Analysis of Western Australian wool quality on a shire basis

John Stanton A/Prof

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Technical Bulletin

Analysis of Western Australian Wool Quality on a Shire Basis

No. 91

A/Prof. John Stanton
Lindy Coss
The authors

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Definition

To define:
- the differences between shires;
- the extent of change within a shire over five years; and
- the correlated changes between correlated characteristics within shire.

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</tr>
<tr>
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<td>150</td>
</tr>
</tbody>
</table>
Summary

Western Australia produces wool in a wide range of environments from high rainfall areas in the south-west of the State through to semi-arid regions in the north and east of the State. Perceptions about the quality of the raw wool tend to be strongly influenced by the production region. To understand the specifications of raw wool from these various regions, a detailed comparative analysis of the specifications of the raw wool was undertaken. This analysis used the information available in the Fremantle auction catalogues which define the specifications and the Wool Selling Area (WSA) for each individual sale lot. The location of the district was further refined by expanding the production district from 20 WSA to 104 shires.

The weight of wool sold (greasy and clean fibre weights), the pre-sale test certificate information (diameter, yield and vegetable matter content) and the staple measurements (staple length, staple strength and proportion of mid breaks) were used from the individual sale lots. These were collected over a five-year period from the 1989/90 selling season through to 1993/94. The results for the individual specifications were tabulated for each shire using a long term average, annual averages and quarterly averages. Attempts were made to express the relative importance of the region (WSA and shire within WSA) and season (year and season within year) with respect to the individual specifications.

The distributions of the specifications across the State were mapped into shire boundaries to show (a) the change in the long term average of the specifications between neighbouring shires across the State, and (b) annual changes from the long term shire average which were designed to show the effect of yearly changes in production within the shire, presumably arising from environmental or management changes.

This document is designed to be a reference for the WA wool production sector to discuss the changes identified, as well as their cause and control, and for the users of the WA wool clip to identify the quality of wool produced in specific regions, and the stability of these specifications across time.
ANALYSIS OF WESTERN AUSTRALIAN WOOL QUALITY ON A SHIRE BASIS

A/Prof. John Stanton and Lindy Coss

1. Introduction

Analyses of the quality of the WA wool clip and comparison with the eastern States have been finished and the results distributed (Stanton 1994).

The response by individual growers to the information has been one of interest, but the results have little relevance to their individual wool enterprises. The objective of this project is therefore to develop a set of information about wool quality which would be relevant to the individual Western Australian wool producer, as well as being useful to the Agriculture Western Australia officers serving groups of producers.

Recently shire information on wool quality has been used in the Wool Market Awareness workshops to aid discussion on wool measurements. The grower response to this limited set was positive as they could identify with the shire (and its boundaries) as well as being able to relate changes in their wool with the wool from neighbouring properties within the shire. A full list of shires with their respective wool selling area (WSA) is shown in Appendix 1.

An analysis was therefore undertaken to prepare results which would relate to shires and to present the results in a variety of forms that allow rapid digestion of the available information.

1.1 Objective

The objectives for the project (from Agriculture Western Australia point of view) were to:

- define the differences between shires;
- define the extent of change within a shire over five years;
- define the correlated changes between correlated characteristics within shire.

These results would:

1. Form a set of benchmarks for research and development programs.

2. Allow examination of the volatility that exists at the shire level for individual characteristics. It is important to identify this volatility as either between year or within year. These production variances (i.e. production risk) can be combined with price analyses (i.e. market risk) over the same period to facilitate risk management.

3. Form the basis for the forecasting work as it may be more relevant to analyse quality shifts at the shire level and sum these changes to develop changes in State quality (i.e. changes in the Fremantle sales) than undertake an exhaustive analysis at the Fremantle level. It may be that the precision of the sum of the individual shire forecasts is superior to the single Fremantle/State forecasts.
1.2 Review of State analyses

The analysis of the Western Australian wool clip has been undertaken (Stanton, 1994) by analysing the wool presented for sale at auction in Fremantle for five consecutive years between 1988 and 1993. This report also compared Fremantle results with results at sale at auction in all other Australian centres. This analysis showed that the long-term average of the WA clip is close to the results from the 'Rest' for most measured wool characteristics. It also showed that there are significant shifts in these Fremantle averages between years.

There were also significant shifts in the Fremantle characteristics between months within a year (Stanton and Chambers, 1992). Monthly differences were also evident within a region (Wool Selling Area), and there were differences between regions in these monthly patterns.

Therefore the understanding of changes in the supply of wool to Fremantle needs to include time and regional effects.

1.3 Review options

The time options available were:

- to use a long-term average description of production (in this case a five-year average);
- to include a series of year averages as well as the long-term average to identify changes between years;
- to include within year as well as between-year effects. This may be necessary as the majority of WA wool production comes from a Mediterranean climate which is strongly seasonal. These within-year effects can be measured on a seasonal basis or on a shorter time basis such as monthly.

The limitations to increasing the time resolution of the analyses (i.e. down to the monthly level) include the increase in the size of the analyses, the associated difficulties in defining significant changes within the results and the presentation of the results in a usable form. To illustrate this the number of permutations (N) to consider are:

- for five-year long-term average and yearly averages N=1+5
- for five-year long-term average, five-year seasonal averages and yearly seasonal averages N=1+4+(5*4)
- for five-year long-term average, five-year monthly average and yearly monthly averages N= 1+12+(5*12)

Similarly the regional options available were:

- State-wide (N=1);
- by wool selling area (WSA) where (N=17);
- by local government area (LGA). These are also known as shires (N=104).

The analysis also increases in complexity when year or seasonal effects are suspected of having significant interactions with the regional effects.

In this analysis, various options for the time and regional effects were considered. The best options were selected after considering:

- which option best explains between season/between region differences;
- the data available to support each option;
- the presentation of the analysis results in an interpretable manner.
As a result of these considerations, this analysis was designed to use shire information on an annual basis, and on quarterly periods. These were reported for individual shires across Western Australia. In the higher wool producing region of the south-west of Western Australia (see Map 1) maps of the average characteristics were generated to show the pattern of these characteristics at the shire level. In addition, the mapping was extended to quantify the changes in these shire results between years from the shire’s long-term average.

Map 1. Distribution of wool production in Western Australia, averaged over five years from July 1989 to June 1993. Each dot represents 50 tonnes of greasy wool. The boxed region is used in subsequent maps of wool quantities and qualities. Data from ABS dataset.
2. Methodology

2.1 Datasets

There are a number of datasets that were used to provide information on the wool production and wool qualities of the Western Australian clip.

2.1.1 Auction dataset

The auction dataset contains the catalogue information from each sale lot sold at auction in Fremantle over the period July 1989 to June 1994. This information contains the wool selling area (WSA) which is supplied by the broker, wool brand which is recorded from the bale, and test results which are supplied by AWTA.

2.1.2 AgWA dataset

The information used from this dataset included the wool brands used and the location of WA properties using these brands. It was used to append the shire information to the auction dataset using the brand information common to both datasets. About 70 per cent of sale lots in the auction dataset were matched allowing the shire data and wool data to be combined. The number of brands matched per shire varied between shires. The number of brands per shire used in these analyses are listed in Appendix 2.

2.1.3 ABS Agricultural Statistics (general summary)

The yearly series of Australian Bureau of Statistics (ABS) information on sheep numbers and wool production is available on a shire basis in the ABS Ag Stat dataset. Part of this series coincides with the period for the auction dataset. Therefore estimates of total wool produced can be related to the wool quality estimates and weight of wool sold at auction.

2.1.4 ABS Livestock Products

This monthly ABS series contains the broker and receivals of taxable wool by month for each State of Australia. This can be used to estimate the monthly production of wool on a shire basis.

2.2 Analyses

As discussed in the Review Options (Section 1.3) there are a number of different time and regional units available, and the choice of the units to use relies on:

- the availability of the data at that unit size;
- the ability to interpret the results from that unit size;
- the ability of the unit size to explain the variance in the characteristic.

The availability of the data was fixed by the records accessible by the project. All available information has been used. Some analyses were therefore not undertaken because the data was unavailable.

The ability to interpret the results is related to the size of the matrix produced and how that matrix can be presented. Tables provide exact results but prove difficult to use when identifying a 'pattern' or 'trend'. Mapping the matrix provides a visual method to assess patterns and trends but does not supply exact results. Providing both forms of results allows them to complement each other. However, there is still a limit to the amount of information that can be presented in a useable format.
In these analyses it was decided to use season by shire as a suitable minimum size unit to work with rather than use month by shire (the two smallest units) which would have resulted in information overload. In these analyses the four seasons were nested within a selling year. This is because the seasons only exist within a selling year. Similarly each shire exists within only one WSA, so the shires were nested within WSA. The calendar months included in the seasons are shown below.

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Calendar months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1</td>
<td>January, February, March</td>
</tr>
<tr>
<td>Q2</td>
<td>April, May, June</td>
</tr>
<tr>
<td>Q3</td>
<td>July, August, September</td>
</tr>
<tr>
<td>Q4</td>
<td>October, November, December</td>
</tr>
</tbody>
</table>

An analysis of variance was undertaken for each characteristic to explain the variance which could be attributed to selling year, season, WSA or shire within WSA. The results for the analysis of variance for each characteristic are presented as a table in the appropriate sections. In general these tables show:

- The degrees of freedom (df) for each term. The corrected total df is the total number of sale lots used in the analysis minus one.

- The variance explained by the model (Model Sum of Squares), the residual or unexplained variance (the Error Sum of Squares) and the total variance (Total Sums of Squares). The proportion of variance explained is calculated as the Model Sums of Squares divided by the Total Sums of Squares).

- The F value is a statistical measure to test the significance of the model in explaining the variance of the characteristic. Therefore the higher the F statistic, the higher the ability of the model to explain the variance in the data.

- The level of significance achieved (Pr>F) measures the probability that the model is detecting real effects using the model. Highly significant results in the F statistic will have Pr>F values of 0.0001. Values larger than 0.0001 have lower significance.

The components of variance table shows the relative contribution of the individual model terms in explaining the variance in the characteristic. This table shows:

- Each component used in the model (under Source).

- The Type III SS which is the partial sums of squares for each component. This has been calculated as essentially independent of the other terms, to assist with the interpretation.

- The Mean Square for each component which corrects the partial Sum of Squares for the degrees of freedom.

- The F statistic and the Pr>F statistics are the same as above. High F values suggest that the term in the model has made a large contribution to explaining the overall variance in the data.

2.3 Analyses performed

Estimations were made of total wool production and a range of wool quality at the shire level. Estimates were also be made of the production and quality of sale lots within various micron categories.
Wool production and wool quality estimates are generated for each WA shire except for the following: Broome, Derby-West Kimberley, Halls Creek, Wyndham-East Kimberley (all of W01) and East Pilbara (from W02), as these are very low producers. From W15 only Swan, Mundaring and Serpentine/Jarrahdale are included. Perth and surrounding suburbs are not included as these are obviously not wool production areas. When the ABS data shows high levels of wool shorn in these areas, it is thought to be the presence of transient 'shipper' flocks.

2.3.1 Total wool production

The greasy wool production figures per shire are taken from the ABS Ag Stats dataset because this dataset is a more complete estimate of production by shire than the matched auction data. This was because the matched auction dataset includes only the sale lots sold at auction (not wool sold privately, which can be up to 30 per cent of the State production) and the matching process only identified about 70 per cent of the auction dataset.

The long-term average wool production figures were a simple average of the five years of data. The deviations from this long-term average are calculated as the production figure for a particular year over the long-term average production, expressed as a percentage difference.

2.3.2 Average quality of wool characteristics

*Measured wool characteristics*

Wool characteristics which were measured for the individual sale lots and reported in the sale catalogues are available in the auction dataset. Therefore the matched sale lots which are allocated to a known shire can be used to generate wool quality estimates for that shire. These wool characteristics include the core test results (diameter, Schlumberger yield and vegetable matter percentage) and the staple measurements (staple length, strength and percentage mid breaks) when they were available.

*Predicted wool characteristics*

Prediction of processing performance of the raw wool was done using the TEAM prediction equations for estimating hauteur and the coefficient of variation of hauteur (CV(H)).

The analysis of the average of wool characteristics is done using merino combing fleece wool only. This ensures the age structure of the flocks (i.e. the proportion of weaners and lambs) and the amount of skirtings do not affect the estimate of the average quality, especially in estimates of length and vegetable matter. However, other factors cannot be controlled in the comparisons within the merino combing fleece wool between shires, such as the ratio of ewes to wethers, and these may influence the estimate of the average.

The calculation of averages for wool characteristics used a clean weight adjusted average. This was done to remove yield differences between shires. Deviations for individual shires from the long-term shire average were calculated as the average for a particular year over the long-term average, expressed as a percentage difference.

