soft cotts includes light cotted fleeces, overlong staple cotted fleeces and cotted edges skirted from fleece lines (AMMO 2000).

**Photo 2. Craig Clancy, Australian Mohair Marketing Organisation Ltd., Narrandera, demonstrating how soft cotted mohair can be pulled apart with some difficulty.**
2.3.1.4 Are producers correctly preparing cott and length classes?
Two brokers said that some producers need more skill and one broker said that most producers needed more skill in correctly preparing cott and length grades.

A big improvement has been seen over the past 15 years. New producers need training and a need exists for updating and refresher courses. About 60% of suppliers to one broker did an excellent or very good job and about 25% needed training. Those needing training either didn’t know what to do or spent no time properly preparing the mohair. Smaller flock size producers have more problems with cotts as they are not on top of their husbandry requirements.

The main problems could be summarised as insufficient skirting, mixed length and lack of uniformity of lines especially for kid and young goat mohair, strong necks that should be taken out of the main line, cotts left in mainlines. Some producers are over sensitive and down grade good fibre. On the other side are the producers who think everything is A length and do not seem to know the length of 15 cm. There is a big $ incentive to do a good classing job at shearing.

Need to improve the feedback from mills as they frequently comment on the great variation within consignments. It is usual for all Australian mohair to be resorted into mill types. A better system for feedback from mills would be an advantage.

---

Photo 3. The hidden cost of short mohair production, high brokerage and handling charges. Jim Stanley, Australian Mohair Marketing Organisation Ltd., sorting a consignment of mohair for type and length.
2.3.1.5 *Suggestions on reducing short and cotted mohair*

The following suggestion on reducing the incidence of short and cotted mohair were received from brokers:

- Shear in February
- Shear in August
- Feed animals better during autumn and winter
- Short kid problem from fixed time shearing
- At least shear kids to obtain B length
- Give kids an extra month before shearing for the first time
- Could give does an extra month in spring if crutch and belly shear prior to kidding
- Book shearing 6 months ahead, plan better
- Need a reasonable percentage of African genetics
- Adjust shearing to avoid problems
- Shear before kidding to reduce incidence of cotts
- Timing of the months of kidding and shearing were important
- Select bucks for performance as not necessarily a strain difference.

*Photo 4. “This is what you want”, David Williams, Australian Mohair Trading P/L, with some A length kid.*
2.3.1.6 The districts with the greatest problems
Brokers provided the following comments:
All States had areas that produced short and cotted mohair. In particular, areas with higher rainfall, more severe bleak winters with cold winds.

The following districts were specifically mentioned;
In New South Wales/ACT: Tablelands, Yass, Canberra, Cooma, Bathurst, Armidale, Grenfell, Scone.
In Queensland: Warrick.

General comment. Many lifestyle farmers purchased land with poor soil and often overstocked their goats. These problems were more likely to contribute to problems with short and cotted mohair.

2.3.1.7 Perception of financial effect of selling short and cotted mohair during 2000
The responses from mohair selling brokers are summarised in Table 2.5. Most indicated a 5 to 10% discount for B length mohair compared to A length mohair although sometimes B length brings as much or more than A length. The discount for C length mohair was regarded as being mainly 30% compared to A length mohair with the discount increasing to 40 to 50% for coarser C length mohair.

Table 2.5. Summary of mohair brokers indicated financial effect of selling short mohair compared with selling A length mohair during the year 2000

<table>
<thead>
<tr>
<th>Mohair type</th>
<th>Discount compared to A length</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 to 10%</td>
<td>20%</td>
</tr>
<tr>
<td>BFKID</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CFKID</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>BKID</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CKID</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>BYG</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>CYG</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>BFH</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CFH</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

On occasions B brings more than A
Sometimes difference in fibre diameter between C and B
On occasions B brings more than A
BFH may bring more than AFH

The following feedback was provided by mohair selling brokers:
Feedback was provided to producers if cotts were present;
One broker initiated a discussion regarding shearing practices if cotts were serious;
Larger producers submitted better prepared mohair;
One broker wanted a new mohair preparation standard as preparation needed to be improved;
South African mohair tested for mean fibre diameter but length assessed according to perceived length after combing;
Approximately 20 to 30 mm difference between greasy mohair and length after top making;
C length mohair of 80 mm ends up as 60 to 65 mm and only suitable for woollen trade;
Mohair often blended so variation in length less important.
3 Experience of mohair producers – outcomes of survey

3.1 Characterising the respondents

3.1.1 Origin of respondents
Completed survey forms were received from 60 mohair producers. These producers farmed mainly in New South Wales (51%) and Victoria (20%) with similar numbers in the other states (Figure 3.1). This level of response is roughly in accordance with the geographical distribution of Angora goats within Australia. Most respondents provided data for all questions but two respondents provided little information.

![Figure 3.1. Origin of respondents to mohair producer survey, by State](image)

3.1.2 Neighbours of respondents
Almost 60% of respondents did not know any other property within 50 km of their own property, that had problems with short and cotted mohair whereas the reminder knew of at least one and one in eight respondents knew of 3 to 6 other properties with similar problems (Figure 3.2). In many cases respondents said that they knew of no one with Angora goats within 50 km.

![Figure 3.2. Percentage of respondents who knew of neighbours within 50 km who had problems with short and cotted mohair](image)
3.1.2.1 Neighbours with problem differentiated by origin
Only respondents from New South Wales, Victoria and Tasmania reported that 3 to 6 neighbours had a problem with short and cotted mohair (Figure 3.3).

![Figure 3.3. Percentage of respondents who knew of neighbours within 50 km who had problems with short and cotted mohair differentiated by origin of respondent](image1)

3.1.3 Size of Angora goats flocks
The number of Angora goats over 6 months of age (June 2000) in the flocks of respondents is shown in Figure 3.4. Eight flocks were over 500 head, while almost a quarter had 250 to 500 head and a similar number had less than 100 head. The most common flock size was 101 to 250 head (23/60).

![Figure 3.4. The percentage of respondents reporting flocks of different sizes](image2)
3.1.3.1 Size of Angora flock differentiated by origin

The flock size of the respondents differentiated by State of origin is shown in Figure 3.5. Origin of respondent did not affect the proportion of flocks larger than 500 Angora goats. New South Wales had a larger proportion of respondents with flocks of 251 to 500 Angora goats and a smaller proportion of respondents with flocks of 101 to 250 Angora goats compared to the respondents from other States. Victoria and Tasmania had the lowest proportion of respondents with flocks of less than 100 Angora goats compared to the other States.

![Flock size of respondents](image)

**Figure 3.5.** The percentage of respondents reporting flocks of different sizes differentiated by origin of respondent

3.1.4 Month of kidding

Respondents reported kidding months from July to November. Kidding was most common in the period from mid August to mid October (Figure 3.6).

![Month of kidding](image)

**Figure 3.6.** The reported months of kidding as a percentage of all responses from the respondents to the survey
3.1.4.1 Month of kidding differentiated by origin
Respondents from Western Australia, South Australia and Queensland reported a more compact kidding period peaking in August and September and with a lower incidence of kidding in October and November compared to respondents from other States (Figure 3.7).

![Graph showing percentage of kidding by month and state]

**Figure 3.7.** The reported months of kidding as a percentage of all responses from the respondents to the survey differentiated by origin of respondent

3.1.5 Time of shearing
Respondents reported shearing throughout the year (Figure 3.8). As expected, there were peaks of shearing in February/March and August/September.

![Graph showing percentage of shearing by month]

**Figure 3.8.** The reported months of shearing as a percentage of all responses from the respondents to the survey
### 3.1.5.1 Time of shearing differentiated by origin

Shearing by respondents in Western Australia, South Australia and Queensland appeared to be more compact about the autumn and winter/spring peaks (Figure 3.9). Shearing by respondents in Victoria and Tasmania and to a lesser extent in New South Wales was less pronounced about the autumn and winter/spring peak and extended all the year round, particularly late into spring.

![Figure 3.9](image)

**Figure 3.9. The reported months of shearing differentiated by origin of respondent as a percentage of all responses from the respondents to the survey**

### 3.1.6 Average genetic background

The respondents reported an average genetic make-up of their flocks as 47% Texan, 38% South African and 15% Australian (Figure 3.10).

![Figure 3.10](image)

**Figure 3.10. The average genetic make-up reported within the flocks of the respondents**
3.1.6.1 Genetic background by origin
The genetic background of flocks of respondents from New South Wales had less South African and more Texan blood than did the flocks of respondents from other States (Figure 3.11).

![Genetics Graph]

Figure 3.11. The average genetic make-up reported within the flocks of the respondents differentiated by origin of respondent

3.1.6.2 Genetic background by perception of seriousness
The perception of seriousness of problems with short and cotted mohair appears to be related to the reported genetic background of the Angora goats (Figure 3.12). Respondents reporting the most serious problems had the least South African genetics and the most Texan genetics while those reporting that the problems occurred in some years in the past had the most South African genetics and the least Texan genetics.

![Australian Genetics Graph]

Figure 3.12. The average genetic make-up reported within the flocks of the respondents differentiated by respondents perception of seriousness of the problem of short and cotted mohair
3.1.6.3 Genetic background differentiated by number of neighbours with the problem

Figure 3.13 indicates that respondents with 3 to 6 neighbours, who have problems with short and cotted mohair, had more Texan genetics and less Australian genetics in their flock than respondents who had no neighbours with problems with short and cotted mohair.

3.1.6.4 Genetic background differentiated by flock size

The size of respondents Angora goat flock was associated with different genetic background of their flock. Larger Angora goat flocks had, on average, a higher proportion of South African genetics and a lower proportion of Texan genetics compared with smaller Angora goat flocks (Figure 3.14).
3.2 Experience of short and cotted mohair

3.2.1 Frequency of experience

The vast majority of respondents reported that they experienced short and cotted mohair in the winter half year in some or most years (Figure 3.15). Almost half of the respondents experienced problems in some years, over 40% experienced problems in most years and only 10% of respondents said that they never experienced problems. It is quite possible that this survey under-represents those producers who never experience problems with short and cotted mohair.

Figure 3.15. Frequency of winters that mohair producer’s experience problems with short and cotted mohair

3.2.1.1 Frequency of experience by State of origin

There were differences between the respondents State of origin and their perception of the frequency of problems with short and cotted mohair. Respondents from Western Australia, South Australia and Queensland appear to have less frequent problems with short and cotted mohair than respondents from New South Wales, Victoria and Tasmania (Figure 3.16). The percentage of respondents reporting to never have a problem with short and cotted mohair was similar irrespective of origin.

Figure 3.16. Frequency of winters that mohair producer’s experience problems with short and cotted mohair differentiated by State of origin of respondent
3.2.2 Seriousness of problems

The problems with short and cotted mohair production were viewed as serious by 17% of respondents, moderate by 36% of respondents and minor or in the past by 45% of respondents (Figure 3.17).

![Figure 3.17. Perception of seriousness of problem with short and cotted mohair](image)

3.2.2.1 Seriousness of problem by State of origin

The problems with short and cotted mohair were regarded as being less serious and of minor importance by respondents from Western Australia, South Australia and Queensland compared to respondents from New South Wales, Victoria and Tasmania (Figure 3.18). However only respondents from New South Wales, Victoria and Tasmania reported that their problems with short and cotted mohair were in the past.

![Figure 3.18. Perception of seriousness of problem with short and cotted mohair differentiated by State of origin of respondent](image)
3.2.3 Financial impact

Almost two thirds of mohair producers responded that they thought the financial effect of short and cotted mohair during 2000 was less than $500. A quarter of respondents reported an impact of $500 to $1000 while one in eight producers (12%) reported an impact of greater than $1000 (Figure 3.19).

![Figure 3.19. The percentage of respondents reporting different financial impacts of short and cotted mohair on their property during the year 2000](image)

3.2.3.1 Financial impact by State of origin

There was a greater proportion of respondents from Western Australia, South Australia and Queensland reporting a financial impact of less than $500 compared with the other States. Correspondingly only respondents from New South Wales, Victoria and Tasmania reported financial impacts from short and cotted mohair of greater than $1000 (Figure 3.20).

![Figure 3.20. The percentage of respondents reporting different financial impacts of short and cotted mohair on their property during the year 2000 differentiated by State of origin of respondent](image)
3.3 Methods producers have used to reduce short and cotted mohair

3.3.1 Most common methods

Most respondents reported trying some approach to reduce the incidence of short and cotted mohair (48/59), even one grower who reported that they never had the problem. Three producers did not indicate which methods they had used to reduce short and cotted mohair.

The most common methods tried were genetics, nutrition, shearing, provision of shelter and other animal husbandry approaches (Figure 3.21).

![Figure 3.21. The percentage of respondents who reported using various methods to reduce short and cotted mohair](image)

**Figure 3.21. The percentage of respondents who reported using various methods to reduce short and cotted mohair**

3.3.1.1 Common methods by State of origin

There were differences in common methods used to reduce short and cotted mohair between respondents from different States. As shown in Figure 3.22, respondents from States other than New South Wales had tried genetic approaches to reduce short and cotted mohair much more frequently than respondents from New South Wales. Respondents from New South Wales had tried shearing more than respondents from other States. Respondents from Victoria and Tasmania had tried nutritional approaches less than half as frequently as respondents from Western Australia, South Australia and Queensland. Respondents from Western Australia, South Australia and Queensland did not report using shelter as a method to reduce short and cotted mohair.