All available lots were used in the calculation of the averages. As a result the analyses of core test results (diameter, yield and vegetable matter) used more sale lots than the analyses of staple measurements (length, strength and percentage mid breaks) and predicted characteristics (hauteur, CV(H)). The average staple testing rate of these lots was 34 per cent over the period, and was much lower in the first year of the analysis. The lower numbers used may lead to an increase in the unexplained variance in the estimates.
2.3.3 Production and quality by micron group

Changes in wool quality may occur differently in the different diameter groups. Location of production for wool with specific diameter ranges can be achieved using the matched auction dataset. Production is expressed as clean weight to remove the yield differences between the different diameter groups. As the matched auction dataset was used, the quantity within micron groups were only part of the total production. The wool quality can also be estimated on wool within specific micron ranges. The calculation of production and quality was repeated using three micron groups shown below.

<table>
<thead>
<tr>
<th>Micron class</th>
<th>Midpoint diameter</th>
<th>Minimum diameter</th>
<th>Maximum diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>19.5</td>
<td>18.6</td>
<td>20.5</td>
</tr>
<tr>
<td>Medium</td>
<td>21.5</td>
<td>20.6</td>
<td>22.5</td>
</tr>
<tr>
<td>Broad</td>
<td>23.5</td>
<td>22.6</td>
<td>24.5</td>
</tr>
</tbody>
</table>

2.4 Results presentation

The presentation of the total production and average quality figures is difficult because of the volume of information present. All results are presented in a tabular form so that exact figures can be extracted. Because of difficulties in collating results from adjacent areas (either WSAs or shires) the results from the analyses have also been displayed in a series of maps. This allows easier interpretation the results from adjacent areas. The maps only show the south-west portion of the State (see Map 1) which includes the higher greasy wool production areas of Western Australia.

2.4.1 ABS LGA maps

ABS Local Government Area (or shire) boundaries for Western Australia are available. These ABS boundaries are subject to copyright requirements which are acknowledged on each of the maps. From these boundaries a number of maps were produced.

Map of shire boundaries and major towns

The shire boundaries of the south-west section of the State and several major towns are shown in Map 2.1. This map is used to provide an orientation when interpreting the results in Sections 3.1 to 3.13.

Maps showing WSAs and shires

Each wool selling area (WSA) combines several shires (and each shire is in only one WSA). (No shire is split by a WSA boundary.) The WSAs are shown over the shire boundaries in Map 2.2. A complete list of individual shires together with shire number, the corresponding wool selling area and shire name is in Appendix 1. The shire number and shire boundaries have also been mapped in Map A1 in Appendix 1.
Map 2.1. Shire boundaries and major towns in the south-west region of Western Australia.
Map 2.2. WSA boundaries and shire boundaries in Western Australia.
Maps of total production and average quality results

The ABS shire boundaries can be used to graphically illustrate the production and quality results. There are three different techniques used:

1. The long-term average production was mapped using colour gradations in the large coloured map for Section 3.1 'Greasy wool production by shire for 1989/90 to 1993/94'. This map shows production levels using a green gradation. Areas of high production with a dark green shading fade to white for the low production shires that have less than 1000 tonnes annually.

2. The long-term average quality was mapped using discrete ranges with the colours indicating shires at, above and below the State long-term average. The State long-term average was white, above average was a range of green, below average was a range of yellow. It depends on the characteristic being mapped whether a high figure is favourable or unfavourable (e.g. staple strength – green is sound wool, diameter – green is broad wool). Theses maps are designed to show which shires are away from the State average and the pattern of this spread across shires.

3. The annual average production/quality (expressed as deviations from the long-term average year) are mapped using discrete ranges. An average year is white, an above average year is a shading of blue, a below average is a shading of red. The ranges are calculated using the standard deviation of the overall State results. As in the other range maps, it depends on the characteristic being mapped whether a high figure can be viewed as favourable or unfavourable (e.g. staple strength – blue is strong wool, diameter – blue is broad wool). These maps show whether each shire had an ‘above average’ year or a ‘below average’ year and the pattern of the year over the State (e.g. the Staple Strength – 1991/92 map shows that the whole State had a below average year). These maps can be examined together to show more complex patterns.
3. Results

3.1 Total greasy wool production

3.1.1 Annual production by State

Estimates of wool production from WA are available directly from the ABS Ag Stats data and only indirectly from the AWC auction catalogue information. The ABS information allows a more complete estimate of the annual greasy wool production by shire. However, as no quality breakdown is available in the ABS data, the results relate to total production, and not merino combing fleece wools.

Therefore the ABS Ag Stats data was used to generate the estimated greasy wool production for each shire over the five-year period from July 1989 to June 1994. The long-term State greasy wool production is 186,393 tonnes. The State greasy wool production for the individual years ranged from 205,415 tonnes to 175,491 tonnes (as shown in Table 3.1.1).

Table 3.1.1. Greasy wool production for Western Australia over the period July 1989 and June 1994. Results are from ABS Ag Stats dataset

<table>
<thead>
<tr>
<th>Period</th>
<th>Greasy wool production (tonnes)</th>
<th>Yearly production as a percentage difference from long-term production (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year average</td>
<td>186,393</td>
<td>0.0</td>
</tr>
<tr>
<td>89/90</td>
<td>194,473</td>
<td>+4.3</td>
</tr>
<tr>
<td>90/91</td>
<td>205,415</td>
<td>+10.2</td>
</tr>
<tr>
<td>91/92</td>
<td>176,967</td>
<td>-5.1</td>
</tr>
<tr>
<td>92/93</td>
<td>179,620</td>
<td>-3.6</td>
</tr>
<tr>
<td>93/94</td>
<td>175,491</td>
<td>-5.8</td>
</tr>
</tbody>
</table>

The change in wool production across years is due to seasonal differences, and to some extent the management response to the removal of the Reserve Price System in July 1991. The reduction in production levels in 91/92 suggest a drastic response to the Reserve Price System removal, but is associated with reductions in diameter and strength and increases in VM% which suggest that the immediate market responses may have been exaggerated by widespread poor seasonal conditions. It is also possible that dramatic changes occurred in managerial inputs which affected the feed supply (such as applications of fertiliser to pasture and supplementary feeding of sheep in summer).

3.1.2 Annual production by shire

The annual greasy wool production by shire is available from the ABS Ag Stats data and is shown in Table 3.1.2. The results show the weight produced in each year, the long-term average and the proportion of the State clip supplied by the shire, calculated from the long-term shire and State production figures.

The highest average production comes from Esperance. The smaller production levels come from the marginal areas along the south-west coast, the outskirts of Perth and from the pastoral regions.

Stanton and Coss 1997
<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Avg. year</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany (S)</td>
<td>W10</td>
<td>4851</td>
<td>5371</td>
<td>4877</td>
<td>4678</td>
<td>4623</td>
<td>4880</td>
<td>2.618</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>724</td>
<td>614</td>
<td>611</td>
<td>695</td>
<td>722</td>
<td>673</td>
<td>0.361</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>390</td>
<td>416</td>
<td>318</td>
<td>287</td>
<td>285</td>
<td>339</td>
<td>0.182</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
<td>2935</td>
<td>3104</td>
<td>2624</td>
<td>2594</td>
<td>2466</td>
<td>2745</td>
<td>1.473</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>1482</td>
<td>1487</td>
<td>1489</td>
<td>1435</td>
<td>1278</td>
<td>1434</td>
<td>0.769</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>5579</td>
<td>5894</td>
<td>5562</td>
<td>5340</td>
<td>5421</td>
<td>5559</td>
<td>2.983</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>812</td>
<td>823</td>
<td>725</td>
<td>744</td>
<td>742</td>
<td>769</td>
<td>0.413</td>
</tr>
<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>2210</td>
<td>2267</td>
<td>1831</td>
<td>1873</td>
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Stanton and Coss 1997
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Table 3.1.2 (cont.). Greasy wool production (tonnes) for individual shires for five selling years between 1989/90 and 1993/94, the five-year average greasy wool production for each shire, and the percentage of the shire of total State production. Results are from ABS Ag Stats dataset

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<tr>
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<td>Trayning (S)</td>
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<td>W05</td>
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<td>Victoria Plains (S)</td>
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<td>Wandering (S)</td>
<td>W12</td>
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<td>1877</td>
<td>1896</td>
<td>1771</td>
<td>1884</td>
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<td>Waroona (S)</td>
<td>W16</td>
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<td>30</td>
<td>58</td>
<td>0.031</td>
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<td>W12</td>
<td>5175</td>
<td>5490</td>
<td>5287</td>
<td>5365</td>
<td>5476</td>
<td>5359</td>
<td>2.875</td>
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<td>786</td>
<td>642</td>
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<td>541</td>
<td>671</td>
<td>0.360</td>
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<td>2534</td>
<td>2677</td>
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<td>2459</td>
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<td>Williams (S)</td>
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<td>4237</td>
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<td>4477</td>
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<td>298</td>
<td>296</td>
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<td>1769</td>
<td>1369</td>
<td>1524</td>
<td>1369</td>
<td>1539</td>
<td>0.826</td>
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<td>1682</td>
<td>1815</td>
<td>1642</td>
<td>1666</td>
<td>1745</td>
<td>1710</td>
<td>0.917</td>
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<td>Wyalkatchem (S)</td>
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<td>753</td>
<td>806</td>
<td>628</td>
<td>700</td>
<td>603</td>
<td>698</td>
<td>0.374</td>
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<tr>
<td>Yalgoo (S)</td>
<td>W04</td>
<td>823</td>
<td>965</td>
<td>857</td>
<td>895</td>
<td>978</td>
<td>904</td>
<td>0.485</td>
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<tr>
<td>Yilgarn (S)</td>
<td>W07</td>
<td>1671</td>
<td>1870</td>
<td>1784</td>
<td>1575</td>
<td>1516</td>
<td>1683</td>
<td>0.903</td>
</tr>
<tr>
<td>York (S)</td>
<td>W11</td>
<td>2194</td>
<td>2312</td>
<td>1919</td>
<td>1971</td>
<td>1810</td>
<td>2041</td>
<td>1.095</td>
</tr>
</tbody>
</table>
3.1.3 Maps of greasy wool production by shire

The long-term average weights by shire are shown in the coloured map ‘Greasy wool production by shire for 1989/90 to 1993/94’ in this Section 3.1. The highest level of wool production is in the south-western agricultural regions of the State. The high rainfall regions in the south-west coastal area and the coastal plain south of Perth have low production levels.

The main band of wool production appears to follow the rainfall isohyets from the south coast to the northern coast around Geraldton.

The highest weight from a single shire is Esperance (Table 3.1.2) and is shown in the large coloured map for 3.1 in the highest production colour range (as dark green).

The deviations of the individual year production from the long-term average are shown in the right hand series of coloured maps (for the selling years 1989/90 to 1993/94). These show the annual changes from the shire’s long-term average production. Some of the patterns visible are a widespread depression in wool production in 1991/92 when most shires reported lower than average wool production, and changes in both directions in 1993/94 (average or above around Narrogin and in the eastern and northern pastoral shires, and below average north of Perth), presumably due to inconsistency in the season.

3.1.4 Monthly production by State

Seasonal changes in the State’s greasy wool production can be estimated from the ABS Livestock Products series (as quoted in the Wool International’s ‘Australian Wool Compendium’). This series provides the greasy weight of wool received by dealers and brokers each month. This is used to estimate the production profile by month, on the assumption that the greasy wool is sent by the producer to store at the completion of shearing.

The proportion of the annual greasy wool production across the State is shown on a monthly basis in Table 3.1.3. This table shows the high level of production due to shearing in the spring and autumn periods.

Table 3.1.3. Proportion of greasy wool production delivered by month in Western Australia, averaged over the period July 1990 to June 1994. Results are for all greasy wool received by brokers and dealers in Western Australia

<table>
<thead>
<tr>
<th>Month</th>
<th>Greasy wool received by brokers and dealers (% of annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>5.3</td>
</tr>
<tr>
<td>February</td>
<td>7.8</td>
</tr>
<tr>
<td>March</td>
<td>8.7</td>
</tr>
<tr>
<td>April</td>
<td>5.7</td>
</tr>
<tr>
<td>May</td>
<td>3.8</td>
</tr>
<tr>
<td>June</td>
<td>2.3</td>
</tr>
<tr>
<td>July</td>
<td>6.4</td>
</tr>
<tr>
<td>August</td>
<td>13.0</td>
</tr>
<tr>
<td>September</td>
<td>16.0</td>
</tr>
<tr>
<td>October</td>
<td>16.1</td>
</tr>
<tr>
<td>November</td>
<td>10.3</td>
</tr>
<tr>
<td>December</td>
<td>4.6</td>
</tr>
</tbody>
</table>

Monthly production by shire is not presented as the ABS results are not available at the shire by month level.
Western Australia

Greasy wool production by shire for 1989/90 to 1993/94

Annual State average = 186393 tonnes

Annual shire average

Weight Range (tonnes)
- 8000 to 15000
- 6000 to 8000
- 4000 to 6000
- 2000 to 4000
- 1000 to 2000
- 10 to 1000
- unreported

Dr John Stanton and Lindy Cox

Percentage change in shire average
- 117.5 and over
- 110.5 to 117.5
- 103.5 to 110.5
- 96.5 to 103.5
- 89.5 to 96.5
- 82.5 to 89.5
- 82.5 and under
- unreported

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.

1989/90
1990/91
1991/92
1992/93
1993/94
3.2 Wool supplied to auction by micron group

The previous total wool production results can be supplemented with estimates of merino combing fleece wool of particular diameters coming from these shires. This was done using the matched auction dataset. The proportion of clean wool available at auction in each micron class over the five-year period is shown below.

<table>
<thead>
<tr>
<th>Micron class</th>
<th>Midpoint diameter (μm)</th>
<th>% clean weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine</td>
<td>19.5</td>
<td>10.8</td>
</tr>
<tr>
<td>Medium</td>
<td>21.5</td>
<td>50.2</td>
</tr>
<tr>
<td>Broad</td>
<td>23.5</td>
<td>38.9</td>
</tr>
</tbody>
</table>

The distribution of the supply in each micron group is shown for:

fine average of 19.5 μm with a range from 18.6 μm to 20.5 μm (Table 3.2.1)
medium average of 21.5 μm with a range from 20.6 μm to 22.5 μm (Table 3.2.2)
broad average of 23.5 μm with a range from 22.6 μm to 24.5 μm (Table 3.2.3)

NOTE: The results below are based on the clean weight, of merino combing fleece only, and only for the matched brands which have the shire identified. Therefore:

(a) these results will not equate to the ABS greasy wool production results in Section 3.1, and

(b) are only indicative of the breakdown of the production between and within the shires into micron groups.

Tables 3.2.1 to 3.2.3 have results of ‘na’ where no wool was identified in the matched auction dataset as coming from these shire, and/or year combinations.

Within-shire weights by micron group:

The clean weight of the matched sale lots from each shire falling in a particular diameter class has been compared with the total State supply at auction from that diameter class. This is expressed as a shire percentage for each diameter class and is shown in Table 3.2.4. The shire result can be compared with the overall proportion of the State clip in each category is also shown in this table.
Table 3.2.1. Weight of clean fine wool (averaging 19.5 µm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average weight for each shire. Results are expressed in clean tonnes. These results are for comparative use only, and are not estimates of total wool production from these shires.

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany (S)</td>
<td>W10</td>
<td>72</td>
<td>152</td>
<td>213</td>
<td>131</td>
<td>99</td>
<td>133</td>
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<td>Ashburton (S)</td>
<td>W03</td>
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<td>50</td>
<td>12</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>9</td>
<td>16</td>
<td>26</td>
<td>17</td>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
<td>105</td>
<td>96</td>
<td>216</td>
<td>103</td>
<td>185</td>
<td>141</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>136</td>
<td>118</td>
<td>137</td>
<td>98</td>
<td>136</td>
<td>125</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>315</td>
<td>341</td>
<td>824</td>
<td>495</td>
<td>342</td>
<td>463</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>26</td>
<td>27</td>
<td>54</td>
<td>24</td>
<td>15</td>
<td>29</td>
</tr>
<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>42</td>
<td>50</td>
<td>127</td>
<td>46</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>Broomehill (S)</td>
<td>W09</td>
<td>42</td>
<td>122</td>
<td>113</td>
<td>64</td>
<td>51</td>
<td>78</td>
</tr>
<tr>
<td>Bruce Rock (S)</td>
<td>W07</td>
<td>55</td>
<td>25</td>
<td>115</td>
<td>20</td>
<td>66</td>
<td>56</td>
</tr>
<tr>
<td>Busselton (S)</td>
<td>W18</td>
<td>13</td>
<td>20</td>
<td>24</td>
<td>23</td>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>Capel (S)</td>
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<td>12</td>
<td>13</td>
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</tr>
<tr>
<td>Carnamah (S)</td>
<td>W06</td>
<td>56</td>
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<td>127</td>
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<td>76</td>
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<tr>
<td>Carnarvon (S)</td>
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<td>12</td>
<td>41</td>
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<td>Chapman Valley (S)</td>
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<td>27</td>
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<td>61</td>
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<tr>
<td>Chittering (S)</td>
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<td>4</td>
<td>14</td>
<td>15</td>
<td>7</td>
<td>18</td>
<td>12</td>
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<tr>
<td>Collie (S)</td>
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<td>29</td>
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<td>28</td>
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<td>34</td>
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<td>Coolgardie (S)</td>
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<td>na</td>
<td>0</td>
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<td>Coorow (S)</td>
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<td>49</td>
<td>31</td>
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<td>40</td>
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<td>Corrigin (S)</td>
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<td>101</td>
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<td>Cranbrook (S)</td>
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<td>180</td>
<td>246</td>
<td>446</td>
<td>232</td>
<td>154</td>
<td>252</td>
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<td>Cuballing (S)</td>
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<td>54</td>
<td>121</td>
<td>38</td>
<td>43</td>
<td>62</td>
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<tr>
<td>Cue (S)</td>
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<td>4</td>
<td>2</td>
<td>8</td>
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<td>Cunderdin (S)</td>
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<td>24</td>
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<td>24</td>
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<td>Esperance (S)</td>
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<td>840</td>
<td>68</td>
<td>238</td>
<td>333</td>
</tr>
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<td>Exmouth (S)</td>
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<td>10</td>
<td>1</td>
<td>na</td>
<td>5</td>
</tr>
</tbody>
</table>
Table 3.2.1 (cont.). Weight of clean fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average weight for each shire. Results are expressed in clean tonnes. These results are for comparative use only, and are not estimates of total wool production from these shires.

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
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<td>Gingin (S)</td>
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<td>47</td>
<td>51</td>
<td>46</td>
<td>54</td>
<td>44</td>
</tr>
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<td>Gnowangerup (S)</td>
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<td>128</td>
<td>320</td>
<td>126</td>
<td>54</td>
<td>140</td>
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<td>Goomalling (S)</td>
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<td>32</td>
<td>52</td>
<td>15</td>
<td>22</td>
<td>28</td>
</tr>
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<td>Greenough (S)</td>
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<td>60</td>
<td>32</td>
<td>19</td>
<td>37</td>
</tr>
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<td>Harvey (S)</td>
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<td>4</td>
<td>4</td>
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<td>3</td>
</tr>
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<td>20</td>
<td>25</td>
</tr>
<tr>
<td>Jerramungup (S)</td>
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<td>119</td>
<td>192</td>
<td>63</td>
<td>68</td>
<td>108</td>
</tr>
<tr>
<td>Kalgoorlie/Boulder (C)</td>
<td>W19</td>
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<td>9</td>
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<td>0</td>
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<td>5</td>
</tr>
<tr>
<td>Katanning (S)</td>
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<td>144</td>
<td>215</td>
<td>120</td>
<td>84</td>
<td>120</td>
</tr>
<tr>
<td>Kellerberrin (S)</td>
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<td>14</td>
<td>50</td>
<td>16</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Kent (S)</td>
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<td>70</td>
<td>76</td>
<td>124</td>
<td>42</td>
<td>43</td>
<td>71</td>
</tr>
<tr>
<td>Kojonup (S)</td>
<td>W09</td>
<td>375</td>
<td>559</td>
<td>790</td>
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Table 3.2.1 (cont.). Weight of clean fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average weight for each shire. Results are expressed in clean tonnes. These results are for comparative use only, and are not estimates of total wool production from these shires.

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## Table 3.2.2. Weight of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average weight for each shire. Results are expressed in clean tonnes. These results are for comparative use only, and are not estimates of total wool production from these shires.

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Table 3.2.2 (cont.). Weight of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average weight for each shire. Results are expressed in clean tonnes. These results are for comparative use only, and are not estimates of total wool production from these shires

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Stanton and Coss 1997
Table 3.2.3. Weight of clean broad wool (averaging 23.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average weight for each shire. Results are expressed in clean tonnes. These results are for comparative use only, and are not estimates of total wool production from these shires.

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Table 3.2.4. Percentage of the State’s fine, medium and broad wool sold from each shire. This uses the five-year average weight for each shire for each diameter class divided by the State five-year average weight for each diameter class. The proportion of State clip is measured as the percentage of the wool from all shires in these analyses (Tables 3.2.1 - 3.2.3) that fall in the respective diameter categories.

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>Fine (19.5 μm)</th>
<th>Medium (21.5 μm)</th>
<th>Broad (23.5 μm)</th>
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Table 3.2.4 (cont.). Percentage of the State’s fine, medium and broad wool sold from each shire. This uses the five-year average weight for each shire for each diameter class divided by the State five-year average weight for each diameter class. The proportion of State clip is measured as the percentage of the wool from all shires in these analyses (Tables 3.2.1 – 3.2.3) that fall in the respective diameter categories.

<table>
<thead>
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<th>Shire</th>
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Table 3.2.4 (cont.). Percentage of the State’s fine, medium and broad wool sold from each shire. This uses the five-year average weight for each shire for each diameter class divided by the State five-year average weight for each diameter class. The proportion of State clip is measured as the percentage of the wool from all shires in these analyses (Tables 3.2.1 – 3.2.3) that fall in the respective diameter categories.

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<th>Fine (19.5 μm)</th>
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</table>

Stanton and Coss 1997
3.2.1 Maps of clean wool supplied to auction by shire by micron group

The long-term average weights by shire are shown in the following coloured map for this Section 3.2, ‘Clean wool production by shire by micron group for 1989/90 to 1993/94 (as sold at auction)’. The colour range is common to all three maps, allowing comparison of supply levels in the different micron groups between maps.

The highest levels of fine wool supply occur in the Kojonup shire. The medium wool weights are highest in Kojonup, Cranbrook, Plantagenet, West Arthur, Boyup Brook and Esperance. The strong wool supply is highest from the Esperance shire.
Western Australia

Clean wool production by shire by micron group for 1989/90 to 1993/94 (as sold at auction)

Annual shire average

Weight Range (tonnes)
- 2000 to 3000
- 1000 to 2000
- 500 to 1000
- 100 to 500
- 10 to 100
- 1 to 10
- unreported

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.

Dr. John Stanton and Lindy Coes
3.3 Average fibre diameter

The matched AWC dataset was used to generate the estimated average fibre diameter by shire for the five-year period from July 1989 to June 1994. The long-term State average diameter is 22.27 μm. The changes about this average between years are shown in Table 3.3.1. The average diameter for the individual years ranges from 22.53 μm to 21.66 μm.

The SD of the yearly means is the between sale lots standard deviation, and can be used as a measure of the range of diameter in the raw wool sold on an annual basis in Fremantle.

Table 3.3.1. Average fibre diameter for Western Australia over the period July 1989 to June 1994. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

<table>
<thead>
<tr>
<th>Period</th>
<th>Average fibre diameter (μm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>5-year average</td>
<td>22.27</td>
</tr>
<tr>
<td>89/90</td>
<td>22.40</td>
</tr>
<tr>
<td>90/91</td>
<td>22.33</td>
</tr>
<tr>
<td>91/92</td>
<td>21.66</td>
</tr>
<tr>
<td>92/93</td>
<td>22.53</td>
</tr>
<tr>
<td>93/94</td>
<td>22.43</td>
</tr>
</tbody>
</table>

3.3.1 Variation in diameter due to year, season and WSA, shire effects

While the differences of fibre diameter evident in the above table are due to between-year effects, it could also be assumed that differences exist between seasons within a year. Attempts have been made to identify and quantify these and other causes of change in diameter of sale lots in Fremantle sales.

Table 3.3.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance of diameter between sale lots. The model is highly significant, but only explains 16.0 per cent of the total variance (model SS total sums of squares) in diameter. So 84.0 per cent of the total variance has been included in the error variance (see Section 2.2 for an explanation). This indicates that the error variance contains important effects not included in the model and random effects.

Therefore the results in Table 3.3.2 suggest that only a small proportion of variance in diameter is due to macro effects such as year, season and region, and although these are significant, the majority of variance is due to factors other than those included in the model. These other factors could include between-flock and between-property differences within shires e.g. strain differences and other flock management effects, and between-month differences within season.