![Figure 3.22. The percentage of respondents who reported using various methods to reduce short and cotted mohair differentiated by origin](image)

**Figure 3.22. The percentage of respondents who reported using various methods to reduce short and cotted mohair differentiated by origin**
3.3.1.2 Common methods by perception of seriousness

There were some differences between methods used by respondents based on their perception of seriousness (Figure 3.23). Respondents with the perception of the most serious problems used shelter and other husbandry methods twice as frequently, shearing only a quarter as often as other respondents and genetics less often than respondents who had the problem in most or some years.

![Successful methods](image1)

**Figure 3.23.** The percentage of respondents who reported using various methods to reduce short and cotted mohair differentiated by perception of seriousness of problem

3.3.1.3 Common methods differentiated by neighbours with problems

The responses suggest that respondents with more neighbours with problems with short and cotted mohair used shelter and other husbandry methods more and nutrition and shearing less frequently than respondents who had less neighbours with problems (Figure 3.24).

![Successful methods](image2)

**Figure 3.24.** The percentage of respondents who reported using various methods to reduce short and cotted mohair differentiated by number of neighbours within 50 km with problems of short and cotted mohair
3.3.1.4 Common methods differentiated by size of flock
Respondents with larger flocks of Angora goats reported using nutrition as a method of reducing problems with short and cotted mohair more frequently than respondents with smaller flocks of Angora goats. Respondents with larger flocks of Angora goats also appeared to use shearing and other husbandry methods less frequently than respondents with smaller flocks of Angora goats (Figure 3.25).

Figure 3.25. The percentage of respondents who reported using various methods to reduce short and cotted mohair differentiated by the size of the Angora goat flock of respondents

3.3.2 Producers with serious problems in most years
3.3.2.1 Origin and other characteristics
Respondents who reported serious problems in most years (n=10), originated from New South Wales (n=5), Victoria (n=2), Tasmania (n=2) and Western Australia (n=1). Seven of these respondents had < 250 goats and only one had > 500 goats. Two respondents reported a financial impact of between $500 and $1000 and two reported a financial impact of > $2500. Four of these respondents knew 3 to 6 other farmers with the problem and only two did not know anyone else with problems with short and cotted mohair. The average genetic background of their goats was: Texan 56%, South African 26%, Australian 18%. Three of these respondents had flocks with a genetic background of 75% Texan.

3.3.2.2 Successful methods used by producers with serious problems
All of the respondents who reported serious problems in most years reported successful methods of reducing short and cotted mohair. The most successful methods used where nutrition, genetics and husbandry, see Table 3.1 for details. Shelter and shearing were also reported as successful methods for reducing problems with short and cotted mohair.
Table 3.1. Methods that successfully reduced the problem of short and cotted mohair as reported by respondents who regarded the problem as serious in most years

<table>
<thead>
<tr>
<th>Nutrition</th>
<th>Husbandry</th>
<th>Genetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced stocking rate of goats</td>
<td>Eradicated lice</td>
<td>Culled poor bucks</td>
</tr>
<tr>
<td>Increased supplementary feeding of energy</td>
<td>Provided selenium</td>
<td>Used South African sires</td>
</tr>
<tr>
<td></td>
<td>Provided iodine</td>
<td>Selected sires with long winter staple length</td>
</tr>
<tr>
<td></td>
<td>Provided Vitamin B₁₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Controlled internal parasites</td>
<td></td>
</tr>
</tbody>
</table>

3.3.3 Producers with moderate or minor problems in most years

3.3.3.1 Origin and other characteristics
Respondents who reported moderate (n=13) or minor problems (n=2) in most years, originated from New South Wales (n=11), Victoria (n=3), and South Australia (n=1). Eight of these respondents had < 250 goats, five had 251 to 500 goats and two had > 500 goats. Four respondents reported a financial impact of between $500 and $1000 and three reported a financial impact of $1000 to $2500. Only one of these respondents knew 3 to 6 other farmers with the problem and eight did not know anyone else with problems with short and cotted mohair. The average genetic background of their goats was: Texan 50%, South African 41%, Australian 9%. Four of these respondents had flocks with a genetic background of at least 70% Texan.

3.3.3.2 Successful methods used by producers with moderate or minor problems
All but two of the respondents who reported moderate or minor problems in most years reported using successful methods for reducing short and cotted mohair. The most common methods used where genetics, nutrition and shearing, see Table 3.2 for details. Shelter and husbandry were also reported as methods for reducing problems with short and cotted mohair.

Table 3.2. Methods that successfully reduced the problem of short and cotted mohair as reported by respondents who regarded the problem as moderate or minor in most years

<table>
<thead>
<tr>
<th>Genetics</th>
<th>Nutrition</th>
<th>Shearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used less Texan sires</td>
<td>Increased feeding during winter</td>
<td>Shore in July and August to avoid summer shearing</td>
</tr>
<tr>
<td>Culled does with short mohair</td>
<td>Increased supplementary feeding of energy</td>
<td>Shore fleeces after 7 months winter growth</td>
</tr>
<tr>
<td>Used South African sires with open fleeces</td>
<td>Provided supplements of cereal grain before kid shearing and at first kidding</td>
<td>Shore summer fleece 4 to 6 weeks earlier</td>
</tr>
<tr>
<td>Selected sires with long winter staple length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcrossed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3.4 Producers with moderate or minor problems in some years

3.3.4.1 Origin and other characteristics
Respondents who reported moderate (n=8), minor problems (n=15) or similar problems in past years (n=4), originated from New South Wales (n=11), Victoria (n=5), Western Australia (n=4), Queensland and South Australia (n=3) and Tasmania (n=1). Ten of these respondents had 101 to 250 goats, five had 251 to 500 goats and five had > 500 goats. Five respondents reported a financial impact of between $500 and $1000 and one reported a financial impact of $1000 to $2500. Seventeen respondents knew no other farmer with problems and the rest knew 1 to 2 other farmers with problems with short and cotted mohair. The average genetic background of their goats was: Texan 43%, South African 43%, Australian 14%. The average genetic background of the flocks of respondents who reported their problems with short and cotted mohair were in the past was: Texan 19%, South African 56%, Australian 25%.

3.3.4.2 Successful methods used by producers with moderate or minor problems
All but four of the respondents who reported moderate or minor problems in some years reported using successful methods for reducing short and cotted mohair. The most common methods used where genetics, nutrition and shearing, see Table 3.3 for details. Husbandry and shelter were also reported as methods for reducing problems with short and cotted mohair.

Table 3.3. Methods that successfully reduced the problem of short and cotted mohair as reported by respondents who regarded the problem as moderate or minor in most years

<table>
<thead>
<tr>
<th>Genetics</th>
<th>Nutrition</th>
<th>Shearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used less Texan sires</td>
<td>Increased nutrition during winter</td>
<td>Moved shearing 2 months earlier</td>
</tr>
<tr>
<td>Used sires with a lower CV of MFD</td>
<td>Provided supplements to weaners during first winter</td>
<td>Shore fleeces after 6½ months growth in winter</td>
</tr>
<tr>
<td>Selected sires with better fleeces</td>
<td>Fed better supplements</td>
<td>Shore only when fleece length correct</td>
</tr>
<tr>
<td>Used better fleece type, avoided over cramped types</td>
<td>Provided trace elements</td>
<td>For pregnant does increased winter growing period</td>
</tr>
<tr>
<td>Avoided very fine fleece types</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.5 Producers who “never” had problems

3.3.5.1 Origin and other characteristics
Respondents who reported never having problems with short and cotted mohair (n=6), originated from New South Wales (n=2), Victoria (n=2), South Australia (n=1) and Queensland (n=1). Of these, four reported the problem as minor with a financial impact < $500 and another said that this year was the first year the problem had occurred. Of the five respondents to the question on flock size, four reported flocks of 101 to 250 Angora goats and the other had < 100 Angora goats. None of these producers reported knowing any other grower with a problem with short and cotted mohair. The average genetic background of their goats was: Texan 50%, South African 31%, Australian 19%.

3.3.5.2 Methods used by producers who “never” had problems
Two producers reported using methods to reduce the problem. One found good nutrition to be most important while the other emphasised the importance of basing a herd on quality does. The producer reporting his first experience with the problem had used a Texan sire for the first time.

A most interesting finding regarding shearing was that two of these respondents shore their goats in May and November. Only one other respondent in the survey indicated that they shore in May.
### 3.3.6 Methods reported as not reducing problems

A summary of method respondents reported as not helping them solve their problems with short and cotted mohair is provided in Table 3.4.

**Table 3.4. Methods that respondents reported as being of no help in reducing their problem with short and cotted mohair**

<table>
<thead>
<tr>
<th>Nutrition</th>
<th>Husbandry</th>
<th>Genetics</th>
</tr>
</thead>
<tbody>
<tr>
<td>High grazing pressure gave internal parasites and cotts</td>
<td>Late spring kidding does</td>
<td>Texan sires</td>
</tr>
<tr>
<td>Providing higher protein supplements in winter</td>
<td>Providing trace minerals without good nutrition</td>
<td>Different Texan sire lines no help</td>
</tr>
<tr>
<td>Supplementary feeding</td>
<td>Mineral licks</td>
<td>Weak culling</td>
</tr>
<tr>
<td>Poor quality pastures</td>
<td>Iodine</td>
<td>Texan goats up to 3 years old</td>
</tr>
<tr>
<td>Increased feeding in autumn</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Shearing</strong></td>
<td><strong>Shelter</strong></td>
<td></td>
</tr>
<tr>
<td>Delayed shearing in summer led to increased fly strike</td>
<td>No shedding</td>
<td></td>
</tr>
<tr>
<td>Late shearing in autumn</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.4 “Trade-offs” identified by producers

Three important “trade-offs” were identified by producers. These “trade-offs” were:

1. **No method works in isolation.**
   The respondent who made this comment had tried the following: culled worst animals; selected sires for staple length; used more African genetics; fed better over winter; moved shearing 4 to 6 weeks earlier; reduced stress, worms and lice.

2. **Longer mohair may be coarser mean fibre diameter.**
   A number of respondents indicated that the trade off for longer and less cotty mohair was an increase in the mean fibre diameter of the mohair. The impact of these issues is discussed later in this report.

3. **Cost of supplementary feeding is greater than the benefits.**
   Several producers made the comment that supplementary feeding was beneficial in reducing the problems of short and cotted mohair but in their view the costs of supplementary feeding was greater than the benefits in increased mohair value. This issue will be discussed later in this report.
4 Case studies - mohair producers

4.1 Market reports from producers
4.1.1 Producer A, 20 years experience, 500 Angora goats
A summary of the actual mohair sale prices and the calculated composition of the mohair clip by length and fault classes over the years 1998 to 2001 are provided in Table 4.1. The estimated lost value of selling C length mohair compared to the actual price received for B length mohair and the lost value of selling cotted mohair compared to selling BYG mohair is shown in Table 4.1.

4.1.1.1 Financial impact of short mohair
By weight, the percentage of kid mohair of C length ranged from 19 to 48%. When locks are included with C length fibre almost 40% of the total clip was of inferior length. Over four successive years’, short mohair reduced income from the sale of mohair by 9.0, 9.6, 18.6 and 20.9%. The largest impact occurred in years when the average price of mohair was above the long-term average and the smallest impact occurred in years that had no C length YG mohair.

The majority of the financial impact from short mohair was from the sale of C kid and C young goat fibre. Fibre classified as hair or fine hair contributed less than 5% of the impact in 1999 and 2000 and about 20% of the impact in 1998 and 2001.

4.1.1.2 Financial impact of cotted mohair
By weight, cotted fibre averaged 3.5% of total mohair production ranging from 0.2 to 6.4%. Over four successive years’, cotted mohair reduced income from the sale of mohair by 1.8, 0.1, 5.0 and 6.7%. The largest impact occurred in years when the average price of mohair was above the long-term average.

4.1.2 Producer B, 25 years experience, 800 Angora goats
A summary of the actual mohair sale prices and the calculated composition of the mohair clip by length and fault classes over the years 1999 to 2001 are provided in Table 4.2. The estimated lost value of selling C length mohair compared to the actual price received for B length mohair and the lost value of selling cotted mohair compared to selling BYG mohair is shown in Table 4.2.

4.1.2.1 Financial impact of short mohair
By weight, the percentage of kid mohair of C length averaged 17.5% and ranged from 14 to 22%. No locks were produced. Over three successive years’, short mohair reduced income from the sale of mohair by 5.8, 5.1 and 9.2%. The largest impact occurred in 2001 which experienced a lower than average rainfall when the average price of mohair was above the long-term average. No locks were produced.

The majority of the financial impact from short mohair was from the sale of C kid and C young goat fibre. Fibre classified as hair or fine hair contributed 12% of the financial impact in 2001 and less than 2% of the impact in 1999 and 2000.