Table 3.3.2 Analysis of variance in diameter due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>193</td>
<td>95026</td>
<td>492.36</td>
<td>263.54</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>266246</td>
<td>497421</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>266439</td>
<td>592448</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stanton and Coss 1997
The relative importance of the individual terms included in the model in explaining the variance in diameter are shown in Table 3.3.3. All sources of variance included were highly significant as the significance level (Pr>F) equals 0.0001 for all terms in the model (sources). Their relative importance is indicated by the size of the F value, with the larger F indicating higher importance. Season and year appear to be the more important terms (of the terms used in this analysis) when explaining the variance in diameter.

Table 3.3.3. Components of variance in diameter (year and season nested within year, WSA and shires nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling year</td>
<td>4</td>
<td>1031</td>
<td>257.74</td>
<td>137.96</td>
<td>0.0001</td>
</tr>
<tr>
<td>Season (within selling year)</td>
<td>15</td>
<td>9931</td>
<td>662.10</td>
<td>354.39</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA</td>
<td>18</td>
<td>11159</td>
<td>619.95</td>
<td>331.83</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shire nested in WSA</td>
<td>84</td>
<td>15998</td>
<td>190.45</td>
<td>101.94</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA x selling year</td>
<td>72</td>
<td>13543</td>
<td>188.09</td>
<td>100.68</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The nature of the shire and year changes in diameter are shown in Table 3.3.4. This is a listing based on the average fibre diameter of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average for each shire.
Table 3.3.4. Average fibre diameter for (µm) individual shires for five selling years between July 1989 and June 1994, and the five-year average diameter for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
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<td>Albany (S)</td>
<td>W10</td>
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<td>22.5</td>
<td>21.8</td>
<td>22.4</td>
<td>22.8</td>
<td>22.5</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>21.8</td>
<td>21.2</td>
<td>21.1</td>
<td>22.5</td>
<td>21.9</td>
<td>21.8</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>22.3</td>
<td>22.3</td>
<td>21.9</td>
<td>22.1</td>
<td>21.8</td>
<td>22.1</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
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<td>22.3</td>
<td>21.3</td>
<td>22.2</td>
<td>21.7</td>
<td>21.9</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>21.3</td>
<td>21.7</td>
<td>21.7</td>
<td>21.8</td>
<td>21.5</td>
<td>21.6</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>21.5</td>
<td>21.7</td>
<td>20.9</td>
<td>21.4</td>
<td>21.7</td>
<td>21.5</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>21.8</td>
<td>22.1</td>
<td>21.4</td>
<td>21.8</td>
<td>22.2</td>
<td>21.9</td>
</tr>
<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>22.5</td>
<td>22.6</td>
<td>21.5</td>
<td>22.3</td>
<td>22.3</td>
<td>22.2</td>
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<td>22.0</td>
<td>21.8</td>
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<td>22.9</td>
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<td>21.2</td>
<td>21.8</td>
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<tr>
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<td>21.0</td>
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<td>21.9</td>
<td>21.6</td>
</tr>
<tr>
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<td>24.0</td>
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<tr>
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<td>22.1</td>
<td>22.0</td>
<td>22.5</td>
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<tr>
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<td>21.9</td>
<td>22.8</td>
<td>22.4</td>
<td>22.6</td>
</tr>
<tr>
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<td>W10</td>
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<td>22.1</td>
<td>21.2</td>
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<td>22.4</td>
<td>21.9</td>
</tr>
<tr>
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<td>22.0</td>
<td>23.1</td>
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<tr>
<td>Dalwallinu (S)</td>
<td>W11</td>
<td>22.4</td>
<td>22.2</td>
<td>21.9</td>
<td>22.7</td>
<td>22.3</td>
<td>22.3</td>
</tr>
<tr>
<td>Dandaragan (S)</td>
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<td>21.9</td>
<td>21.8</td>
<td>22.7</td>
<td>21.9</td>
<td>22.1</td>
</tr>
<tr>
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<td>22.9</td>
<td>21.5</td>
<td>21.1</td>
<td>22.8</td>
<td>22.9</td>
<td>22.2</td>
</tr>
<tr>
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<td>W10</td>
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<tr>
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<td>21.5</td>
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<td>22.4</td>
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<td>23.1</td>
<td>22.4</td>
</tr>
<tr>
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<tr>
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</tbody>
</table>
Table 3.3.4 (cont.). Average fibre diameter (μm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average diameter for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingin (S)</td>
<td>W14</td>
<td>22.4</td>
<td>22.0</td>
<td>21.6</td>
<td>21.7</td>
<td>21.3</td>
<td>21.8</td>
</tr>
<tr>
<td>Gnowangerup (S)</td>
<td>W09</td>
<td>22.8</td>
<td>22.4</td>
<td>21.8</td>
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</tr>
<tr>
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<td>22.8</td>
<td>22.2</td>
<td>23.2</td>
<td>22.8</td>
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</tr>
<tr>
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<td>22.0</td>
<td>22.8</td>
<td>22.9</td>
<td>22.5</td>
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<tr>
<td>Kalgoorlie/Boulder (C)</td>
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<td>24.7</td>
<td>23.4</td>
<td>23.7</td>
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<tr>
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<tr>
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<td>23.1</td>
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<tr>
<td>Kondinin (S)</td>
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<td>22.9</td>
<td>22.4</td>
<td>22.6</td>
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<tr>
<td>Koorda (S)</td>
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<tr>
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<td>22.9</td>
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<td>23.1</td>
<td>22.9</td>
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<td>23.4</td>
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<tr>
<td>Leonora (S)</td>
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<td>23.5</td>
<td>22.5</td>
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<td>23.5</td>
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<tr>
<td>Manjimup (S)</td>
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<tr>
<td>Meekatharra (S)</td>
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<td>23.4</td>
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<td>23.2</td>
<td>22.5</td>
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<tr>
<td>Menzies (S)</td>
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<td>24.4</td>
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<td>24.4</td>
<td>24.1</td>
<td>23.9</td>
</tr>
<tr>
<td>Merredin (S)</td>
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<td>22.3</td>
<td>23.0</td>
<td>21.8</td>
<td>23.0</td>
<td>22.2</td>
<td>22.5</td>
</tr>
<tr>
<td>Mingenew (S)</td>
<td>W06</td>
<td>23.0</td>
<td>22.9</td>
<td>22.4</td>
<td>23.0</td>
<td>22.7</td>
<td>22.8</td>
</tr>
<tr>
<td>Moora (S)</td>
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<td>22.2</td>
<td>21.5</td>
<td>22.7</td>
<td>22.0</td>
<td>22.1</td>
</tr>
<tr>
<td>Morawa (S)</td>
<td>W06</td>
<td>22.1</td>
<td>22.1</td>
<td>21.4</td>
<td>22.5</td>
<td>22.2</td>
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</tr>
<tr>
<td>Mount Magnet (S)</td>
<td>W04</td>
<td>23.5</td>
<td>22.1</td>
<td>21.8</td>
<td>23.5</td>
<td>22.9</td>
<td>22.8</td>
</tr>
<tr>
<td>Mount Marshall (S)</td>
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<td>22.7</td>
<td>22.7</td>
<td>22.0</td>
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Table 3.3.4 (cont.). Average fibre diameter (μm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average diameter for each shire

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</table>

Stanton and Coss 1997
3.3.2 Maps of average fibre diameter by shire

The five-year average results for individual shires are displayed on the large map in this Section 3.3, ‘Fibre diameter by shire for 1989/90 to 1993/94’, which is coloured using a three-part colour scale – white for shire results closest to the State average, with the shires supplying broader diameters shown in grades of green, and the shires with finer diameters in grades of yellow. This map shows that the finer wool is found in the high rainfall region in the south-west region of the State. The broadest diameter merino fleece wool is delivered from the Eastern Goldfields (around Kalgoorlie).

The deviations of the individual year average fibre diameter from the long-term average are also shown in the series down the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average diameters from the long-term shire average. These maps are coloured using a three-part colour scale – white for shires with annual results about their long-term shire average, with increases in the shire annual average diameter shown in grades of blue, and the decreases in the shire annual average diameter in grades of red.

Wide-scale changes in diameter can be seen across the State in 1991/92, and across the northeastern pastoral shires in 1990/91. In contrast, the 1992/93 season, the majority of supply from individual shires was at above average diameter, with the exception in the south-west shires which were at or below their long-term average diameter.

3.3.3 Seasonal changes in average fibre diameter by shire

The analysis of variance in diameter in Table 3.3.3 showed that the season effect is highly significant (given the model used) in explaining differences in diameter. These differences have been summarised across shires and are shown on a monthly basis for all matched merino combing fleece offered in Fremantle over a five-year period (Table 3.3.5).

Table 3.3.5. Average fibre diameter for WA by month for the period July 1989 to June 1994, and the long-term average fibre diameter. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

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<th>Period</th>
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<td>November</td>
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<tr>
<td>December</td>
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Western Australia

Fibre diameter by shire for 1989/90 to 1993/94

Five-year State average = 22.3 µm

Five-year shire average

Dr John Stanton and Lindy Coss

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS
To reduce the volume of information being presented in the following shire tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Table 3.3.6. Average fibre diameter (μm) for individual shires in each quarter between July 1989 and June 1994, and the five-year average diameter for each shire

<table>
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<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
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Table 3.3.6 (cont.). Average fibre diameter (μm) for individual shires in each quarter between July 1989 and June 1994, and the five-year average diameter for each shire

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Stanton and Coss 1997
Table 3.3.6 (cont.). Average fibre diameter (μm) for individual shires in each quarter between July 1989 and June 1994, and the five-year average diameter for each shire

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3.4 Average yield

The matched AWC dataset was used to generate the estimated average yield by shire for the five-year period from July 1989 to June 1994. The long-term State average Schlumberger yield for the merino combing fleece wool is 67.4 per cent. The effect of year on this average is shown in Table 3.4.1. The average yield for the individual years ranges from 65.9 per cent to 68.4 per cent.

The SD of the yearly means is the between sale lots deviation, and can be used as a measure of the range of yields in the raw wool sale lots sold on an annual basis in Fremantle.

Table 3.4.1. Average yield for Western Australia over the period July 1989 and June 1994. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

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<th>Average yield (%)</th>
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<td>89/90</td>
<td>67.27</td>
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<td>90/91</td>
<td>67.20</td>
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<tr>
<td>92/93</td>
<td>68.47</td>
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<tr>
<td>93/94</td>
<td>68.14</td>
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3.4.1 Variation in yield due to year, season and WSA, shire effects

The changes in yield evident in the above table are due to between-year effects. It is assumed also that differences exist between seasons. The existence of differences also needs to be proved and quantified between WSAs, and between shires within WSA.

Table 3.4.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance of yield between sale lots. The model is highly significant, and explains 43.3 per cent of the total variance. This suggests that a large part of the variance in yield occurs between shires and WSAs over time. This level of 43 per cent variance explained can be compared with the result of 16 per cent for diameter. The remainder of the variance (56.7 per cent) is likely to occur between flocks and between properties within shires.

Table 3.4.2. Analysis of variance in yield due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

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</table>

As the overall model was significant, the relative importance of the individual terms of the model in explaining the variance in yield was analysed and is shown in Table 3.4.3. All terms of the model were significant. WSA and season made by far the largest contributions in explaining the variance in yield.
Table 3.4.3. Components of variance in yield-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction. The partial Sums of Squares showing the relative contribution of the components to the variance in yield

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The average yield of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.4.4.
Table 3.4.4. Average yield (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average yield for each shire

<table>
<thead>
<tr>
<th>Shire</th>
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<th>91/92</th>
<th>92/93</th>
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Table 3.4.4 (cont.). Average yield (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average yield for each shire

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### Table 3.4.4 (cont.). Average yield (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average yield for each shire

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3.4.2 Maps of average yield by shire

The five-year average results for individual shires are displayed on the large map in Section 3.4, ‘Yield by shire for 1989/90 to 1993/94’, which is coloured using a three-part scale – white for shire results which are closest to the State average, with the shires supplying higher yields shown in grades of green, and the shires with lower yields in grades of yellow. This map shows that the cleaner wool is found in the high rainfall region in the south-west region of the State. The lower yielding merino fleece wool is delivered from the northern agricultural and parts of the pastoral region.

The deviations of the individual year average yield from the long-term average are shown in the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average yield from the long-term shire average, both within year in adjacent shires, and between years. These maps are coloured using a three-part colour scale – white for shires with annual results about their long-term shire average, increases in the shire annual average yield shown in grades of blue, and the decreases in the shire annual average yield in grades of red.

Wide-scale reduction in yield can be seen for the 1991/92 selling season, followed by an increase in yield in the majority of shires in the next two selling seasons.