4.1.2.2 Financial impact of cotted mohair
Over three successive years’, no cotted mohair was produced.
Table 4.1. Summary of the mohair sales over four years of Producer A who has 20 years of experience and over 500 Angora goats

<table>
<thead>
<tr>
<th>Year</th>
<th>Mohair class</th>
<th>% of Class</th>
<th>Sale $/kg</th>
<th>Lost value compared to B length $&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Lost value COT compared to BYG $&lt;sup&gt;2&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>A &amp; B Kid</td>
<td>65.1</td>
<td>28.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>34.9</td>
<td>15.00</td>
<td>1611</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>70.4</td>
<td>14.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>29.6</td>
<td>6.30</td>
<td>452</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>54.3</td>
<td>6.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>45.7</td>
<td>4.25</td>
<td>598</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>6.2&lt;sup&gt;4&lt;/sup&gt;</td>
<td>5.00</td>
<td></td>
<td>971</td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>9.8&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1.35</td>
<td></td>
<td>393</td>
</tr>
<tr>
<td>Total $</td>
<td>% of total</td>
<td>39.0&lt;sup&gt;2&lt;/sup&gt;</td>
<td>20.9&lt;sup&gt;3&lt;/sup&gt;</td>
<td>6.7&lt;sup&gt;3&lt;/sup&gt;</td>
<td>3054</td>
</tr>
<tr>
<td>2000</td>
<td>A &amp; B Kid</td>
<td>51.7</td>
<td>49.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>48.3</td>
<td>31.70</td>
<td>3403</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>76.3</td>
<td>16.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>23.7</td>
<td>14.00</td>
<td>935</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>60.6</td>
<td>7.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>39.4</td>
<td>6.15</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>6.4&lt;sup&gt;4&lt;/sup&gt;</td>
<td>6.35</td>
<td></td>
<td>1229</td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>2.7&lt;sup&gt;4&lt;/sup&gt;</td>
<td>2.10</td>
<td></td>
<td>178</td>
</tr>
<tr>
<td>Total $</td>
<td>% of total</td>
<td>32.5&lt;sup&gt;2&lt;/sup&gt;</td>
<td>18.6&lt;sup&gt;3&lt;/sup&gt;</td>
<td>5.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>4543</td>
</tr>
<tr>
<td>1999</td>
<td>A &amp; B Kid</td>
<td>80.8</td>
<td>26.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>19.2</td>
<td>17.70</td>
<td>1010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>100.0</td>
<td>13.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>48.7</td>
<td>5.55</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>51.3</td>
<td>4.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>0.2&lt;sup&gt;4&lt;/sup&gt;</td>
<td>9.50</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>6.7&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1.10</td>
<td></td>
<td>485</td>
</tr>
<tr>
<td>Total $</td>
<td>% of total</td>
<td>35.0&lt;sup&gt;2&lt;/sup&gt;</td>
<td>9.6&lt;sup&gt;3&lt;/sup&gt;</td>
<td>0.1&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1578</td>
</tr>
<tr>
<td>1998</td>
<td>A &amp; B Kid</td>
<td>77.7</td>
<td>17.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>22.3</td>
<td>11.00</td>
<td>455</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>100.0</td>
<td>8.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>66.5</td>
<td>4.75</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>33.5</td>
<td>4.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>2.2&lt;sup&gt;4&lt;/sup&gt;</td>
<td>3.75</td>
<td></td>
<td>186</td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>6.0&lt;sup&gt;4&lt;/sup&gt;</td>
<td>1.25</td>
<td></td>
<td>280</td>
</tr>
<tr>
<td>Total $</td>
<td>% of total</td>
<td>26.9&lt;sup&gt;2&lt;/sup&gt;</td>
<td>9.0&lt;sup&gt;3&lt;/sup&gt;</td>
<td>1.8&lt;sup&gt;3&lt;/sup&gt;</td>
<td>940</td>
</tr>
</tbody>
</table>

<sup>1</sup> Calculated as the weight of C length mohair multiplied by the difference in the price between C and B length mohair within the same class at the same sale

<sup>2</sup> Percentage of total mohair clip classed as C length, excluding COT and Locks

<sup>3</sup> Percentage expressed as increase in actual total income for year less 3.5% levies

<sup>4</sup> Percentage of total mohair sold that was cott or locks in year
### Table 4.2. Summary of the mohair sales over a period of three years of Producer B who has 25 years of experience and over 800 Angora goats

<table>
<thead>
<tr>
<th>Year</th>
<th>Mohair class</th>
<th>% of Class</th>
<th>Sale $/kg</th>
<th>Lost value C compared to B length $1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>A &amp; B Kid</td>
<td>82.7</td>
<td>28.00</td>
<td>703</td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>17.3</td>
<td>15.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>70.8</td>
<td>14.00</td>
<td>409</td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>29.2</td>
<td>6.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>85.6</td>
<td>6.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>14.4</td>
<td>4.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total $</strong></td>
<td></td>
<td></td>
<td><strong>1260</strong></td>
</tr>
<tr>
<td></td>
<td>% of total</td>
<td></td>
<td></td>
<td><strong>13.0</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>9.2</strong></td>
</tr>
<tr>
<td>2000</td>
<td>A &amp; B Kid</td>
<td>77.7</td>
<td>49.50</td>
<td>1053</td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>22.3</td>
<td>31.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>78.0</td>
<td>16.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>22.0</td>
<td>14.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>71.0</td>
<td>7.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>29.0</td>
<td>6.15</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total $</strong></td>
<td></td>
<td></td>
<td><strong>1207</strong></td>
</tr>
<tr>
<td></td>
<td>% of total</td>
<td></td>
<td></td>
<td><strong>19.0</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>5.1</strong></td>
</tr>
<tr>
<td>1999</td>
<td>A &amp; B Kid</td>
<td>86.1</td>
<td>26.00</td>
<td>801</td>
</tr>
<tr>
<td></td>
<td>CKid</td>
<td>13.9</td>
<td>17.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B YG</td>
<td>100.0</td>
<td>13.50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CYG</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>A &amp; B FH</td>
<td>68.2</td>
<td>5.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CFH</td>
<td>31.8</td>
<td>4.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>COT</td>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Locks</td>
<td>04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total $</strong></td>
<td></td>
<td></td>
<td><strong>912</strong></td>
</tr>
<tr>
<td></td>
<td>% of total</td>
<td></td>
<td></td>
<td><strong>14.6</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>5.8</strong></td>
</tr>
</tbody>
</table>

1. Calculated as the weight of C length mohair multiplied by the difference in the price between C and B length mohair within the same class at the same sale
2. Percentage of total mohair clip classed as C length, excluding COT and Locks
3. Percentage expressed as increase in actual total income for year less 3.5% levies
4. Percentage of total mohair sold that was cott or locks in year
4.2 Interviews with producers reporting serious problems

4.2.1 Producer A, 25 years experience, 500 Angora goats

Short mohair was more obvious with Texan goats of higher density. Their longest mohair came from upgraded Australian goats. However before they began using Texan goats they had problems with short mohair during winter. With the objective to limit density and the short mohair problem they now use Texan bucks one year with South African bucks used over the progeny. Trying now to purchase finer South African bucks as they had experience of African bucks being too coarse.

Always shore does just before kidding so that during cold/wet weather the does will take their kids to shelter (Table 4.3). When asked why does were not shorn in February, to help produce longer mohair during winter, the grower replied that there were difficulties in arranging shearing at that time of year. Shearers were not willing to do small numbers of animals with the small rate of pay.

Table 4.3. The usual shearing and kidding practice of Producer A

<table>
<thead>
<tr>
<th>Date</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>All goats shorn</td>
</tr>
<tr>
<td>April</td>
<td>Four weeks after shearing depasture bucks with does, sell cull does</td>
</tr>
<tr>
<td>Mid September</td>
<td>Does shorn just before first kids arrive, all adult stock shorn</td>
</tr>
</tbody>
</table>

Usual practice was to feed does during winter at a rate of 240 kg per 300 does each week, a rate equivalent to 114 g/day. This feeding was undertaken from autumn shearing until kidding. Hay also fed during periods of very wet weather. Does also dosed with selenium supplements.

Puzzling issues identified by the grower.

Why do some breeders not have the problem?

What is the acceptable variation/range in mohair length for each length class?

Why no D length?

What is the real definition for locks?

Is their some trace elements that Angoras are missing?

How do we grow long fine mohair?

4.2.2 Producer C, 20 years experience, 200 Angora goats

This grower’s property is situated at an altitude of 850 m above sea level. The problem of short mohair is greater with Texan animals than with the Australian goats. The shorter mohair is often found with the finer goats. In recent years have used South African bucks with longer and more free-falling mohair.

Normal routine summarised in Table 4.4. Has found that they cannot mate does earlier than April as the does are not coming into season. In the past does came into season two months earlier. They would prefer to kid earlier. In recent years have tested for selenium but it was not deficient. Goats all have shelters now as in past goats without shelters have had shorter mohair.

Feed oats and hay from late April/early May, depending on the season, until early September when spring arrives. Normally feed 100g/doe/d building up to 250 g/head/d at kidding. From May they feed approximately 1.7 kg of lucerne hay/doe/day plus grazing. Monitors does using body condition scoring and increase feeding if does lose condition.

The length of mohair in summer is approximately, A length 80% of does, B length 20% of does and some kids, C length most yearlings and kids. In winter A length 10% of does, B length 20% of does, C length 70% does, 100% yearlings and kids.
Table 4.4. The usual shearing and kidding practice of Producer C

<table>
<thead>
<tr>
<th>Date</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late February</td>
<td>All goats shorn</td>
</tr>
<tr>
<td>1\textsuperscript{st} week of April</td>
<td>Depasture bucks with does for 8 weeks</td>
</tr>
<tr>
<td>Mid August</td>
<td>Adult stock shorn 3 to 4 weeks before kidding</td>
</tr>
<tr>
<td>September</td>
<td>Kidding</td>
</tr>
</tbody>
</table>

4.2.3 Producer D, 20 years experience, 150 Angora goats

This producer is aiming to produce 10 cm long kid mohair. They have produced mohair with a kid mean fibre diameter up to the fourth shearing. However using the traditional classing of the fibre at the fourth shearing classifies the fibre as either C length adult or B length kid.

They are attempting to resolve the conflict between the African goats with a coarser mean fibre diameter and the Texan goats with failing fleece constitution. One of their responses has been to mate only half of their yearling kids in an attempt to maintain production of long fine mohair. These kids are mated two weeks earlier (and only for two cycles) than the does and 80% kid on their first cycle.

They reported that they had a response to Vitamin B\textsubscript{1} and the provision of multi mineral block has assisted maiden does to grow. They would prefer to kid earlier than the first week in September as October born kids tend not to grow out. In the past they supplied lucerne hay but gained no response. The feeding of 50% oats and 50% lucerne provided an improvement. Have tried other feed mixes as well.
5 Literature review

5.1 Introduction

Little information exists on managing mohair producing goats to reduce the incidence of short mohair, particularly during winter and to reduce the incidence of cotted mohair. One relevant advisory article (McGregor 1995a), that was subsequently revised and republished in Australian Goat Notes (McGregor 2001), discusses the topic of growing longer mohair.

The present review expands on these articles by including data available from previous RIRDC funded research projects, information from a recent scientific review on mohair growth and other articles considered relevant to the topic. This review includes reference to articles discussing the problem of wool growth and cottedness in wool. It also reviews some relevant biological issues and management practices that are considered to be appropriate in understanding potential impacts upon or solutions to the issues under consideration.

5.2 Biological issues

5.2.1 Photoperiod

The variation in day length between seasons has been reported to affect the growth of wool (Nagorcka, 1979), mohair (Stapleton, 1978), and cashmere, with fibre growth being lowest in midwinter and highest in midsummer. Nagorcka (1979) considered the photoperiod response in Merino sheep to be a modification of the “archaic pattern of shedding” seen in unimproved breeds such as Wiltshire Horn sheep. The variation in day length (natural photoperiod) is related to latitude.

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).

5.2.1.1 Mohair

Stapleton (1978) fed Australian Angora wether (castrate) goats to maintain a near constant live weight for 18 months, eliminating nutritional variation as an influence on fibre growth. The amplitude in mohair fibre growth rates was 55%, with mohair growth rate greater in summer than in winter. The proportion of medullated and kemp fibres in the fleece also varied in a similar fashion.

Margolena (1974) reported that the proportion of non-growing follicles in Texan and South African mohair goats was much greater in winter than in spring (Table 5.1). These observations appear to have confounded genotype with season of observation but may suggest that the primary exogenous control of mohair fibre growth is photoperiod. The data also indicate that in the Texan Angora goats used in the study one of the main effects of age was an increase in the proportion of non-growing (shedding) follicles during the short day season.

<table>
<thead>
<tr>
<th>Age</th>
<th>% Non growing fibres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Winter</td>
</tr>
<tr>
<td>6 months</td>
<td>1.2 (SA)</td>
</tr>
<tr>
<td>1 year</td>
<td>10.5 (T)</td>
</tr>
<tr>
<td>2 years</td>
<td>19.0 (T)</td>
</tr>
<tr>
<td>3 years</td>
<td>24.5 (T)</td>
</tr>
<tr>
<td>4 years</td>
<td>39.0 (T)</td>
</tr>
</tbody>
</table>

Table 5.1. Percentage of non growing mohair fibres in South African (SA) and Texan (T) Angora does by age and season (adapted from Margolena 1974)
Both these observations (Margolena 1974, Stapleton 1978) may have confounded temperature variation with photoperiod and Margolena may have also confounded reproduction with photoperiod. Therefore the influence of photoperiod per se on mohair production is likely to have been overstated. None-the-less, photoperiod and the increase in the number of non-growing mohair follicles in winter will substantially reduce the potential mohair growth during the winter half year.

5.2.2 Susceptibility to cold stress

5.2.2.1 Critical conditions

The impact of cold stress on the energy requirements of grazing animals is discussed in detail in the manual “Feeding Standards for Australian Livestock: Ruminants” (Anon 1990). Grazing ruminants such as goats try to maintain a near-constant body temperature of approximately 39°C, and this is not a major issue when an animal is in the “zone of thermoneutrality”. The lower limit of the zone of thermoneutrality is the lower critical temperature (Tlc). Tlc varies with the thermal insulation and the rate of heat production of an animal. Thermal insulation is the resistance to heat loss and is provided by tissues, fleece, the boundary layer of air trapped in the fleece, and is affected by wind speed, rainfall and the air temperature.

An animal will increase its heat production if the air temperature falls below the Tlc. The maximum attainable heat production is called the summit metabolism. In sheep, the summit metabolism is approximately 2.16 MJ/kg W^{0.75} per day, where W is live weight (Anon 1990). The summit metabolism cannot be maintained for more than a few hours although a sheep can maintain half the summit metabolism for a number of days. Some examples of Tlc are provided in Tables 5.2 and 5.3. For a 40 kg doe, at the summit metabolism, the total energy usage in 4 hours is equivalent to 5.7 MJ, similar to the metabolisable energy content of about 500 g of wheat or barley grain.

As can be seen from Tables 5.2 and 5.3, the critical temperature in wet and windy temperature when a sheep or calf has a 10 mm coat can be as high as 27 to 32°C. The information available for goats is limited. The data for calves are provided as their coat more closely resembles that of many goats although the body shape of calves is different to that of goats.

Holmes and Clark (1989) reported that the Tlc of cashmere goats, weighing 14 to 22 kg, was increased by 3 to 5°C when wind speed was increased from 0.7 to 6 km/h. At 16°C, following 4 hours of simulated rain, the metabolic rate of the cashmere goats increased 90% over that of the goats in dry conditions.

Table 5.2 Estimated lower critical temperatures (Tlc) for sheep as provided by Anon (1990) and for feral and cashmere goats (Holmes and Moore 1981, Holmes and Clark 1989)

<table>
<thead>
<tr>
<th>Animal</th>
<th>Air and feeding conditions</th>
<th>Coat depth</th>
<th>Tlc, °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheep, Adult</td>
<td>Still air, fasted</td>
<td>Shorn, 5 mm</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Still air, maintenance</td>
<td>Shorn, 5 mm</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Still air, full fed</td>
<td>Shorn, 5 mm</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Still air, maintenance</td>
<td>50 mm</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Still air, maintenance</td>
<td>100 mm</td>
<td>-3</td>
</tr>
<tr>
<td>Feral goat, 21 kg</td>
<td>Still air, maintenance</td>
<td>57 mm</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Wind 7 km/h, maintenance</td>
<td>57 mm</td>
<td>12</td>
</tr>
<tr>
<td>Cashmere goat, 18 kg</td>
<td>Still air, 1.25 times maintenance</td>
<td>4 mm</td>
<td>16-22</td>
</tr>
<tr>
<td></td>
<td>Still air, 1.25 times maintenance</td>
<td>8 mm</td>
<td>11-15</td>
</tr>
</tbody>
</table>
Table 5.3. The lower critical temperatures (°C) at thermoneutral conditions for a 50 kg live weight adult sheep and a 40 kg live weight calf fed at maintenance (Anon 1990)

<table>
<thead>
<tr>
<th>Coat depth</th>
<th>Wind km/h</th>
<th>Calm</th>
<th>10</th>
<th>20</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm Rain mm/d</td>
<td>0</td>
<td>10</td>
<td>30</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Adult sheep 50 kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>30</td>
<td>5</td>
<td>8</td>
<td>11</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td>50</td>
<td>-5</td>
<td>-2</td>
<td>1</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Calf 40 kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>22</td>
<td>25</td>
<td>26</td>
<td>28</td>
<td>29</td>
</tr>
</tbody>
</table>

5.2.2.2 Thermal insulation
Compared to the most common sheep in Australia, the Merino sheep, Australian Angora goats have less thermal insulation and protective features from extreme weather conditions (McGregor 1985a).

Compared to Merino sheep, Angora goats have:
- much less water repelling grease (wool wax) in their fleece. The grease content of mohair (about 5 to 10%) is substantially less than that of Merino wool (10 to 25%);
- much lower fibre density. Angora goats have far less growing fibres per unit area of skin than Merino sheep;
- lower thermal insulation of the outer fleece. The insulation properties of the mohair fleece are lower as the mohair fleece hangs from the body, is disturbed by wind gusts and is often parted along the back-line allowing easier wetting of the skin and penetration of air;
- generally smaller body mass at any given age compared to sheep and lambs. The smaller body mass of Angora goats provides less buffering to extreme weather;
- thinner subcutaneous fat depots along the back;
- more lustrous fleeces compared to the dark soiled tip of wool. This further reduces the relative thermal insulation of Angora goats compared to Merino sheep.

5.2.2.3 Saturation of fleeces and hypothermia
Relative to sheep, goats appear to be more vulnerable to continuous rain at low wind speed and to intense storms (Wentzel et al. 1979, Holmes and Moore 1981, Poolman 1984, McGregor and Presidente 1985, McGregor and Rizzoli 1991). Part of the increased vulnerability of goats is that less rain is required to saturate their fleece compared to sheep (>7 mm of rain is required to saturate sheep). Rainwater displaces the warm insulating layer of air within the fleece.

Holmes and Moore (1981) demonstrated that goats have a higher critical temperature than sheep when their coats were the same depth. In Holmes and Moore’s study, for sheep to have the same critical temperature as goats with a 60 mm deep fleece, the wool fleece needed to be only 30 mm deep. Signs of physiological stress increase and heat production of goats increases rapidly as the air temperature falls below 15°C and under wet and windy conditions the heat production can increase at 27 to 29°C (Wentzel et al. 1979, Poolman 1984).

Research in South Africa concluded that Angora goat deaths could occur as soon as minimum temperatures dropped below 10°C with 15 mm rainfall and a simultaneous wind run of 7.5 km per hour. These criteria had a 73% correlation to goat death rates (Rowswell 1986). In southern Australia, McGregor (1984 unpublished) found high stocking rate, low body condition score and low live weight all positively correlated to deaths of Angora goats from hyperthermia.
Following shearing the general industry advice to fibre producers is that the most susceptible time for death is for:

- sheep, the first 2 weeks;
- fibre goats, the first 6 weeks.

### 5.2.2.4 Shearing practice

Shearing removes the external natural insulation of the goats and leaves them exposed to the elements. Shearing practice also reduces the total amount of insulation found on Angora goats compared to Merino sheep. Angora goats are shorn twice each year, usually in autumn and spring. As a result of shearing, the thermal insulation provided by the fleece of Angora goats during the coldest period of the year is significantly less than that of spring shorn Merino sheep. During winter for example, autumn shorn Angora goats may have 1 to 1.5 kg of fleece, whereas spring shorn Merino sheep have at least 3 to 3.5 kg of fleece (McGregor 1985b).

Birrell (1989) determined the influence of pasture and animal factors on the consumption of pasture in Corriedale sheep shorn annually and grazed on mixed perennial/annual species pastures at Hamilton, Victoria. Intake rate was elevated by 40 to 50% immediately after shearing but then took over six months (more than 180 days) in 55 kg sheep to fall to a steady state. In heavier sheep (75 kg) it took only four months (120 days) for intake rate to fall to a steady state. Farrell and Corbett (1970) provided evidence that the fasting heat production of Merino sheep increased significantly after shearing and that the return to pre-shearing values in heat production was not observed until 135 days after shearing. They concluded that sheep at pasture had an increased energy requirement for maintenance for a considerable period after shearing.

On the basis of the data provided including the observations that:
- the fleece of the Angora goat is not as efficient an insulator as is the fleece of a Merino sheep;
- Angora goats are shorn bi-annually; and
- the mean live weight of Angora goats is less than 55 kg,

it is highly likely that Angora goats suffer the effects of exposure to cold stress throughout the year.

### 5.2.3 Effects of nutrition

#### 5.2.3.1 Climate-herbage system

Because nutritional variation both within and among years is the most important environmental factor influencing wool growth of sheep (Black and Reis, 1979) experiments have been undertaken in Australia to assess the influence of nutrition on mohair production. In Australia, the majority of farmed goat grazing occurs on grasslands, either improved or native, which exhibit very seasonal patterns of pasture growth. Growing seasons are most commonly of 5 to 8 months in mediterranean and some temperate areas and but may extend up to 10 or 12 months in high rainfall areas and in regions with irrigation.

Mean annual rainfall in the wheat-sheep zone varies from 400 to 750 mm. Usually growing seasons extend from mid autumn to late spring although in northern parts of the wheat-sheep zone (northern Tableland of New South Wales and in southern Queensland) summer rainfall predominates. In the mediterranean, wheat-sheep and parts of the temperate rainfall zones, hot summers and autumns are characterised by declining quantities and qualities of mature dead pasture residues. In some higher altitude temperate regions (eg Southern Tablelands of New South Wales) winters may be so cold that little pasture growth occurs and the summers are characterised by higher pasture growth.

It has been known for many years that mature dead pasture residues are deficient in both energy and nitrogen resulting in loss of live weight and declining fibre production of sheep grazing such pastures (Donald and Allden, 1959). Angora goats grazing such pastures are also affected to a similar extent as Merino sheep (McGregor 1985b, 1990, 1998). In an environment with a mean annual rainfall of 520 mm, McGregor recorded, over a period of three years, Angora goats losing live weight during summer and autumn for 5, 7 and 4 months. These live weight losses were equivalent to 14%, 21% and 20% of the previous end of spring maximum live weight. These periods of live weight loss are normal as there are no or few browse plants available as alternative feed sources. In this environment ad libitum
nutrition only occurs in spring for about 2 to 3 months (when mohair goats are likely to grow greater quantities of kemp). Maintenance of live weight is rarely observed but during winter goats may only gain 10g/d whereas Merino sheep may gain 60 g/d. In this environment, mohair growth was least during summer and greatest during autumn.

5.2.3.2 Soil-plant trace nutrient composition
Deficiencies in trace mineral nutrition cause loss of production and health in fibre producing animals. With increasing research, formulation of mineral requirements for goats is becoming less of an extrapolation of sheep and cattle work (Haenlein, 1992). Effects of mineral deficiencies on fibre goats are known to be large in practice but the requirements have not been clearly established for maintenance or production.

Qi et al. (1992) reported quadratic responses to sulphate (sulphur) for mohair growth, staple strength and staple length with no response in other mohair quality traits. They concluded that optimum sulphur levels were 0.267% of DM and a nitrogen:sulphur ratio of 7.2:1. This work suggests that previous recommendations for dietary sulphur are inadequate for mohair growth.

In the wheat-sheep and temperate environments of southern Australia Se, Cu, Co and I deficiencies and probably Zn have been reported in certain regions (Hosking et al. 1986, McGregor 1990). Kids born during late winter and spring in areas of high winter rainfall may exhibit goitre, lack of vigour and fleece development problems.

5.2.3.3 Influence of rate of stocking on mohair production
The rate of stocking of pasture is the single most important management decision that influences the productivity and economic viability of fibre producing farms in Australia. A study into the influence of the rate of stocking of Angora goats grazing annual temperate pastures in the wheat-sheep zone (McGregor, 1985b, 1987) showed that as the rate of stocking increased, the availability of pasture decreased, pasture composition changed and pasture structure changed. The effects of rate of stocking on mohair fibre characteristics were large and commercially significant (Table 5.4).

Table 5.4. The main effects of stocking rate on mohair production and mohair quality parameters of Angora goats grazed on annual pastures in southern Australia

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Effects of stocking rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohair weight</td>
<td>High stocking rate reduced production by up to 20% per goat but increased production per hectare.</td>
</tr>
<tr>
<td>Fibre diameter</td>
<td>High stocking rate gave up to 5 m finer mohair.</td>
</tr>
<tr>
<td>Kemp incidence</td>
<td>Grazing goats at high stocking rates increased kemp.</td>
</tr>
<tr>
<td>Clean yield</td>
<td>High stocking rates reduced clean washing yield by up to 5%.</td>
</tr>
<tr>
<td>Mohair length</td>
<td>High stocking rate reduced mohair length.</td>
</tr>
</tbody>
</table>

The limiting factor in these grazing studies was the effect of increasing the rate of stocking on the rate of mortality and the level of gastrointestinal parasitism in Angora goats. Angora goats ingested more infective trichostrongylid larvae than did sheep (Jallow et al., 1994). It was concluded that heavier trichostrongylid burdens of goats compared with sheep, when grazed together, are due in part to greater rates of infection consequent on different grazing patterns as well as greater susceptibility to infection. At high rates of stocking, the mortality rate (primarily gastrointestinal parasitism and post shearing weather stress) was twice that at lower rates of stocking.