3.4.3 Seasonal changes in average yield by shire

Season effects have been shown to have a strong influence on the yield of sale lots offered in Fremantle. The results in Table 3.4.5 show the long-term changes in yield by month, and illustrate the effect of month of the catalogue offering, with the highest yield in the December offering, and the lowest yield from the April/May offerings.

Table 3.4.5. Average yield for Western Australia by month for the period July 1989 to June 1994. Results show the long-term average, and the monthly average yield

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<td>December</td>
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To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Western Australia

Yield by shire for 1989/90 to 1993/94

Five-year State average = 67.4 %

Five-year shire average

Yield Range (%)
- 72.5 to 75.0
- 70.0 to 72.5
- 67.5 to 70.0
- 65.0 to 67.5
- 62.5 to 65.0
- 60.0 to 62.5
- unreported

Percentage change in shire average
- 103.7 and over
- 102.2 to 103.7
- 100.7 to 102.2
- 99.3 to 100.7
- 97.8 to 99.3
- 96.3 to 97.8
- 96.3 and under
- unreported

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.

Dr. John Stanton and Lindy Coss
Table 3.4.6. Average yield (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average yield for each shire

<table>
<thead>
<tr>
<th>Shire</th>
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Table 3.4.6 (cont.). Average yield (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average yield for each shire

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<tr>
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<td>69.4</td>
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<tr>
<td>Kalgoorlie/Boulder (C)</td>
<td>W19</td>
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<td>67.4</td>
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<tr>
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</tr>
<tr>
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<td>68.6</td>
<td>67.3</td>
</tr>
<tr>
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<tr>
<td>Menzies (S)</td>
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<td>65.7</td>
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</tr>
<tr>
<td>Merredin (S)</td>
<td>W07</td>
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<td>65.3</td>
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<td>65.6</td>
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<tr>
<td>Mingewin (S)</td>
<td>W06</td>
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<td>58.9</td>
<td>62.9</td>
<td>65.5</td>
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</tr>
<tr>
<td>Moora (S)</td>
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<td>Morawa (S)</td>
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<td>59.8</td>
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<tr>
<td>Mount Magnet (S)</td>
<td>W04</td>
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<td>65.9</td>
<td>66.8</td>
<td>66.7</td>
<td>66.0</td>
</tr>
<tr>
<td>Mount Marshall (S)</td>
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<tr>
<td>Mullewa (S)</td>
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</tr>
<tr>
<td>Mundaring (S)</td>
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<td>Murray (S)</td>
<td>W16</td>
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<td>66.8</td>
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<td>69.0</td>
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<tr>
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<td>69.1</td>
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<tr>
<td>Narembeen (S)</td>
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<td>65.0</td>
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<td>67.4</td>
<td>66.4</td>
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<tr>
<td>Narrogin (S)</td>
<td>W12</td>
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<td>68.7</td>
<td>69.6</td>
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</table>
Table 3.4.6 (cont.). Average yield (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average yield for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Average year</th>
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<td>Northam (S)</td>
<td>W11</td>
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<td>67.3</td>
<td>69.1</td>
<td>67.8</td>
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<tr>
<td>Northampton (S)</td>
<td>W06</td>
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<td>59.4</td>
<td>62.8</td>
<td>64.5</td>
<td>62.5</td>
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<tr>
<td>Nungarin (S)</td>
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<td>58.6</td>
<td>63.4</td>
<td>65.3</td>
<td>62.6</td>
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<tr>
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<td>61.8</td>
<td>64.2</td>
<td>66.2</td>
<td>64.4</td>
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<tr>
<td>Pingelly (S)</td>
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<tr>
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<td>71.5</td>
<td>71.3</td>
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<tr>
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<td>W02</td>
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<td>60.8</td>
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<tr>
<td>Sandstone (S)</td>
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<tr>
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<tr>
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<td>69.3</td>
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<tr>
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<td>66.3</td>
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<tr>
<td>Trayning (S)</td>
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<td>67.5</td>
<td>65.1</td>
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<tr>
<td>Upper Gascoyne (S)</td>
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</tr>
<tr>
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<td>67.9</td>
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<tr>
<td>Wagin (S)</td>
<td>W12</td>
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<td>65.1</td>
<td>68.1</td>
<td>69.5</td>
<td>67.7</td>
</tr>
<tr>
<td>Wandering (S)</td>
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<td>67.7</td>
<td>70.0</td>
<td>71.2</td>
<td>69.2</td>
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<tr>
<td>Waroona (S)</td>
<td>W16</td>
<td>69.1</td>
<td>66.1</td>
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<td>70.4</td>
<td>69.0</td>
</tr>
<tr>
<td>West Arthur (S)</td>
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<td>67.1</td>
<td>69.1</td>
<td>70.8</td>
<td>68.8</td>
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<tr>
<td>Wickepin (S)</td>
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<tr>
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<td>62.4</td>
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<td>63.7</td>
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<tr>
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<td>Wyalkatchem (S)</td>
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<td>Yalgoo (S)</td>
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<td>66.9</td>
<td>65.4</td>
</tr>
<tr>
<td>Yilgarn (S)</td>
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<td>64.8</td>
<td>63.8</td>
</tr>
<tr>
<td>York (S)</td>
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<td>66.3</td>
<td>68.6</td>
<td>69.6</td>
<td>68.6</td>
</tr>
</tbody>
</table>
3.5 Average vegetable matter content

The matched AWC dataset was used to generate the estimated vegetable matter content by shire for the five-year period from July 1989 to June 1994. The long-term State average vegetable matter content is 0.96 per cent. The effect of year on this average is shown in Table 3.5.1. The average vegetable matter content for the individual years ranges from 0.88 per cent to 1.11 per cent.

The SD of the yearly means is the between sale lots standard deviation, and can be used as a measure of the range of vegetable matter content in the raw wool sold on an annual basis in Fremantle.

Table 3.5.1. Average vegetable matter content for Western Australia over the period July 1989 to June 1994. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

<table>
<thead>
<tr>
<th>Period</th>
<th>Vegetable matter content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>5-year average</td>
<td>0.96</td>
</tr>
<tr>
<td>89/90</td>
<td>0.92</td>
</tr>
<tr>
<td>90/91</td>
<td>0.96</td>
</tr>
<tr>
<td>91/92</td>
<td>1.11</td>
</tr>
<tr>
<td>92/93</td>
<td>0.94</td>
</tr>
<tr>
<td>93/94</td>
<td>0.88</td>
</tr>
</tbody>
</table>

3.5.1 Variation in vegetable matter content due to year, season and WSA, shire effects

The differences of vegetable matter content evident in the above table illustrate the between-year effects. It is assumed that differences also exist between seasons. The existence of differences also needs to be confirmed and quantified between WSAs, and between shires within WSA.

Table 3.5.2 contains a statistical analysis done on time (year, season), regional (WSA, shire) effects and their interactions designed to examine their contributions to the variance of vegetable matter content between individual sale lots offered in Fremantle. The model used to explain the variance in vegetable matter content is highly significant, and explains 26.2 per cent of the total variance. This level of explained variance is higher than for diameter but still represents a small proportion of the total variance (total sums of squares) in vegetable matter content. The error variance contains effects not included in the model and random effects. Therefore the results in Table 3.5.2 suggest that a small but significant proportion of variance in vegetable matter content is due to the model which included macro effects such as year, season and region. Other factors could include, for example, between-flock and property differences within shires (for example, strain differences and other flock management effects) and between-month differences within season.

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Stanton and Coss 1997
Table 3.5.2. Analysis of variance in vegetable matter content due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
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<td>Model</td>
<td>193</td>
<td>47518</td>
<td>246.21</td>
<td>532.86</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>266227</td>
<td>134087</td>
<td>0.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>266420</td>
<td>181605</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The relative importance of the individual terms in explaining the variance in vegetable matter content is shown in Table 3.5.3. All terms except selling year are highly significant, with season and WSA being by far the most important. The relative size of the F values for year and season suggest that the annual result is stable, but that there are large changes across seasons. These changes are also occurring over wide areas of production, and so are better explained by WSA than by using the individual shires.

Table 3.5.3. Components of variance in vegetable matter content-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling year</td>
<td>4</td>
<td>7</td>
<td>1.81</td>
<td>3.59</td>
<td>0.0062</td>
</tr>
<tr>
<td>Season (within selling year)</td>
<td>15</td>
<td>16709</td>
<td>1113.95</td>
<td>2211.73</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA</td>
<td>18</td>
<td>10977</td>
<td>609.86</td>
<td>1210.86</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shire nested in WSA</td>
<td>84</td>
<td>8522</td>
<td>101.45</td>
<td>201.43</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA x selling year</td>
<td>72</td>
<td>2315</td>
<td>33.16</td>
<td>63.86</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The average fibre vegetable matter content of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.5.4.
### Table 3.5.4. Average vegetable matter content (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average vegetable matter content for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
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</thead>
<tbody>
<tr>
<td>Albany (S)</td>
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<td>0.5</td>
<td>0.7</td>
<td>0.6</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>1.2</td>
<td>1.1</td>
<td>0.6</td>
<td>0.6</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>0.5</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
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Stanton and Coss 1997
### Table 3.5.4 (cont.). Average vegetable matter content (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average vegetable matter content for each shire

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Table 3.5.4 (cont.). Average vegetable matter content (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average vegetable matter content for each shire

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3.5.2 Maps of average vegetable matter content by shire

The five-year average results for individual shires are displayed on the large map in Section 3.5, 'Vegetable matter by shire for 1989/90 to 1993/94', which is coloured using a three-part colour scale – white for the shire results closest to the State average, with the shires supplying higher vegetable matter content wool shown in grades of green, and shires within lower vegetable matter content wool in grades of yellow. This map shows the higher levels of vegetable matter in the northern and pastoral regions of the State. The lowest vegetable matter content was delivered from the south coast and some of the eastern agricultural regions. Above average levels are also seen in shires around West Arthur.

The deviations of the individual year average vegetable matter content from the long-term average are shown in the series on the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average vegetable matter content from the long-term shire average. These maps are coloured using a three-part colour scale – white for shires with results about their long-term shire average, with increases in the shire annual average vegetable matter content shown in grades of blue, and the decreases in the shire annual average vegetable matter content in grades of red.

It should be noted that the high levels of vegetable matter shown in 1991/92 on the south coast and Esperance and the subsequent reductions in the next two selling years are opposite to the pattern of changes in diameter for these shires, with 1991/92 being low and the next years at or above average diameter.

3.5.3 Seasonal changes in average vegetable matter content by shire

The non-significance of selling year in explaining the variance in vegetable matter content could be due to the time-frame of one year being too long to account for the differences. The differences by month are listed below and show a greater range of results.

Table 3.5.5. Average vegetable matter content for WA over the period July 1989 to June 1994. Results show the long-term average, and the monthly average vegetable matter content

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<tr>
<th>Period</th>
<th>Vegetable matter content (%)</th>
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<td>5-year average</td>
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<tr>
<td>January</td>
<td>0.86</td>
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<tr>
<td>February</td>
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<tr>
<td>March</td>
<td>1.38</td>
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<tr>
<td>April</td>
<td>1.44</td>
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<tr>
<td>May</td>
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<tr>
<td>June</td>
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<td>July</td>
<td>1.08</td>
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<tr>
<td>August</td>
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</tr>
<tr>
<td>September</td>
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</tr>
<tr>
<td>October</td>
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</tr>
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<td>November</td>
<td>0.59</td>
</tr>
<tr>
<td>December</td>
<td>0.61</td>
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To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Western Australia