The research concluded that:

mohair producers need to graze Angoras at rates of stocking no greater than that recommended for sheep; and to minimise both gastrointestinal parasitism and post shearing weather stress, rate of stocking should be no higher than 8 dry sheep equivalents/ha (a dry sheep equivalent being the feed required to maintain a 45 kg wether sheep).
Angora goats managed in this way, in a wheat-sheep environment, gain relatively rapidly, grow more mohair that will be longer and coarser than more heavily stocked goats but the greasy mohair is likely to have lower levels of medullated fibre and the health and welfare of the goats will be maximised.

5.2.3.4 Seasonal energy deficiency in Angora goats
The main period of energy deficiency in the wheat-sheep environment is in the summer dry period when goats usually lose live weight. In temperate or perennial regions that experience bleak cold winters, the winter period may be the main period when goats need energy supplements.

In some environments it may be that grazing goats are energy deficient in both mid winter and in late summer-autumn. For example, in southern Victoria during winter (June and July), yearling bucks grazing green annual pastures grew rapidly in response to supplements of whole lupin grain while goats offered low quality hay or unsupplemented goats did not grow until mid August when spring pasture growth commenced (McGregor 1996).

5.2.4 Staple length
5.2.4.1 The length:diameter relationship
Increased wool length is associated with increased mean fibre diameter (Reis 1992) and the ratio of fibre length (l) to mean fibre diameter (d) remains nearly constant for individual sheep over a wide range of fibre growth rates caused by normal fluctuations in nutrition. There is however, no clear agreement in the literature about whether the ratio l/d or l/d^2 is the preferred constant for comparing the affects of treatment on wool fibre metrology (Hynd 1989, 1994). Many scientists prefer to use l/d^2 as d^2 more closely represents the cross-sectional area of a fibre than does d.

In Australian Angora does, nutritional manipulation during pregnancy and lactation did not affect the l/d or l/d^2 ratios of mohair grown during pregnancy or during lactation. With kids born to these Australian Angora does, the l/d and l/d^2 of mohair grown during the first six months was affected by nutritional manipulation of their dams during lactation but not during pregnancy. Mohair grown during the subsequent winter and summer (the second and third fleeces) was unaffected by nutritional manipulation during pregnancy or lactation (McGregor 1995b).

5.2.4.2 Staple and fibre length
While it is well known that the length of staples within a fleece (SL) is not equal to the length of the longest fibres in a staple (FL) the two measurements are correlated. Lang and Chaudhri (1948) reported that SL and FL bear an approximately constant ratio in Merino and they therefore considered the practice of using straight staple length in assessing fleece length to be justified. In their study, the mean fibre length was approximately equal to 1.37 times the staple length. However Whan (1972a) studied a wider range of staples from 21 lots of Merino wool. He reported that both the ratio of average fibre length to staple length and the regression coefficients for these parameters varied over a wide range (1.1 to 1.6 for the ratios and 0.4 to 1.0 for the regression coefficients). He concluded that the large variation and relatively low correlation coefficients indicated that the use of staple length as a predictor of the average fibre length of greasy wool was inefficient.

There is considerable staple length variation in bales of greasy wool. Whan (1972b) provided details of the effect of the removal of short wool during skirting on the staple length variation. He concluded that skirting made the biggest contribution to staple length uniformity, with classing having a secondary effect. Of the variation in staple length occurring within a bale, about half was found within fleeces and a half was found between fleeces. Further research by Rottenbury et al. (1980) concluded that within a mob of Merino sheep, the variability in staple length between fleeces was less than the variability found within a fleece. Furthermore, they confirmed that only a small proportion of the variability found between fleeces was reduced by then current fleece classing procedures.

Whan (1972a) cites a number of other workers who have found that the staple length can account for 87% of the variation in the average fibre-length in tops. It is the current practice within the Australian
wool industry to objectively measure the mean length of staples from a grab sample of wool taken prior to sale.

5.2.4.3 Crimp form and fibre length
While the crimped length of a wool staple (CL), being the length of the crimped form of the staple, is also correlated with SL, CL is affected by the crimp form and frequency (Balasubramaniam and Whitely 1964). The effect of crimp form on the actual straight length of a fibre is that helical crimped fibres are longer than sine crimped fibres given the same initial crimped length.

These findings suggest that mohair with more style (ringlets or helical crimp) may be longer than mohair with a similar crimp frequency but with flat locks (sinusoidal crimp). However it is necessary to take crimp frequency into account as well as the amplitude or depth of the crimp wave before determining the theoretical affect of crimp form and frequency on fibre length.

5.2.4.4 Staple style and character and processed fibre length
McGregor (1997) recently review the two published papers on the influence of the style and character of mohair on the processed length of mohair. The review highlighted that differences existed between how scientists in Texas defined style and character (Table 5.5) and how scientists in South Africans defined these attributes. There were also important differences in the processing of the mohair that may have contributed to the different conclusions reached by the researchers.

Table 5.5. Definitions of style and character used by textile researchers

<table>
<thead>
<tr>
<th></th>
<th>Texan study Minikhiem et al. (1994).</th>
</tr>
</thead>
<tbody>
<tr>
<td>Style</td>
<td>the number of ringlets, twists or curls per cm</td>
</tr>
<tr>
<td>Character</td>
<td>the number of crimps or waves per cm</td>
</tr>
</tbody>
</table>

South African study Hunter et al. (1997).
Traits included in the assessment of style and character:
the curliness and waviness of the staple,
the kempiness of the mohair and
other unspecified traits.

Minikhiem et al. (1994) concluded that objectively determined style and character of greasy Texan mohair had little impact on the fibre length characteristics of mohair tops. Style did provide an indication of kemp in the top. The South African study reported significant effects of style and character on both raw staple length and processed mohair length (Table 5.6).

It is important to note that definitions of style and character can include such parameters as staple tip shape, staple colour, and vegetable matter contamination. If any of these attributes were included in the South African definition such attributes may have significantly contributed to their apparent success in the prediction effects of style and character. The inclusion of kempiness in the South African would have altered their assessments whereas it did not “bias” the Texan measurements. In other words, the two studies may not be comparing apples with apples when they compared style and character results.

As Australian mohair is marketed in various ways by different brokers the direct application of the definition to style and character to the marketing of Australian mohair needs clarification.
Table 5.6. The predicted effects of increasing the diameter, the style and character and the staple length of Cape greasy mohair or mohair tops on the properties of mohair top or yarn (derived from Hunter, Smuts and Dorfling 1997)

<table>
<thead>
<tr>
<th>Top or yarn property</th>
<th>Increasing fibre diameter 1 µm</th>
<th>Increasing style &amp; character one grade</th>
<th>Increasing staple length 10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top fibre length (mm)</td>
<td>+ 2.1</td>
<td>+ 6.2</td>
<td>+ 3.0</td>
</tr>
<tr>
<td>Noil (%)</td>
<td>+ 0.42</td>
<td>+ 0.2</td>
<td>- 0.02</td>
</tr>
<tr>
<td>Spinnability (revs/min)</td>
<td>- 175</td>
<td>+ 105</td>
<td></td>
</tr>
<tr>
<td>Yarn strength (cN/tex)</td>
<td>- 0.28</td>
<td>+ 0.26</td>
<td></td>
</tr>
<tr>
<td>Yarn extension (%)</td>
<td>- 1.3</td>
<td>+ 1.0</td>
<td></td>
</tr>
</tbody>
</table>

5.2.5 Genetic selection

It is possible to apply genetic selection with Angora goats to increase mohair length. Bigham (1990) summarised the data available on the genetics of Angora goats. He concluded that mohair staple length has a relatively high heritability of about 0.3 in Texan Angoras but the heritability of staple length in South African goats is regarded as low (< 0.2).

5.2.6 Cotting

Cotting of wool is discussed at some length by Henderson (1955, 1968) and Ryder and Stephenson (1968) but the subject is ignored by many authorities on wool.

5.2.6.1 Definition

Wool buyers regard a fleece as cotted if the staples cannot be easily torn apart. Cotted wools are classified as “soft” or “hard” depending on the severity of fibre entanglement. Ryder and Gabra-Sanders (1984) refer to cotting as felting of the wool.

The commercial value of cotted fleeces is reduced by:

- the requirement during textile manufacture for an extra opening process to separate the staples, a process that is costly and severe;
- the presence of many short fibres in the fleece;
- the resultant increase in fibre breakage and shortening of the length of processed fibres.

5.2.6.2 Causes of cotting in wool

Cotting or matting of the fleece is a result of extensive and sometimes very severe entanglement of fibres (Roberts 1926). Ryder and Gabra-Sanders (1984) claim that the same physical parameters that cause felting during textile processing are at work on fibre animals. On this basis the differential friction effect (DFE) of animal hairs, that allows them to move more readily in one than another as a result of the projecting edges of the cuticle scales, is a primary effect of cotting. Australian mohair producers can read more about the DFE in Leeder et al. (1998).

In Merino wool, finer wool felts more readily than coarser wool and wool with sinusoidal crimps felt more readily than wools with helical crimp (Khan 1966). British lustre longwools have much greater mean fibre diameter than Merino wools, they have helical crimping and are prone to cotting (Ryder and Gabra-Sanders 1984). Ryder and Gabra-Sanders (1984) studied cotted and normal wool from British Blackface, Cheviot, Swaledale and Border Leicester sheep. They found no evidence that mean fibre diameter, the number of cuticle scale edges, fibre crimp wavelength or the number of shed fibres differed between normal and cotted wool. They did observe that in cotted wool there was a greater number of loops in which one fibre encircled at least one other fibre.

Henderson (1968), Professor of Wool Science, Lincoln College, New Zealand, describes the fibres on the outside of a fleece as being slightly entangled due to rubbing but this is seldom severe enough to cause trouble. He states that practically all cotting severe enough to be noticed is found a level in the
wool staple that corresponds to the part grown during the winter months, usually in a zone about 1 cm in depth. In wool, cotting is usually confined to certain regions of the fleece and an over-all cotted fleece is rare.

In discussing cotting, Ryder and Stephenson state 1968, (p. 81) that there is a “tendency for many sheep to shed a proportion of their fibres at the end of winter in response to a seasonal stimulus, in the same way as many wild animals moult. The tendency to shed is hereditary and so can be selected against. If a few fibres are shed the free wool fibres in the fleece can cause cotting or matting of the fleece”.

Henderson (1968) had no doubt that cotting can only happen if fibres are first shed from the skin. “It would be impossible for the high degree of entanglement that does occur to take place if fibres were held firmly at one end by the skin and at the other end by the mild entanglement of fibres at the staple tip” (Henderson 1968). Under normal conditions in sheep with variable fleeces it is usual to find large numbers of secondary fibres being shed. Surveys in the Romney breed in New Zealand have shown that the incidence of cotting in the more variable fleeces was more than twice the incidence of cotting in the more even fleeces. He concluded by stating that the known higher fibre shedding rates within the more variable fleeces was no doubt account for this association between cotting and more variable fleeces.

On the other hand, D’Arcy (1979), who trained wool classers in New South Wales, regarded cotted wool as partly felted and largely caused by environment rather than breeding. He appears, however, to contradict himself as he asserts that cotting was more of a problem 30 to 40 years ago but breeders (my emphasis) have checked this fault to a great extent.

In Britain, cotting in wool is regarded as being more prevalent in rainy seasons (Ryder and Stephenson 1968). D’Arcy (1979) says that wool cotting is often a result of a serious set-back such as starvation or sickness that causes fibres to break or shed. Under warm moist conditions and when the wool is not well nourished rubbing causes the fibres to move. D’Arcy identifies the conditions most prone to cotted wool production as: when lush feed follows drought, in old sheep, with sheep of poor constitution, strong-woolled sheep on poor country. However Ryder and Stephenson (1968) claim that one of the benefits of improved pasture nutrition of wool sheep is the greater value of wool lacking faults such as breaks and cotting.

Studies of cotting in New Zealand Romney Marsh sheep, showed that cotting was associated with the gradients of wool growth over the body, appearing first on the breech, followed by the belly, the lower fore-legs and then the sides and last on the back (Henderson 1955, 1968). Features of this pattern are most severe on regions of the body having the lowest rates of wool growth. The breech is the region with the greatest fibre variability and is more hairy. Further Henderson (1968) reports that “It is well known that the incidence and severity of cotting is higher among the lower producing individuals within a flock”. Based on his survey of producers, Henderson (1955) found that cotted fleeces were 100 to 150 g lighter than non-cotted fleeces from the same flocks. He also found that the incidence of cotting was more frequent in poor seasons and with older sheep and with breeding sheep.

Ryder and Stephenson (1968) regard cotting and felting as having a association with similar factors such as wetness, rubbing and warmth. Clearly animals with ectoparasites such as lice, are more prone to rubbing and therefore increase the likeliness for cotting.

In some breeds of Egyptian sheep, two third of the fleeces have medium to high levels of cotting at shearing. Higher levels of cotting in these sheep was associated with lower secondary to primary follicle (S/P) ratios and higher diameters of both primary and secondary follicles (Guirgis et al. 2001). However, the breeds of sheep studied had very low secondary to primary follicle ratios, mean values 3.5 to 4.0, coarse primary hairs, mean fibre diameter values 33 to 68 µm and relatively fine secondary fibres, mean fibre diameters values 16 to22 µm.
An unlikely suggestion as to the cause of cotting appears in Ensminger’s (1964) glossary of wool terms. He suggests that cotty wool is caused by insufficient wool grease being produced by the sheep but provides no evidence or working hypothesis to support this statement. However Henderson (1965) explains that cotted regions in the staple of wool interfere with the distribution of wool grease (yolk, wax). As a consequence, the outside of a fleece may become badly weathered and so fibre breakage and wastage during processing may be higher than normal.

5.2.6.3 Genetic selection
Henderson (1955) observed that a Romney Marsh sheep having a cotted fleece in one year was likely to produce a cotted fleece in other years with the implication that it was a genetic fault found in some sheep and not in others. Hairy tips on staples of long wool are strongly associated with cotting. The presence of hairy staple tips is a strong reason to cull animals (Henderson 1955, 1968). In this case, hairy staple tips are an expression of highly variable fibre lengths within the staple, representing different periods of fibre growth.

5.2.6.4 Cotting in goats
The subject of cotting of mohair was not found in any textbook or research article. Ryder and Stephenson (1968) assert on the basis of Ryder’s study of dairy goats (Ryder 1966) that the coat of the goat, although similar in structure to that of a Mouflon sheep, appeared to have too few fine fibres to cott with the straight guards hairs. This view is clearly mistaken. The author of this review has seen cotted fleeces on Australian dairy, mohair and cashmere goats and cashmere goats in north-east, central and western China and in southern and eastern Iran (McGregor unpublished observations and this report). On this basis it is clear that the assertion of Ryder and Stephenson is incorrect with each breed and at each location mentioned.

Combining the results of several studies of Angora goats provides an indication of the potential magnitude of the number of fibres involved in cotting of mohair. The numbers of follicles per 100 square centimeter of skin in an Angora goat ranges from approximately 90,000 to 250,000 (McGregor 1995b and unpublished data). The actual number of fibres not growing during winter can be calculated using the percentage calculated as not growing in the two year old goat in Margolenia’s study (see Table 5.1). The result is an estimated 18,000 to 50,000 per 100 cm² of non growing fibres in Australian goats assuming the data is applicable, with the numbers of non growing fibres doubling by four years of age.

5.2.6.5 “Hair loss” in mohair goats
The issue of hair loss in Angorans is mentioned by van der Westhuysen et al. (1988). These authors refer to reports of spontaneous hair loss in Angora goats. They reported that hair loss follows conditions such as severe stress, disease, lice, nutritional setbacks especially during lactation and as a result of age. In both South Africa and in Turkey hair loss occurred towards the end of winter. They also reported that hair loss was possibly aggravated by shearing during the wrong time of the year. In South Africa, hair loss in cross-bred goats was noticed but in well-bred Angora goats it was rare.

In South Africa, the causes of mohair loss were not well understood (van der Westhuysen et al. 1988). These authors suggest that certain mineral imbalances, such as high calcium and low zinc, may be a cause.
5.3 Management issues

5.3.1 Manipulating the shearing interval
There are two ways of manipulating shearing to alter mohair length, the static method and the dynamic method (McGregor 1995a).

5.3.1.1 Make the winter period longer (Static method).
This method allows for the fact that mohair growth is least during the winter half year as a result of short days (photoperiod) and nutritional effects (limited pasture availability and colder wetter conditions). It is best to shear before any fleeces become matted or cotted around September and with does around kidding time in spring.

5.3.1.2 Measure the fleece and shear at the correct length (Dynamic method).
This involves using a ruler to measure staple length and arranging shearing when the correct length has been achieved. Arranging shearing for this method is more difficult than the static method when arrangements can be booked well ahead.

5.3.1.3 Manipulation of shearing interval in carpet wool sheep
Reid and Sides (1984) evaluated the then current practice of shearing Elliotdale carpet wool 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. Using the formula given in section 5.1, the amplitude of wool growth can be calculated as 88%. They 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.

5.3.2 Grazier weather warnings

5.3.2.1 Australian sheep grazier warnings
The method by which sheep grazier warnings are predicted are described by the Bureau of Meteorology (Anon 1982). Warnings of wet, windy conditions are issued to enable graziers to take action to reduce losses among animals susceptible to hypothermia. The Bureau of Meteorology developed a nomogram based on research relating the physiological reaction of sheep to weather conditions. The nomogram is used as an aid in deciding whether or not an alert is warranted. Warnings are issued at a forecaster’s discretion and take into account the predictions for the lowest temperature, highest hourly mean wind speed, total rainfall, and preceding weather conditions.

Goat producers hearing sheep grazier warnings are advised to include themselves in the target audience and take appropriate action (McGregor 2001b).

5.3.2.2 Criteria for cold weather warnings in South Africa
The South African Weather Bureau has used the criteria in Table 5.7 to determine if weather warnings are required for the Angora Goat Industry.
Table 5.7. Cut-off values used by the South African Weather Bureau for warnings to the Angora goat industry (Poolman 1984)

<table>
<thead>
<tr>
<th>Weather condition</th>
<th>Any two of the following conditions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rain</td>
<td>More than 5 mm of rain</td>
</tr>
<tr>
<td>Temperature</td>
<td>Less than 10 °C minimum in wet conditions</td>
</tr>
<tr>
<td></td>
<td>Less than 3 °C minimum in dry conditions</td>
</tr>
<tr>
<td>Wind</td>
<td>Stronger than 10 knots</td>
</tr>
</tbody>
</table>

5.3.3 Supplementary feeding

It is possible to increase mohair length and weight by supplementary feeding but it has never been shown to be economic to provide supplementary energy or protein just to grow additional mohair. This may not be true in districts with a severe winter growth problem. The best use of supplementary feeding is during pregnancy and early lactation and in districts with the winter mohair length problem it is not known if adequate energy provision will reduce the problem.

5.3.3.1 Supplementary feeding of energy for mohair growth

In the wheat-sheep environment cereal grains (wheat, barley and oats) are cheap and do not contaminate fibre. Cereal grains are fed commonly to grazing ruminants in late pregnancy, during lactation, in autumn and winter and to minimise live weight loss during long droughts. In some regions pulse crops (lupins, faba beans, broad bean) or oilseed crops are common and either whole grain or residues available after processing (such as oilseed meal) may be available for stock feeding purposes.

Usually it is more cost effective in terms of megajoules of metabolisable energy (MJ ME) to provide energy supplements in the form of cereal grains rather than as hay or pulse crops. Many pulse crops are more valuable for feeding monogastric humans and farm animals (poultry and pigs) rather than ruminants. This is not to say that in certain circumstances, such as drought feeding early weaned kids, or in some districts, where second grade pulse crops may be cheaply available, that pulse crops will not be a cheaper source of energy.

5.3.3.2 Non breeding Angora goats

Energy supplementation affects live weight change and therefore mohair fibre diameter. Goats that lose live weight grow less mohair (-15 to -40%) and the mohair is commonly 2 to 3 m finer than mohair from goats which maintain their live weight (McGregor and Hodge, 1989). Goats fed to gain live weight grow more mohair (up to +100%) with fibre diameter often 2 to 3 m coarser compared to goats fed to maintain their live weight (McGregor, 1984).

However energy supplementation to maintain live weight and increase mohair growth is unlikely to be economic as the increase in mohair growth was only half the value of the grain (McGregor and Hodge, 1989). A contribution to the lack of economic response is that the increase in growth is accompanied by increases in cross sectional area of mohair, resulting in a decline in economic value of the entire fleece. The value mohair declines at a rate of 5% per 1 m increase in mean fibre diameter, up to mean fibre diameters of 32 m (van der Westhuysen, 1982).

Supplementary feeding at levels to produce live weight gain has also reduced the incidence of medullated fibres in Australian kid mohair compared to feeding goats to maintain live weight (McGregor, 1984a and unpublished). This response could be economic depending on the discount prevailing for kempy mohair and the way the fibre was classed before selling.

5.3.3.3 Pregnant and lactating Angora does and their kids

Experimental data from the USA (Huston et al., 1993), South Africa (Grobbelaar and Hayward, 1987) and Australia (McGregor 1995b) are in general agreement on the relative effects of energy supplementation on mohair grown during pregnancy and lactation (Table 5.8).
The main benefits for supplementary feeding energy to does are to obtain high reproductive rates and increased survival rates for kids, increase lactation performance of does and increase kid mohair growth rates with little deterioration in quality. These benefits can possibly result in an increase in the amount of higher value fine kid mohair sold by producers. The potential increases in doe live weight are also important particularly during the following mating season because live weight has a large influence on ovulation rates (Shelton and Groff, 1974).

In Texas, the digestible dry matter (DDM) intake of Angora does grazing low quality range was increased by low levels of energy supplementation but as energy supplementation increased, forage DDM intake decreased at an increasing rate (Huston 1994). Total DDM intake plateaued from supplementary feeding levels of 10 g/kg\(^{0.75}\)/d. Thus as supplementary feeding level increased, complementary, additive and substitutive effects on forage intake were observed.

In southern Australia during winter, the feeding over four months of a supplement of 600 g/goat/day of lucerne hay in addition to the grazing allowance of sparse annual pasture did not increase the mohair growth of does. There was a slight increase in mohair growth to the feeding of barley grain at levels of 375 and 500 g/goat/day compared to the feeding of barley grain at levels of 250 g/goat/day or less, but the response was less than 10% additional mohair (McGregor 1995b). The feeding of barley grain at 250 to 500 g/goat/day to does significantly improved the mohair style and mohair character scores and mohair length compared to does fed no grain or fed 125 g/goat/day of barley.

Fibre growth is maintained when pregnant Merino ewes (Williams and Butt, 1989) and pregnant Angora does (McGregor 1995b) are fed adequate energy to maintain maternal live weight.

In conclusion, supplementary energy is indicated when the welfare of the goats is at risk (droughts, pregnancy) and large benefits to reproductive performance can arise when energy is fed to pregnant and lactating does.

**Table 5.8. The main effects of improved nutrition of pregnant and lactating does on the production and quality of mohair grown by does and their kids and live weight changes**

<table>
<thead>
<tr>
<th>Production trait</th>
<th>Effect on doe production</th>
<th>Effect on kid production to 6 months of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mohair weight</td>
<td>Significant increase</td>
<td>Significant increase</td>
</tr>
<tr>
<td>Mohair fibre diameter</td>
<td>No or small increase</td>
<td>No or small increases of 1 mm</td>
</tr>
<tr>
<td>Mohair medullated fibre</td>
<td>Increase (Australian data) or no change</td>
<td>No or small increases of 1%</td>
</tr>
<tr>
<td>Mohair length</td>
<td>No or small change</td>
<td>Small increase or decrease</td>
</tr>
<tr>
<td>Mohair style</td>
<td>No change</td>
<td>Decrease</td>
</tr>
<tr>
<td>Live weight at weaning</td>
<td>Significant increase</td>
<td>Significant increase</td>
</tr>
</tbody>
</table>

5.3.3.4 Supplementary feeding of protein and urea for mohair production
Information on the effects of protein supplements on mohair growth is mainly derived from Texas where both the range and the commonly used cereal grain (corn) are low in nitrogen. Huston et al. (1971) reported that yearling bucks grew 33% more mohair when fed diets with 18% crude protein (CP) compared to diets with 12 and 15% CP while feed intakes were similar. This response was probably a reflection of a high degree of protein “protection”. Most protein consumed by ruminants is denatured during rumen digestion and is either used by rumen micro-organisms for their growth or converted into urea or ammonia (Harmeyer and Martens, 1980). Diets with more than 15% CP can have substantial losses of nitrogen caused by rumen degradation. If additional protein fed to ruminants can be “protected” from rumen degradation, then additional animal production can be obtained. “Protected” or “bypass” protein increases wool growth (Black and Reis, 1979) and mohair growth (Throckmorton et
al., 1982). Supplementary feeding of protein and non-protein nitrogen is not usually warranted in Australia, as feed wheat used to overcome energy deficiencies usually has 12 to 14% CP.