Vegetable matter content by shire for 1989/90 to 1993/94

Five-year State average = 0.96 %

Dr John Stanton and Lindy Coes

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS
<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Average year</th>
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Stanton and Coss 1997
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<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Meekatharra (S)</td>
<td>W04</td>
<td>2.6</td>
<td>2.0</td>
<td>1.8</td>
<td>2.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Menzies (S)</td>
<td>W19</td>
<td>1.9</td>
<td>1.3</td>
<td>0.9</td>
<td>1.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Merredin (S)</td>
<td>W07</td>
<td>1.0</td>
<td>1.2</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Mingenew (S)</td>
<td>W06</td>
<td>1.4</td>
<td>1.5</td>
<td>0.8</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Moora (S)</td>
<td>W14</td>
<td>1.2</td>
<td>1.3</td>
<td>0.9</td>
<td>0.7</td>
<td>0.9</td>
</tr>
<tr>
<td>Morawa (S)</td>
<td>W06</td>
<td>1.4</td>
<td>1.3</td>
<td>1.0</td>
<td>0.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Mount Magnet (S)</td>
<td>W04</td>
<td>2.4</td>
<td>2.2</td>
<td>1.8</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Mount Marshall (S)</td>
<td>W07</td>
<td>1.3</td>
<td>1.1</td>
<td>0.9</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Muckinbudin (S)</td>
<td>W07</td>
<td>1.4</td>
<td>1.4</td>
<td>1.0</td>
<td>1.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Mullewa (S)</td>
<td>W06</td>
<td>1.9</td>
<td>1.6</td>
<td>0.9</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Mundaring (S)</td>
<td>W15</td>
<td>0.9</td>
<td>1.6</td>
<td>0.7</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Murchison (S)</td>
<td>W04</td>
<td>na</td>
<td>2.2</td>
<td>1.5</td>
<td>na</td>
<td>2.1</td>
</tr>
<tr>
<td>Murray (S)</td>
<td>W16</td>
<td>0.7</td>
<td>1.2</td>
<td>1.0</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Nannup (S)</td>
<td>W13</td>
<td>0.6</td>
<td>1.5</td>
<td>0.7</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Narembeen (S)</td>
<td>W07</td>
<td>0.8</td>
<td>1.0</td>
<td>0.6</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Narrogin (S)</td>
<td>W12</td>
<td>1.0</td>
<td>1.3</td>
<td>0.9</td>
<td>0.6</td>
<td>0.9</td>
</tr>
</tbody>
</table>
Table 3.5.6 (cont.). Average vegetable matter content (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average vegetable matter content for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northam (S)</td>
<td>W11</td>
<td>1.4</td>
<td>1.9</td>
<td>1.0</td>
<td>0.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Northampton (S)</td>
<td>W06</td>
<td>1.5</td>
<td>1.6</td>
<td>1.0</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Nungarin (S)</td>
<td>W07</td>
<td>1.9</td>
<td>2.5</td>
<td>1.4</td>
<td>1.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Perenjori (S)</td>
<td>W06</td>
<td>1.2</td>
<td>1.2</td>
<td>0.7</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Pingelly (S)</td>
<td>W12</td>
<td>1.8</td>
<td>1.7</td>
<td>0.9</td>
<td>0.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Plantagenet (S)</td>
<td>W10</td>
<td>0.5</td>
<td>1.0</td>
<td>0.7</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Port Hedland (T)</td>
<td>W02</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>0.9</td>
<td>1.2</td>
</tr>
<tr>
<td>Quairading (S)</td>
<td>W11</td>
<td>1.0</td>
<td>1.2</td>
<td>0.8</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Ravensthorpe (S)</td>
<td>W20</td>
<td>1.2</td>
<td>1.6</td>
<td>0.8</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Roebourne (S)</td>
<td>W03</td>
<td>0.6</td>
<td>0.7</td>
<td>0.6</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Sandstone (S)</td>
<td>W04</td>
<td>2.6</td>
<td>2.1</td>
<td>2.0</td>
<td>2.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Serpentine-Jarrahdale (S)</td>
<td>W15</td>
<td>1.2</td>
<td>1.1</td>
<td>0.7</td>
<td>0.5</td>
<td>1.1</td>
</tr>
<tr>
<td>Shark Bay (S)</td>
<td>W05</td>
<td>2.7</td>
<td>2.7</td>
<td>2.2</td>
<td>4.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Swan (S)</td>
<td>W15</td>
<td>0.6</td>
<td>1.2</td>
<td>1.0</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>Tambellup (S)</td>
<td>W09</td>
<td>1.0</td>
<td>1.4</td>
<td>0.8</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Tammin (S)</td>
<td>W11</td>
<td>0.8</td>
<td>0.8</td>
<td>0.5</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Three Springs (S)</td>
<td>W06</td>
<td>1.4</td>
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<td>1.0</td>
<td>0.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Toodyay (S)</td>
<td>W11</td>
<td>1.0</td>
<td>1.8</td>
<td>1.0</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Trayning (S)</td>
<td>W07</td>
<td>1.0</td>
<td>1.5</td>
<td>1.0</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Upper Gascoyne (S)</td>
<td>W05</td>
<td>2.3</td>
<td>1.7</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Victoria Plains (S)</td>
<td>W14</td>
<td>1.1</td>
<td>1.4</td>
<td>0.8</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Wagin (S)</td>
<td>W12</td>
<td>1.4</td>
<td>1.5</td>
<td>1.0</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Wandering (S)</td>
<td>W12</td>
<td>1.6</td>
<td>1.6</td>
<td>1.0</td>
<td>0.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Waroona (S)</td>
<td>W16</td>
<td>0.7</td>
<td>0.9</td>
<td>0.8</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>West Arthur (S)</td>
<td>W12</td>
<td>1.7</td>
<td>1.9</td>
<td>1.1</td>
<td>0.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Westonia (S)</td>
<td>W07</td>
<td>2.7</td>
<td>2.2</td>
<td>1.3</td>
<td>1.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Wickepin (S)</td>
<td>W12</td>
<td>1.0</td>
<td>1.2</td>
<td>0.8</td>
<td>0.6</td>
<td>0.9</td>
</tr>
<tr>
<td>Williams (S)</td>
<td>W12</td>
<td>1.5</td>
<td>1.9</td>
<td>0.9</td>
<td>0.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Wiluna (S)</td>
<td>W04</td>
<td>0.9</td>
<td>1.8</td>
<td>1.6</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>Wongan-Ballidu (S)</td>
<td>W11</td>
<td>0.8</td>
<td>0.8</td>
<td>0.6</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Woodanilling (S)</td>
<td>W09</td>
<td>1.2</td>
<td>1.6</td>
<td>0.9</td>
<td>0.7</td>
<td>1.1</td>
</tr>
<tr>
<td>Wyalkatchem (S)</td>
<td>W11</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
<td>0.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Yalgoo (S)</td>
<td>W04</td>
<td>2.5</td>
<td>2.6</td>
<td>2.1</td>
<td>1.9</td>
<td>2.4</td>
</tr>
<tr>
<td>Yilgarn (S)</td>
<td>W07</td>
<td>2.0</td>
<td>2.1</td>
<td>1.5</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>York (S)</td>
<td>W11</td>
<td>1.5</td>
<td>1.5</td>
<td>1.0</td>
<td>0.8</td>
<td>1.0</td>
</tr>
</tbody>
</table>
3.6 Average seed and shive level

The matched AWC dataset was used to generate the estimated average seed and shive level by shire for the five-year period from July 1989 to June 1994. The long-term State average seed and shive level is 0.66 per cent. The effect of year on this average is shown in Table 3.6.1. The average seed and shive level for the individual years ranges from 0.84 per cent to 0.46 per cent.

<table>
<thead>
<tr>
<th>Period</th>
<th>Average seed and shive (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>5-year average</td>
<td>0.66</td>
</tr>
<tr>
<td>89/90</td>
<td>0.46</td>
</tr>
<tr>
<td>90/91</td>
<td>0.55</td>
</tr>
<tr>
<td>91/92</td>
<td>0.84</td>
</tr>
<tr>
<td>92/93</td>
<td>0.74</td>
</tr>
<tr>
<td>93/94</td>
<td>0.71</td>
</tr>
</tbody>
</table>

3.6.1 Variation in seed and shive level due to year, season and WSA, shire effects

The differences of seed and shive level evident in the above table are due to between-year effects. It is also assumed that differences exist between seasons. The existence of differences also need to be proved and quantified between WSAs, and between shires within WSA.

Table 3.6.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance in seed and shive levels between sale lots. The model used to explain the variance in seed and shive level is highly significant, and explained 24.0 per cent of the total variance. This level of variance explained is similar to the vegetable matter level in Section 3.3.

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>193</td>
<td>27864</td>
<td>144.37</td>
<td>429.64</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>263260</td>
<td>88463</td>
<td>0.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>263453</td>
<td>116326</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The relative importance of the individual terms in explaining the variance in seed and shive level is shown in Table 3.6.3. All sources of variance tested were highly significant. The most important effects were season and WSA. These were the same terms that dominated the analysis of vegetable matter content in Section 3.5. This suggests that the changes in seed and shive levels occur over months (not years), and occurs over a wide area (that is, WSAs) and not just within shires.
Table 3.6.3. Components of variance in seed and shive level-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling year</td>
<td>4</td>
<td>131</td>
<td>32.76</td>
<td>97.50</td>
<td>0.0001</td>
</tr>
<tr>
<td>Season (within selling year)</td>
<td>15</td>
<td>8276</td>
<td>551.76</td>
<td>1642.00</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA</td>
<td>18</td>
<td>6248</td>
<td>347.12</td>
<td>1033.00</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shire nested in WSA</td>
<td>84</td>
<td>2778</td>
<td>33.07</td>
<td>98.41</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA x selling year</td>
<td>72</td>
<td>1120</td>
<td>15.56</td>
<td>46.32</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

As these patterns of change are similar to that of total vegetable matter content, no maps have been included for this section. For map information on vegetable matter content, readers are advised to use the map in Section 3.5.

The average seed and shive level of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.6.4.
Table 3.6.4. Average seed and shive level (%) for individual shires in each selling year between July 1989 and June 1994, and the five-year average seed and shive level for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany (S)</td>
<td>W10</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>0.9</td>
<td>0.9</td>
<td>0.5</td>
<td>0.6</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>0.3</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
<td>0.8</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>0.7</td>
<td>0.9</td>
<td>1.1</td>
<td>0.9</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>0.5</td>
<td>0.6</td>
<td>0.9</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>0.4</td>
<td>0.5</td>
<td>0.7</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>0.4</td>
<td>0.5</td>
<td>0.9</td>
<td>0.7</td>
<td>0.8</td>
<td>0.6</td>
</tr>
<tr>
<td>Broomehill (S)</td>
<td>W09</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
<td>0.8</td>
<td>0.8</td>
<td>0.7</td>
</tr>
<tr>
<td>Bruce Rock (S)</td>
<td>W07</td>
<td>0.3</td>
<td>0.4</td>
<td>0.7</td>
<td>0.6</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Busselton (S)</td>
<td>W18</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Capel (S)</td>
<td>W17</td>
<td>0.5</td>
<td>0.4</td>
<td>0.5</td>
<td>0.7</td>
<td>0.4</td>
<td>0.5</td>
</tr>
<tr>
<td>Carnamah (S)</td>
<td>W06</td>
<td>0.6</td>
<td>0.7</td>
<td>1.1</td>
<td>0.8</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Carnarvon (S)</td>
<td>W05</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.8</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Chapman Valley (S)</td>
<td>W06</td>
<td>0.6</td>
<td>0.7</td>
<td>0.8</td>
<td>0.9</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Chittering (S)</td>
<td>W14</td>
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<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Collie (S)</td>
<td>W17</td>
<td>0.4</td>
<td>0.5</td>
<td>0.8</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
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Table 3.6.4 (cont.). Average seed and shive level (%) for individual shires in each selling year between July 1989 and June 1994, and the five-year average seed and shive level for each shire

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Table 3.6.4 (cont.). Average seed and shive level (%) for individual shires in each selling year between July 1989 and June 1994, and the five-year average seed and shive level for each shire

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<td>Williams (S)</td>
<td>W12</td>
<td>0.6</td>
<td>0.6</td>
<td>1.1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Wiluna (S)</td>
<td>W04</td>
<td>0.8</td>
<td>1.0</td>
<td>1.0</td>
<td>1.8</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Wongan-Ballidu (S)</td>
<td>W11</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Woodanilling (S)</td>
<td>W09</td>
<td>0.6</td>
<td>0.7</td>
<td>1.0</td>
<td>0.9</td>
<td>0.7</td>
<td>0.8</td>
</tr>
<tr>
<td>Wyalkatchem (S)</td>
<td>W11</td>
<td>0.4</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Yalgoo (S)</td>
<td>W04</td>
<td>1.7</td>
<td>1.6</td>
<td>1.9</td>
<td>2.1</td>
<td>1.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Yilgarn (S)</td>
<td>W07</td>
<td>0.4</td>
<td>0.5</td>
<td>0.7</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>York (S)</td>
<td>W11</td>
<td>0.5</td>
<td>0.4</td>
<td>1.1</td>
<td>0.9</td>
<td>0.9</td>
<td>0.8</td>
</tr>
</tbody>
</table>
3.6.2 Seasonal changes in average seed and shive level by shire

The monthly changes in seed and shive in sale lots follows a similar pattern to the vegetable matter content, with maximum levels of 0.99 per cent in April/May and minimum levels of 0.42 per cent in November.