Results in the USA have shown that the most strategic use of protein is to enable young female goats to reach mating live weight by 17 months of age. Feeding both energy and protein from weaning, at 5 months of age, for 3 months increased live weight 3.6 kg, mohair growth by 20% and mohair fibre diameter by <1 m. Forage quality was low (DMD 50%) and the supplements of both energy and protein were additive to forage intake thereby increasing total dry matter intake (Huston et al., 1993). Grégoire et al. (1996) reported, that when weaned female Angora kids were fed a base diet of hay with corn and barley, the addition of either one of four different protein supplements, including diets with protected methionine, had little effect on mohair production but significantly increased live weight.

The addition of the sulphur amino-acid methionine, when protected from rumen degradation increased the mohair growth of the more productive American goats (Bassett et al., 1981, 1982) but with Australian goats the responses have been poor (McGregor and Hodge, 1989). While the American goats supplemented with 0.1% methionine grew an extra 0.52 kg of mohair over a 6 months period this response would also be uneconomic under Australian conditions. One of the main problems with supplements of small amounts of amino-acids is the requirement for a relatively expensive carrier, a slow release intra ruminal capsule or for frequent animal handling which is also prohibitively expensive. Recent research with pregnant and lactating ewes has indicated that lack of sulfur containing amino acids is unlikely to be limiting wool growth and lack of arginine, lysine or threonine may be limiting wool growth (Masters et al., 1993).

In south-eastern Australia oats are commonly used as a drought feed, but they have a low nitrogen content (7 to 9% CP). If these oats are fed to lactating ewes, their milk production is much lower compared to ewes that are fed oats with urea (Hodge et al., 1981). Urea can be successfully added to oats for use as a drought feed for does (McGregor and Hodge, 1988). In the study of McGregor and Hodge, there was no evidence of urea toxicity even though some does consumed 29 g/d of urea.

5.3.3.5 Normal feeding of high energy cereal grains to goats
Recommendations for the feeding of whole cereal grains to small ruminants in Australia are:
- gradual introduction at the rate of 50 g/(head.day) followed by;
- slow increases in quantity of 50 g/head every second day.

Such a practice will minimise the potential onset of acidosis (grain poisoning) with the associated reduced voluntary food intake, and the potential death of animals in severe cases of acidosis.

5.3.3.6 Rapid feeding of high energy cereal grains to goats
Rapid introduction to high energy cereal grains may be required during adverse weather following shearing and after fires or flooding destroy pastures. Rapid introduction to high levels of cereal grain increase the risk of acidosis.

van der Westhuysen et al. (1988) described the use of calcium hydroxide treated maize for supplementary feeding of small livestock and proposed the use of sodium monensin to modify the process of rumen fermentation and limit rumen acidification. Owing to the brownish appearance of the end product, South African Angora goat and sheep farmers call such treated maize “chocolate mealies”. They indicated that feeding of 900 to 1200 g of chocolate mealies (2 feeds per week) provided good results. It was advised that ammonium chloride (0.5%) should be added to the grain to prevent formation of urinary calculi in males fed more than 500 g/day of treated grain.

Australian farmers have not used such techniques on wheat. Research with Australian goats showed that inclusion of slaked lime in whole wheat diets increased rumen pH (reduced acidity) when compared to diets without slaked lime. Inclusion of rumensin in whole wheat fed to goats at intakes of 300-500 g/day appeared unnecessary as the rumen pH was no higher than that provided by slaked lime, and resulted in less stable feed intake. It was also observed that the rapid introduction of 500 g/day of wheat to individually fed Angora goats occurred without mortality. These results suggest that treating wheat with
2% slaked lime for rapid introduction to goats is a practical method for rapid introduction to high energy grains (McGregor 1991, McGregor et al. 1994).

5.3.3.7 Frequency of supplementary feeding and substitution
When grazing animals are offered supplements of grain or hay, the intake of pasture is usually depressed. The extent of the depression divided by the weight of supplement eaten is called the substitution rate (Anon 1990). Substitution rates of 1.0 occur with high quality supplements on abundant high quality pasture, but the rate may be as low as 0.65 on low quality pastures. Substitution rates of 0 to 0.50 are predicted when pasture availability is less than 0.5 tonne DM/ha and will remain at about 0.45 when the digestibility of the pasture is less than 0.5 and the digestibility of the supplement is 0.80.

When hay (dry matter digestibility of approximately 60%, crude protein 13.9%) was offered to Romney Marsh wethers, the frequency of feeding affected wool production (Birrell and Bishop 1970). Increasing the frequency of feeding had the effect of reducing wool production. Sheep fed weekly grew 10% more wool than those fed daily.

During winter at Werribee in southern Victoria, ad libitum supplementary feeding of whole sweet lupin grain to cashmere bucks resulted in significantly increased live weight at the end of winter and at the end of spring compared to controls grazing pasture only or to bucks offered grazing with ad libitum low quality roughage (McGregor 1996). This ad libitum supplementation of lupins resulted in significant substitution of lupins for pasture, as indicated by the doubling in pasture availability on lupin plots while pasture availability on other treatment plots remained almost constant. It is most likely that the lupins overcame restricted energy intake as the green pasture consumed would have provided adequate nitrogen for the growth of these goats.

5.3.4 Genetic selection
Bucks and does could be selected on their ability to grow sufficient mohair during the winter half year. Progress is likely to be slow but will be cumulative. Any selection for increased mohair length must ensure that mohair fibre diameter does not increase. Mohair staple length is negatively correlated to mohair follicle density, in other words, increasing follicle density will reduce mohair staple length.

McGregor (1981,1985c) suggested that producers apply heavy selection pressure based on the measurement of winter fleece production rather than the commonly advocated 12 to 18 month (summer) fleece production or use the total fleece production from 6 to 18 months of age. This suggestion was aimed at reducing the seasonality in mohair follicle activity. If selection pressure could reduce the current winter decline in mohair growth (Section 5.2.1) to only a 10% decline, then annual mohair production would increase 13 to 23%.
6 Discussion and implications

6.1 Discussion

6.1.1 Analysis of mohair market
Production of short and cotted mohair has had a large impact on the financial returns to the Australian mohair industry. Over the past 4 years, income has been reduced by 10%, amounting to over $1 million. By weight, short mohair represents about 13.5% of production and cotted mohair represents a further 7% of production. There was no evidence that production of short and cotted mohair were decreasing.

The analysis of market prices demonstrated that after adjustment for other factors, including mean fibre diameter, vegetable matter etc, C length mohair is sold at a 45% discount to B length mohair and cotted mohair is discounted 37 to 91%.

The industry is correct in identifying the production of short and cotted mohair as a serious problem.

6.1.2 Mohair brokers
While each mohair broker has a different perspective on the problems of short and cotted mohair, they all reported significant effects of these products on their business and income. However, when the views of the brokers (Section 2.3.1.7) are compared with the statistical analysis of market data (Section 2.1.2), the brokers generally significantly underestimated, by about 20%, the financial impact of C length compared to A length on the price received. This discrepancy may in part be explained by differences in mean fibre diameter and other attributes that can be adjusted for during statistical analyses. Such a finding may also suggest that objective testing prior to sale is necessary for mohair. This finding also implies that buyers at auctions are taking into account more than length when they appraise lots of C length mohair.

Discussions revealed some variation in the practices used for assessing mohair for length. As would be expected, the brokers were well informed of the importance of mohair length and in getting the classification of mohair correct.

Brokers were aware of some of the options available to producers in their attempts to reduce the impact of short and cotted mohair on financial returns. All brokers agreed that many producers prepared mohair poorly and they regarded cotted mohair as a sign that routine husbandry practices were not being carried out at the optimal time. The brokers suffered three impacts of short and cotted mohair:
1. smaller lot sizes of preferred length mohair;
2. increased costs of preparing mohair for sale;
3. reduced income from commission for the sale of lower valued mohair.

6.1.3 Producers

6.1.3.1 Survey
Approximately 15% of mohair producers responded to the survey. This response is considered good for an unsolicited mail-out, as the average response to mail-outs is 10%. It is not possible to be more precise in estimating the response rate as it is not precisely known how many of the subscribers to the Australian Goat Report are actually mohair producers.

The respondents appear to be a typical cross-section of Australian mohair producers. They reported that problems with short and cotted mohair exist in all States of Australia although the problem appears more concentrated in some districts, particularly in south-eastern Australia. The origin of responses was representative of the distribution of Angora goats within Australia and appears to provide a sound basis for the evaluation of the data. Respondents reported that the most popular month for kidding was September with only a few respondents reporting kidding in July. Several
respondents indicated that kidding was now later than they preferred as a consequence of the new
       genotypes not exhibiting oestrus until April. Shearing occurred in each month of the year but few
       respondents shore in May and November.

       Most of the respondents reported problems with short and cotted mohair, with 40% reporting
       problems in most or all years and only 10% reporting no problems in any year. The problem was
       regarded as moderate to serious by 55% of respondents. A comparison of the case studies (Chapter 4)
       and market analysis (Section 2.1) with the impressions of the financial impact of short and cotted
       mohair (Section 3.2.3) suggests that producers have underestimated the impact of the problem.

       The survey responses indicate that those producers reporting the more serious impacts had, on
       average, a greater Texan genetic background in their Angora goats compared to those reporting less
       serious impacts (Figure 3.12) who had a higher proportion of South African genetics. The
       respondents with the larger flocks indicated a lower proportion of Texan genetics and a greater
       proportion of South African genetics compared to respondents with smaller flocks (Figure 3.14).

       Many respondents were aware of the common methods to reduce short and cotted mohair. The most
       common methods used to reduce short and cotted mohair were genetics, nutrition, shearing,
       husbandry and provision of shelter. There were differences between State of origin of respondent, the
       seriousness of the problem and herd size in the common methods used to reduce short and cotted
       mohair. Some respondents indicated that they had difficulty in obtaining shearers at their preferred
       time.

       The following trade-offs were identified:

       no method works in isolation;
       longer mohair may be coarser mean fibre diameter;
       cost of supplementary feeding is greater than the benefits.

       The survey results also indicated that many mohair producers have few or no neighbours who
       produce mohair. Generally the lack of near neighbours producing mohair does not appear to have
       affected husbandry practices but there is a suggestion that neighbours are influencing some decisions
       (Figure 3.24). The potential beneficial role of industry discussion groups is relevant given the
       experience of other primary industries, although such a role used to be provided by regional groups
       within Mohair Australia.

       6.1.3.2 Case studies

       The producer case studies provided further objective evidence of the impact that short and cotted
       mohair can have on the production and financial returns of experienced mohair producers. Up to 40%
       of the mohair output (by weight) and 21% of the income could be affected by these problems.

       The case studies also showed that in some cases the production of cotted mohair and of locks can be
       completely avoided.

       6.1.4 Literature review

       There are many biological and management issues affecting short and cotted mohair production. The
       experience of the wool industry is generally of relevance for mohair producers although the problem
       with cotted wool appears to differ somewhat from that of cotted mohair. The review identifies a
       number of practical and theoretical approaches that producers could apply to reduce the impact of
       short and cotted mohair.

       6.1.4.1 Environmental influences

       The review highlights the importance of environmental influences on mohair production generally
       and specifically on the high incidence of non-growing mohair follicles during late winter. While the
       physiology of photoperiod induced changes in skin follicle activity is not the subject of the review it
       appears an inescapable fact that compared to the highly improved Australian Merino sheep, less
       improved wool bearing animals, such as British breed of sheep and Angora goats, exhibit a large
seasonal amplitude in fibre growth. The amplitude in fibre growth interacts with environmentally
induced changes in nutrition so that in the colder regions of southern Australia the impact on mohair
growth is large fluctuations in growth of between 50 and 300%.

It is highly likely that non-growing fibres and the subsequent shedding of fibres is the main cause of
cotted mohair. The severity of cotting will therefore be minimised by reducing the number of fibres
that shed. Clearly management that enables continuous mohair fibre growth must be the objective.

It is highly probable that Angora goats are subject to the effects of cold stress throughout the year as
a consequence of their thermal insulation attributes and the bi-annual shearing husbandry practices.
As a consequence, Angora goats must expend considerable energy in maintaining themselves in
temperatures below their lower critical temperature. The consequences of this energy expenditure
must be lower production, reduced live weight and fleece growth and lowered lactation performance.

Evidence was provided that, in southern Australia under typical grazing conditions during winter,
fibre goats either grow slowly or do not at all. However, if provided with sufficient energy, the goats
can grow at 1 kg per week. Unfortunately the effects of photoperiod during winter will reduce the
potential fibre growth response at this time compared to the potential growth responses in other
seasons.

6.1.4.2 Nutritional management
The review summarised relevant results from a range of experiments conducted in Texas and
Australia. Generally, the feeding of supplements to grazing animals will result in some depression of
pasture intake as some of the supplement is substituted for grazing.

Results from nutrition experiments in Texas suggest that in poor pasture conditions, supplementary
feeding of energy at about 10 g/kg$^{0.75}$/d will provide near maximum total feed intake. This translates
to a level of supplementary feeding of 175 g/d of grain for a 45 kg doe. Experience from Australian
experiments suggests that this quantity may not be sufficient as 250 g/d of barley grain was needed
to elicit a significant response.

Some producers indicated that they supplied their adult Angora goats with protein supplements or
with lucerne hay. These practices are not necessary with adult goats grazing green pasture in southern
Australia as these pastures are most unlikely to be deficient in nitrogen. The main feed requirement is
usually energy. High protein feeds are usually the most expensive way of providing energy. The
feeding of hay is also expensive in terms of cost per energy unit and in labour requirements. These
producers need to change their feeding pattern to higher energy and cheaper forms of supplementary
feeding.

Unfortunately there is no objective evidence that supplementary feeding to produce mohair is cost
effective. However, it is possible that under certain condition, such as ensuring that kid and young
goat fleeces reach sufficient length to achieve B length classification, that supplementary feeding
may be cost effective. This view was also held by one of the case study participants. The benefits
arising from the feeding of young does need to include the future benefit of increased reproductive
performance resulting from a higher ovulation rate consequent upon heavier live weight at mating.

Technology is available to help mohair producers introduce high-energy cereal grains either slowly
or rapidly to minimise grain poisoning (acidosis).

6.1.4.3 Shearing practices
The review discussed various options that are available to mohair producers. The experience of
Tasmanian carpet wool producers suggests that the most appropriate shearing times may be different
from current industry practice. There is also the potential interaction between kidding time and
shearing time upon cotting, a subject not discussed in the literature.
Cotting in mid to late spring can be reduced by shearing close to the time of any fibre shedding at the start of spring. Cotting is likely to first appear in the breech area of the goats. Mohair producers must be aware of the signs of cotting in the fleece, particularly if they intend to shear after September. The potential for cotting is exacerbated by overlaying the nutrient demands of kidding in September on top of the potential for fibre shedding at the start of spring (August/September).

6.1.4.4 Genetics
Producers can apply selection pressure to reduce the problems with both short and cotted mohair. The review has identified areas where selection may be useful including:
- Selection for longer mohair;
- Selection for greater winter mohair growth;
- Selection for reduced incidence of non-growing mohair follicles during winter;
- Selection for long and fine mohair;
- Selection for more blocky mohair staples ie less tippy;
- Selection for more uniformity in mohair length across the body;
- Increasing the density of secondary follicles in the skin;
- Crimp form (style and character) can influence perceived fibre length.

Clearly mohair producer have to concentrate selection pressure on a few important attributes. It may be possible to include some of the above as independent culling levels during the selection of bucks.

6.1.4.5 Fleece preparation and processing
Research in the Australian wool industry has demonstrated that adequate skirting is the most important method for reducing variation in staple length in commercial wool. While the mohair industry acknowledges that adequate skirting is important there is no documentation of the effects of skirting on mohair length.

There is also a poor understanding of the variation in staple length over the body of the new synthetic genotypes of Australian mohair goats. The impact of different staple style and character attributes on the mean length of fibres and the effect of processing on the breakage of the staple tip of mohair are not defined and have left some producers confused about the objectivity of mohair length classifications. The wool industry has defined the relationships between staple length and fibre length in processed tops. There is no objective data for mohair on this important relationship.

6.2 Implications
Some of the implications from this study are:
1. The mohair textile processing industry is giving producers a strong message via market signals that short and cotted mohair are inferior products that are heavily discounted in the market.
2. If the current approach to mohair production continues, about 20% of Australia’s mohair will be short and cotted costing the Australian industry in excess of $250,000 per annum.
3. The current level of production of short and cotted mohair is costing the industry about 10% of total income. This level of financial loss may be impacting on the attractiveness of mohair production as an alternative farm enterprise.
4. Buyers at mohair auctions take into account more than length when they appraise short mohair.
5. The problems associated with the production of short and cotted mohair were reported Australia wide. A large percentage of producers regard the issue as serious and affecting their income in most years. Case studies indicate that financial losses in excess of 20% can arise in any one year.
6. Producers of short and cotted mohair are very interested in eliminating the production of these products and generally understand the financial impacts on their enterprise.
7. Mohair length growth will be less during the winter half year compared to the summer half year as a consequence of the influence of photoperiod and, in certain districts of southern Australia, the effects of cold stress and inadequate energy nutrition.
8. As a consequence of the cessation of fibre growth, many Angora goats exhibit a seasonal shedding of mohair fibres during early to mid spring (September). These shed fibres show up as cross fibres in the
staple. Fleeces that have shed fibres can exhibit matting and cotting (natural felting). Goats need to be shorn before fleeces begin to cot.

9. The decline in the proportion of actively growing follicles during winter, as goats age, indicates that there will be an optimum age for culling the goats. It is not clear whether the current Australian genotypes of mohair goats exhibit the extent of fibre shedding reported for mohair goats in overseas environments. The impact of the decline in the number of actively growing follicles during winter is poorly understood.

10. Growers should seek to develop management procedures that provide continuous mohair fibre growth.

11. Environmental influences on mohair production are large. This implies that some districts may be less suited to mohair production compared to others.

12. As Angora goats are likely to be affected by the effects of cold stress throughout the year, they expend considerable energy to maintain themselves. Restricted provision of energy and/or long periods of cold stress will exacerbate the seasonal depression in mohair growth. Consequently, mohair production and fibre length will be reduced.

13. In cold districts the provision of adequate shelter for Angora goats is a high priority.

14. Angora goat producers must take heed of Sheep Grazier Weather Warnings to safeguard the welfare of their goats, particularly in the six weeks after shearing, and to provide them with adequate shelter in adverse weather conditions.

15. Angora goats grazing in colder regions of southern Australia and in mountainous regions are likely to need additional energy provision particularly during the winter half year.

16. Nutritional management skills need to be improved to reduce short and cotted mohair production. The priority is to reduce the incidence of short kid and short young goat mohair and to prevent fibre shedding in late winter.

17. Mohair producers who provide supplementary feed need to change to more cost effective forms of energy feeding.

18. There needs to be a clear focus on breeding productive goats that grow long and fine mohair.

19. There is a trade off between different genotypes and the ideal form of mohair. Generally, producers are aware of trade-offs although some do not appear to be aware of this issue. This issue needs to be addressed by genetic improvement and genestock evaluation programs.

20. Selection of mohair sires should take into account winter mohair production.

21. Producers need objective information about the impact of staple characteristics such as style, character, tip shape and length, upon classed assessed length and upon processed fibre length.

22. Mohair harvesting procedures must be correctly implemented to harvest fibre before it cots in spring and to ensure it achieves B length classification.

23. Alternative approaches to mohair harvesting should be investigated to provide more flexibility in harvesting mobs of one and two year old goats.

24. Larger size mohair enterprises will experience fewer problems with shearing management than smaller enterprises as they will command a higher commercial priority.

25. There is a lack of knowledge about strategies that enable newer genotypes to breed earlier in autumn or in late summer.

26. There is a continuing role for mohair discussion groups. In the past, this role has been provided by regional groups within Mohair Australia. The producer survey indicated that many producers now have no other known mohair producer within 50 km. This lack of contact with other producers is reflected in the findings of the survey.

27. There is a clear need for continuing training in a range of subjects covered in this report. Subjects requiring training include: fleece preparation, harvesting and breeding strategies, nutrition and energy supplementation and evaluation of suitable sires.
7 Recommendations

On the basis of the findings of this project the following recommendations are made:

1. That the findings be published and made available to mohair producers and brokers
This report should be made available to members of Mohair Australia and to suppliers of mohair to Australian Mohair Marketing Pools, National Mohair Pools, Australian Mohair Trading and other supply chains. Publication on the RIRDC web site would provide wide spread availability.

2. Extension material and messages for mohair producers should be revised
Extension articles should be written to summarise the findings of this work. These articles should be suitable for publication in industry journals and magazines and as advisory bulletins. Appropriate material should be included in revisions of Australian Goat Notes.

Subjects to be covered in extension material should include:
the impact of short and cotted mohair on industry financial returns; options for short term action and longer term strategic options to reduce problems with short and cotted mohair; the importance of skirting in preparing fleeces for sale; methods to facilitate the mating of Angora goats during the period January to March; importance of grazier weather alerts for mohair producers.

3. That focussed learning and evaluation trials be undertaken
Applied research and development trials with active producer group participation should be established. These trials should evaluate options suitable for districts that are severely affected by short and cotted mohair production. The objectives of such trials should be to involve producers in focussed learning and evaluation to minimise or substantially reduce the problems of short and cotted mohair production.

Such field trials should determine the effects of providing adequate levels of nutrition and energy supplementation in a range of environments during winter half year. The focus of these trials should be with goats cutting their second and fourth fleece. “Flow-on” effects in does breeding at two years of age should be included in such trials.

4. Quantify the acceptable variance in staple length for different mohair length classes
Many producers want further clarity of the industry accepted length classifications, especially C length for finer mohair. There is also a poor understanding of the variation in staple length over the body of the new genotypes of Australian mohair goats. The impact of skirting, different staple style and character attributes on the mean length of fibres and the effect of processing on the breakage of the tip of mohair staples should be clearly defined. Attempts should be made to quantify the relationships between mohair staple length and fibre length in mohair tops.

5. Evaluate different shearing strategies
There is a need to evaluate different shearing options for mohair goats, that are more appropriate in certain environments. The timing of shearing in relation to kidding, winter growth depression and supplementary feeding need to be evaluated. This work is a priority for younger Angora goats that produce the finer and more valuable mohair.

6. Investigate the potential limits for producing long fine mohair
In association with the RIRDC supported Mohair Sire Evaluation project, the variation in fleece length characteristics should be clearly documented. The mohair industry must actively seek to clarify the appropriate genetic mixture for the various environments in which mohair is produced. The aim of producers is to maximise financial returns, implying heavy fleece weight at fine mean fibre diameters with an even staple length achieving B length classification at both shearings each year. The winter depression in mohair production must be minimised.
References


Turpie, D.W.F., 1985. Some of SAWTRI’s important research findings on mohair. SAWTRI Special Publication (SAWTRI: Port Elizabeth).


Appendix 1. Short and cotted mohair survey

The Rural Industries Research and Development Corporation (RIRDC) and the Victorian Department of Natural Resources and Environment are supporting a project that aims to gain a greater understanding of:

1. the extent of the short and cotted mohair problem in Australia and
2. potential causes and potential solutions to this problem.

The experience of mohair producers is vital for this project to be successful. You are invited to provide feedback on YOUR experiences and the project, even if you have never had any problems with short or cotted mohair.

The information you provide will be kept confidential. Information from this survey will not be used to identify participants. Only general results will be published.

Respondents will go into a draw to WIN one copy of AUSTRALIAN GOAT NOTES, recently published by RIRDC (rrp $55).

We would like to know about your experience. Please tick the most appropriate box.

1. I have experienced problems with short and cotted mohair during the winter half year:
   D In most or all years
   D Only in some years
   D Never *(please go to question 7)*

2. I think that problems with short and cotted mohair on my property are:
   D Serious *(please go to question 3)*
   D Moderate *(please go to question 3)*
   D Minor *(please go to question 3)*
   D In the past *(please go to question 4)*.

3. I think that the financial effect of short and cotted mohair on my property during 2000 was:
   D Less than $500
   D $500 to $1000
   D $1001 to $2500
   D More than $2500.

4. I have tried ways of reducing the problem of short and cotted mohair:
   D Yes *(please go to question 5)*
   D No *(please go to question 7)*

We would like to know about the ways you have tried to reduce short and cotted mohair that worked and the ways that did not work. Describe the animals you used.

5. Methods I have used that successfully reduced short and cotted mohair: *(please explain)*

........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
...........................................................................................................................................................................Please turn over to page 2
6. Methods I tried that did not work in reducing short and cotted mohair: (please explain)

…………………………………………………………………………………………………………
…………………………………………………………………………………………………………
…………………………………………………………………………………………………………

7. Do you know anyone within 50 km of your property who has had problems with short and cotted mohair?
   D  none
   D  1 to 2
   D  3 to 6
   D  more than 6

To help us interpret the data, we ask a few questions about your property.

8. The postcode of my property is:.................

9. In June 2000, the number of Angora goats over 6 months of age in my herd was:
   D  less than 100
   D  101 to 250
   D  251 to 500
   D  more than 500.

10. I normally kid in the month of (please circle all that apply):
    Jan  Feb  Mar  April  May  June  July  August  September  October  November  December

11. I normally shear in the months of (please circle all that apply):
    Jan  Feb  Mar  April  May  June  July  August  September  October  November  December

12. The average genetic background of my herd is about: Please circle those that apply. The numbers must add up to 100%. For example, South African 75%, Australian 25%.
   South African 100%  90%  80%  75%  70%  60%  50%  40%  30%  25%  20%  10%  5%
   Texan  100%  90%  80%  75%  70%  60%  50%  40%  30%  25%  20%  10%  5%
   Australian 100%  90%  80%  75%  70%  60%  50%  40%  30%  25%  20%  10%  5%

Thank you for your time. Please send the completed form, to arrive by 30 September, to: Bruce McGregor, Department of Natural Resources and Environment, 475 Mickleham Road, Attwood 3049.

If you would be prepared to be interviewed and provide more detailed information, please provide your contact details here:
Name:...................................................................................................................
Address:..................................................................................................................
Telephone:........................................... Email:.........................................................
Best time to call:.................................................................................................