Table 3.6.5. Average seed and shive level for Western Australia over the period July 1989 to June 1994. Results show the long-term average, and the monthly average seed and shive level

<table>
<thead>
<tr>
<th>Period</th>
<th>Vegetable matter content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year average</td>
<td>0.66</td>
</tr>
<tr>
<td>January</td>
<td>0.61</td>
</tr>
<tr>
<td>February</td>
<td>0.84</td>
</tr>
<tr>
<td>March</td>
<td>0.90</td>
</tr>
<tr>
<td>April</td>
<td>0.99</td>
</tr>
<tr>
<td>May</td>
<td>0.99</td>
</tr>
<tr>
<td>June</td>
<td>0.93</td>
</tr>
<tr>
<td>July</td>
<td>0.65</td>
</tr>
<tr>
<td>August</td>
<td>0.59</td>
</tr>
<tr>
<td>September</td>
<td>0.51</td>
</tr>
<tr>
<td>October</td>
<td>0.44</td>
</tr>
<tr>
<td>November</td>
<td>0.42</td>
</tr>
<tr>
<td>December</td>
<td>0.45</td>
</tr>
</tbody>
</table>
3.7 Average staple strength

The matched AWC dataset was used to generate the estimated average staple strength by shire for the five-year period from July 1989 to June 1994. The long-term State average staple strength is 33.88 N/ktex. The effect of year on this average is shown in Table 3.7.1. The average staple strength for the individual years ranges from 34.6 N/ktex. to 31.1 N/ktex.

The SD of the yearly means is the between sale lots standard deviation, and can be used as a measure of the range of staple strength in the raw wool sold on an annual basis in Fremantle.

Table 3.7.1. Average staple strength for Western Australia over the period July 1989 to June 1994. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year average</td>
<td>33.88</td>
<td>7.19</td>
</tr>
<tr>
<td>89/90</td>
<td>34.68</td>
<td>6.72</td>
</tr>
<tr>
<td>90/91</td>
<td>33.41</td>
<td>6.89</td>
</tr>
<tr>
<td>91/92</td>
<td>31.10</td>
<td>6.22</td>
</tr>
<tr>
<td>92/93</td>
<td>34.38</td>
<td>6.99</td>
</tr>
<tr>
<td>93/94</td>
<td>34.16</td>
<td>7.76</td>
</tr>
</tbody>
</table>

3.7.1 Variation in staple strength due to year, season and WSA, shire effects

The differences of staple strength evident in the above table are due to between-year effects. It is assumed also that differences exist between seasons within these years. The existence of differences also need to be proved and quantified between WSAs, and between shires within WSA.

Table 3.7.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance of staple strength between sale lots. The model is significant, but only explains 11.0 per cent of the total variance (total sums of squares) in strength. So 89.0 per cent of the total variance has been included in the error variance. This error variance contains effects not included in the model and random effects.

Therefore the results in Table 3.7.2 suggest that only a small proportion of variance in staple strength is due to macro effects such as year, season and region, and the majority of variance is due to factors other than those included in the model. These other factors could include between-flock and between-property differences within shires (for example, strain differences and other flock management effects) and between-month differences within season.

Table 3.7.2. Analysis of variance in staple strength due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>192</td>
<td>504073</td>
<td>2625.38</td>
<td>56.90</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>88667</td>
<td>4091371</td>
<td>46.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>88859</td>
<td>4595445</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The relative importance of the individual terms in explaining the variance in staple strength is shown in Table 3.7.3. All terms in the analysis were highly significant. However the effect of season (within selling year) dominates the other terms in the model.

Table 3.7.3. Components of variance in staple strength-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling year</td>
<td>4</td>
<td>4009</td>
<td>1002.13</td>
<td>21.72</td>
<td>0.0001</td>
</tr>
<tr>
<td>Season (within selling year)</td>
<td>15</td>
<td>222718</td>
<td>14847.86</td>
<td>321.78</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA</td>
<td>18</td>
<td>48774</td>
<td>2709.69</td>
<td>58.72</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shire nested in WSA</td>
<td>84</td>
<td>46375</td>
<td>552.08</td>
<td>11.96</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA x selling year</td>
<td>71</td>
<td>63287</td>
<td>891.36</td>
<td>19.32</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The average staple strength of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.7.4.
Table 3.7.4. Average staple strength (N/ktex) for individual shires in each selling year between July 1989 and June 1994, and the five-year average staple strength for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany (S)</td>
<td>W10</td>
<td>34.9</td>
<td>34.3</td>
<td>33.2</td>
<td>34.8</td>
<td>32.9</td>
<td>34.1</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>26.3</td>
<td>24.9</td>
<td>26.4</td>
<td>32.8</td>
<td>28.7</td>
<td>28.6</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>40.1</td>
<td>31.2</td>
<td>32.5</td>
<td>32.2</td>
<td>32.2</td>
<td>33.7</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
<td>34.0</td>
<td>34.3</td>
<td>31.4</td>
<td>34.9</td>
<td>34.5</td>
<td>34.2</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>34.5</td>
<td>32.6</td>
<td>32.8</td>
<td>33.8</td>
<td>35.1</td>
<td>34.0</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>37.2</td>
<td>31.6</td>
<td>32.4</td>
<td>34.5</td>
<td>35.0</td>
<td>34.6</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>35.3</td>
<td>32.7</td>
<td>31.5</td>
<td>31.7</td>
<td>33.3</td>
<td>33.3</td>
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<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>33.6</td>
<td>34.2</td>
<td>30.5</td>
<td>35.6</td>
<td>35.5</td>
<td>34.6</td>
</tr>
<tr>
<td>Broomehill (S)</td>
<td>W09</td>
<td>33.9</td>
<td>34.1</td>
<td>32.1</td>
<td>33.8</td>
<td>36.0</td>
<td>34.5</td>
</tr>
<tr>
<td>Bruce Rock (S)</td>
<td>W07</td>
<td>31.9</td>
<td>33.4</td>
<td>28.2</td>
<td>34.2</td>
<td>33.0</td>
<td>32.7</td>
</tr>
<tr>
<td>Busselton (S)</td>
<td>W18</td>
<td>29.8</td>
<td>28.9</td>
<td>30.1</td>
<td>33.6</td>
<td>33.3</td>
<td>31.1</td>
</tr>
<tr>
<td>Capel (S)</td>
<td>W17</td>
<td>39.7</td>
<td>27.4</td>
<td>28.0</td>
<td>33.0</td>
<td>28.4</td>
<td>33.9</td>
</tr>
<tr>
<td>Carnamah (S)</td>
<td>W06</td>
<td>32.9</td>
<td>32.7</td>
<td>30.6</td>
<td>33.8</td>
<td>33.3</td>
<td>32.9</td>
</tr>
<tr>
<td>Carnarvon (S)</td>
<td>W05</td>
<td>33.9</td>
<td>32.8</td>
<td>33.4</td>
<td>29.3</td>
<td>34.5</td>
<td>33.0</td>
</tr>
<tr>
<td>Chapman Valley (S)</td>
<td>W06</td>
<td>33.2</td>
<td>34.0</td>
<td>32.3</td>
<td>32.2</td>
<td>33.9</td>
<td>33.2</td>
</tr>
<tr>
<td>Chittering (S)</td>
<td>W14</td>
<td>37.3</td>
<td>36.9</td>
<td>27.7</td>
<td>38.1</td>
<td>30.5</td>
<td>33.4</td>
</tr>
<tr>
<td>Collie (S)</td>
<td>W17</td>
<td>35.3</td>
<td>29.6</td>
<td>36.1</td>
<td>33.7</td>
<td>33.9</td>
<td>33.3</td>
</tr>
<tr>
<td>Coolgardie (S)</td>
<td>W19</td>
<td>42.4</td>
<td>40.5</td>
<td>40.3</td>
<td>40.2</td>
<td>46.6</td>
<td>42.5</td>
</tr>
<tr>
<td>Coorow (S)</td>
<td>W06</td>
<td>32.7</td>
<td>30.4</td>
<td>30.4</td>
<td>34.2</td>
<td>31.7</td>
<td>32.0</td>
</tr>
<tr>
<td>Corrigin (S)</td>
<td>W08</td>
<td>32.6</td>
<td>34.6</td>
<td>29.9</td>
<td>34.6</td>
<td>33.6</td>
<td>33.5</td>
</tr>
<tr>
<td>Cranbrook (S)</td>
<td>W10</td>
<td>37.2</td>
<td>34.4</td>
<td>32.2</td>
<td>34.9</td>
<td>34.7</td>
<td>34.9</td>
</tr>
<tr>
<td>Cuballing (S)</td>
<td>W12</td>
<td>34.1</td>
<td>36.4</td>
<td>31.6</td>
<td>33.8</td>
<td>36.1</td>
<td>34.6</td>
</tr>
<tr>
<td>Cue (S)</td>
<td>W04</td>
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<td>34.9</td>
<td>33.3</td>
<td>35.8</td>
<td>34.6</td>
<td>34.6</td>
</tr>
<tr>
<td>Cunderdin (S)</td>
<td>W11</td>
<td>32.1</td>
<td>34.2</td>
<td>27.8</td>
<td>35.5</td>
<td>34.8</td>
<td>33.9</td>
</tr>
<tr>
<td>Dalwallinu (S)</td>
<td>W11</td>
<td>33.9</td>
<td>33.0</td>
<td>30.9</td>
<td>34.6</td>
<td>34.5</td>
<td>33.9</td>
</tr>
<tr>
<td>Dandaragan (S)</td>
<td>W14</td>
<td>34.2</td>
<td>32.4</td>
<td>30.2</td>
<td>33.8</td>
<td>31.9</td>
<td>32.7</td>
</tr>
<tr>
<td>Dardanup (S)</td>
<td>W17</td>
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<td>33.8</td>
<td>33.0</td>
<td>40.2</td>
<td>38.0</td>
<td>38.6</td>
</tr>
<tr>
<td>Denmark (S)</td>
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<tr>
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<td>W17</td>
<td>35.6</td>
<td>28.9</td>
<td>31.0</td>
<td>30.7</td>
<td>29.5</td>
<td>30.7</td>
</tr>
<tr>
<td>Dowerin (S)</td>
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<td>32.3</td>
<td>27.8</td>
<td>34.5</td>
<td>32.4</td>
<td>32.2</td>
</tr>
<tr>
<td>Dumbleyung (S)</td>
<td>W12</td>
<td>35.0</td>
<td>34.6</td>
<td>32.6</td>
<td>34.2</td>
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<td>34.9</td>
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<tr>
<td>Dundas (S)</td>
<td>W20</td>
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<td>36.7</td>
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<td>36.2</td>
<td>37.1</td>
<td>36.8</td>
</tr>
<tr>
<td>Esperance (S)</td>
<td>W20</td>
<td>33.8</td>
<td>31.9</td>
<td>27.7</td>
<td>36.7</td>
<td>34.1</td>
<td>33.8</td>
</tr>
<tr>
<td>Exmouth (S)</td>
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<td>na</td>
<td>28.0</td>
<td>35.9</td>
<td>33.3</td>
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</tbody>
</table>
Table 3.7.4 (cont.). Average staple strength (N/ktex) for individual shires in each selling year between July 1989 and June 1994, and the five-year average staple strength for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingin (S)</td>
<td>W14</td>
<td>38.0</td>
<td>34.1</td>
<td>31.1</td>
<td>33.3</td>
<td>34.0</td>
<td>34.3</td>
</tr>
<tr>
<td>Gnowangerup (S)</td>
<td>W09</td>
<td>33.8</td>
<td>33.5</td>
<td>33.0</td>
<td>34.0</td>
<td>34.8</td>
<td>34.0</td>
</tr>
<tr>
<td>Goomalling (S)</td>
<td>W11</td>
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<td>35.5</td>
<td>30.0</td>
<td>35.7</td>
<td>35.9</td>
<td>34.9</td>
</tr>
<tr>
<td>Greenough (S)</td>
<td>W06</td>
<td>33.9</td>
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<td>32.7</td>
<td>33.2</td>
<td>33.1</td>
<td>33.3</td>
</tr>
<tr>
<td>Harvey (S)</td>
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<td>37.1</td>
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<td>36.1</td>
<td>33.8</td>
<td>33.4</td>
</tr>
<tr>
<td>Jerramungup (S)</td>
<td>W09</td>
<td>33.1</td>
<td>33.2</td>
<td>33.3</td>
<td>35.2</td>
<td>34.6</td>
<td>34.2</td>
</tr>
<tr>
<td>Kalgoorlie/Boulder (C)</td>
<td>W19</td>
<td>41.0</td>
<td>36.5</td>
<td>36.6</td>
<td>38.9</td>
<td>41.0</td>
<td>39.1</td>
</tr>
<tr>
<td>Katanning (S)</td>
<td>W09</td>
<td>35.9</td>
<td>36.0</td>
<td>33.5</td>
<td>32.6</td>
<td>34.6</td>
<td>34.5</td>
</tr>
<tr>
<td>Kellerberrin (S)</td>
<td>W07</td>
<td>31.5</td>
<td>32.3</td>
<td>27.5</td>
<td>32.7</td>
<td>33.1</td>
<td>32.1</td>
</tr>
<tr>
<td>Kent (S)</td>
<td>W09</td>
<td>35.5</td>
<td>33.2</td>
<td>30.8</td>
<td>35.8</td>
<td>35.1</td>
<td>34.5</td>
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<tr>
<td>Kojonup (S)</td>
<td>W09</td>
<td>35.3</td>
<td>32.1</td>
<td>31.9</td>
<td>32.9</td>
<td>34.0</td>
<td>33.6</td>
</tr>
<tr>
<td>Kondinin (S)</td>
<td>W08</td>
<td>32.9</td>
<td>34.6</td>
<td>29.9</td>
<td>34.5</td>
<td>33.0</td>
<td>33.5</td>
</tr>
<tr>
<td>Koorda (S)</td>
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Table 3.7.4 (cont.). Average staple strength (N/ktex) for individual shires in each selling year between July 1989 and June 1994, and the five-year average staple strength for each shire

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3.7.2 Maps of average staple strength by shire

The five-year average results for individual shires are displayed on the large map for Section 3.7, ‘Staple strength by shire for 1989/90 to 1993/94’, which is coloured using a three-part colour scale – white for shire results closest to the State average, with the shires supplying higher strength wool shown in grades of green, and the shires with lower strength wool in grades of yellow. This map shows that the weaker wool is found scattered through the eastern wheatbelt and northern agricultural region of the State. The high strength merino fleece wool is delivered from the Goldfields/Kalgoorlie region.

The deviations of the individual year average staple strength from the long-term average are also shown in the series down the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average strength from the long-term shire average. These maps are coloured using a three-part colour scale – white for shires with annual results about their long-term shire average, with increases in the shire annual average staple strength shown in grades of blue, and the decreases in the shire annual average staple strength in grades of red.

3.7.3 Seasonal changes in average staple strength by shire

The analysis of variance in staple strength showed that the season is highly significant in explaining differences in staple strength. These differences are shown on a monthly basis for all matched merino combing fleece offered in Fremantle over a five-year period.

Table 3.7.5. Average staple strength for Western Australia over the period July 1989 to June 1994. Results show the long-term average, and the monthly average staple strength

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<td>June</td>
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<td>July</td>
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<tr>
<td>August</td>
<td>33.80</td>
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<tr>
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<tr>
<td>December</td>
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To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Western Australia

Staple strength by shire for 1989/90 to 1993/94

Five-year State average = 33.9 N/ktx

Five-year shire average

Staple Strength Range (N/ktx)
- 40 to 44
- 38 to 40
- 36 to 38
- 34 to 36
- 32 to 34
- 30 to 32
- unreported

Percentage change in shire average
- 110.7 and over
- 106.4 to 110.7
- 102.1 to 106.4
- 97.9 to 102.1
- 93.6 to 97.9
- 89.3 to 93.6
- 89.3 and under
- unreported

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.

Dr John Stanton and Lindy Coss
Table 3.7.6.  Average staple strength (N/ktex) for individual shires in each quarter between July 1989 and June 1994, and the five-year average staple strength for each shire

<table>
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<th>Shire</th>
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<th>Q3</th>
<th>Q4</th>
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Stanton and Coss 1997
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Table 3.7.6 (cont.). Average staple strength (N/ktex) for individual shires in each quarter between July 1989 and June 1994, and the five-year average staple strength for each shire

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3.8 Average staple strength by micron group

Results of staple strengths described were supplemented with estimates of staple strength of merino combing fleece wool of particular diameter groups coming from these shires. This was done using the matched AWC dataset, and the following diameter classes:

- **fine**: average of 19.5 µm with a range from 18.6 µm to 20.5 µm (Table 3.8.2)
- **medium**: average of 21.5 µm with a range from 20.6 µm to 22.5 µm (Table 3.8.3)
- **broad**: average of 23.5 µm with a range from 22.6 µm to 24.5 µm (Table 3.8.4)

Note that the estimates were done on a reduced number of sale lots which had this staple information available, compared to the diameter, vegetable matter and yield estimates which were available for all sale lots.

The average annual staple strength for these micron groups is shown in Table 3.8.1. The average strength over the five years shows the finer wool has a lower strength and the broad micron group has the highest strength. The changes in strengths are evident in all the micron groups. The difficulty in interpreting these changes is that the strength and diameter are correlated, in that when the diameter is reduced through low nutrition, the strength will also be reduced. So Table 3.8.1 should not be seen as evidence that all fine wools are tender.

<table>
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<th>Broad</th>
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Results were calculated annually for the five-year period for each shire. The first years of the analysis had low numbers of staple measurement results available for the State. Therefore some shires had very low numbers of tested lots available for the analysis. The actual number of staple measurements used in the analysis is shown in Appendix 4. The annual average strength for the individual shires over the five-year period is shown in Table 3.8.2.
Table 3.8.2. Average staple strength of the fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 29.8 N/ktex

<table>
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<th>91/92</th>
<th>92/93</th>
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Table 3.8.2 (cont.). Average staple strength of the fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 29.8 N/ktex

<table>
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<th>Shire</th>
<th>WSA</th>
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Table 3.8.2 (cont.). Average staple strength of the fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 29.8 N/ktex

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Table 3.8.3. Average staple strength of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 32.4 N/ktex

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Table 3.8.3 (cont.). Average staple strength of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 32.4 N/ktex

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Stanton and Coss 1997
Table 3.8.3 (cont.). Average staple strength of clean medium wool (averaging 21.5 µm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 32.4 N/ktext.

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Table 3.8.4. Average staple strength of clean broad wool (averaging 23.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average staple strength for each shire. The State average for this diameter group was 35.2 N/tex

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<td>Wickepin (S)</td>
<td>W12</td>
<td>33.9</td>
<td>36.4</td>
<td>33.0</td>
<td>36.2</td>
<td>37.4</td>
<td>36.2</td>
</tr>
<tr>
<td>Williams (S)</td>
<td>W12</td>
<td>37.3</td>
<td>35.4</td>
<td>34.9</td>
<td>34.2</td>
<td>34.3</td>
<td>34.9</td>
</tr>
<tr>
<td>Wiluna (S)</td>
<td>W04</td>
<td>34.5</td>
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<td>36.2</td>
<td>40.8</td>
<td>37.0</td>
</tr>
<tr>
<td>Wongan-Ballidu (S)</td>
<td>W11</td>
<td>32.9</td>
<td>35.9</td>
<td>29.9</td>
<td>36.3</td>
<td>34.3</td>
<td>34.7</td>
</tr>
<tr>
<td>Woodanilling (S)</td>
<td>W09</td>
<td>37.1</td>
<td>39.0</td>
<td>40.9</td>
<td>40.9</td>
<td>35.7</td>
<td>37.5</td>
</tr>
<tr>
<td>Wyalkatchem (S)</td>
<td>W11</td>
<td>34.2</td>
<td>36.4</td>
<td>30.1</td>
<td>36.3</td>
<td>37.3</td>
<td>36.1</td>
</tr>
<tr>
<td>Yalgoo (S)</td>
<td>W04</td>
<td>35.3</td>
<td>37.4</td>
<td>32.2</td>
<td>33.3</td>
<td>36.3</td>
<td>35.1</td>
</tr>
<tr>
<td>Yilgarn (S)</td>
<td>W07</td>
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<td>33.4</td>
<td>31.6</td>
<td>34.4</td>
<td>34.9</td>
<td>34.3</td>
</tr>
<tr>
<td>York (S)</td>
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<td>37.1</td>
<td>35.2</td>
<td>29.6</td>
<td>34.6</td>
<td>35.6</td>
<td>35.3</td>
</tr>
</tbody>
</table>

Stanton and Coss 1997
3.8.1 Maps of staple strength by shire by micron group

The long-term average staple strength by shire is shown for Section 3.8 in the map ‘Staple strength by shire by micron group for 1989/90 to 1993/94’. The colour range is common to all three maps, allowing comparison of strength in the different micron group maps.

In general the maps show that the finer wools are weaker than the broader wools. This pattern holds across most shires within the State.
Western Australia

Staple strength by shire by micron group for 1989/90 to 1993/94

Five-year shire average

Staple Strength Range (N/ktex)
- 40 to 44
- 36 to 40
- 32 to 36
- 28 to 32
- 24 to 28
- 20 to 24
- unreported

Dr. John Stanton and Lindy Coss

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.
3.9 Average staple length

The matched AWC dataset was used to generate the estimated average staple length by shire for the five-year period from July 1989 to June 1994. The long-term State average staple length is 91.6 mm. The effect of year on this average is shown in Table 3.9.1. The average staple length for the individual years ranges from 87.4 mm to 93.8 mm.

The SD of the yearly means is the between-sale lot deviation, and can be used as a measure of the range of staple lengths in the raw wool sale lots sold on an annual basis in Fremantle.

Table 3.9.1: Average staple length for Western Australia over the period July 1989 to June 1994. Results show the long-term average, and the annual average staple length. Results are for all matched merino combing fleece sale lots sold at auction with staple measurements in Fremantle.

<table>
<thead>
<tr>
<th>Period</th>
<th>Average staple length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>5-year average</td>
<td>91.6</td>
</tr>
<tr>
<td>89/90</td>
<td>91.05</td>
</tr>
<tr>
<td>90/91</td>
<td>91.41</td>
</tr>
<tr>
<td>91/92</td>
<td>87.39</td>
</tr>
<tr>
<td>92/93</td>
<td>93.80</td>
</tr>
<tr>
<td>93/94</td>
<td>91.48</td>
</tr>
</tbody>
</table>

3.9.1 Variation in staple length due to year, season and WSA, shire effects

The differences of staple length evident in the above table are due to between-year effects. It is assumed also that differences exist between seasons. The existence of differences also needs to be proved and quantified between WSAs, and between shires within WSA.

Table 3.9.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance of staple length between sale lots. The model is highly significant, but only explains 14.4 per cent of the total variance (total sums of squares) in staple length. So 85.6 per cent of the total variance has been included in the error variance. This error variance contains effects not included in the model, and random effects.

Therefore the results in Table 3.9.2 suggest that only a small proportion of variance in staple length is due to macro effects such as year, season and region, and the majority of variance is due to factors other than those included in the model. These other factors include between-flock and between-property differences within shires (for example, strain differences and other flock management effects) and between-month differences within season.

Table 3.9.2: Analysis of variance in staple length due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>192</td>
<td>954594</td>
<td>4971.85</td>
<td>77.60</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>88692</td>
<td>5682360</td>
<td>64.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>88884</td>
<td>6636955</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The relative importance of the individual model terms in explaining the variance in staple length are shown in Table 3.9.3. All sources of variance were significant. Of the terms used in the model, season made the highest contribution to explaining the variance in staple length.

**Table 3.9.3. Components of variance in staple length-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling year</td>
<td>4</td>
<td>9269</td>
<td>2317.17</td>
<td>36.17</td>
<td>0.0001</td>
</tr>
<tr>
<td>Season (within selling year)</td>
<td>15</td>
<td>263512</td>
<td>17567.49</td>
<td>274.20</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA</td>
<td>18</td>
<td>71781</td>
<td>3987.85</td>
<td>62.24</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shire nested in WSA</td>
<td>84</td>
<td>72407</td>
<td>861.99</td>
<td>13.45</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA x selling year</td>
<td>71</td>
<td>133316</td>
<td>1877.69</td>
<td>29.31</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The average staple length of merino combing fleeces sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.9.4.
Table 3.9.4. Average staple length (mm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average staple length for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany (S)</td>
<td>W10</td>
<td>97.3</td>
<td>94.4</td>
<td>91.0</td>
<td>95.7</td>
<td>95.2</td>
<td>95.4</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>88.4</td>
<td>81.6</td>
<td>78.3</td>
<td>91.9</td>
<td>88.8</td>
<td>86.6</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>92.1</td>
<td>95.2</td>
<td>88.3</td>
<td>93.0</td>
<td>91.5</td>
<td>92.7</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
<td>89.1</td>
<td>90.4</td>
<td>86.8</td>
<td>93.1</td>
<td>89.2</td>
<td>90.2</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>89.1</td>
<td>91.8</td>
<td>91.6</td>
<td>93.5</td>
<td>90.4</td>
<td>91.5</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>92.0</td>
<td>92.0</td>
<td>87.3</td>
<td>93.6</td>
<td>93.8</td>
<td>92.7</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>92.8</td>
<td>94.9</td>
<td>90.2</td>
<td>93.9</td>
<td>93.2</td>
<td>93.2</td>
</tr>
<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>90.2</td>
<td>95.4</td>
<td>91.8</td>
<td>94.4</td>
<td>89.7</td>
<td>91.9</td>
</tr>
<tr>
<td>Broomehill (S)</td>
<td>W09</td>
<td>93.0</td>
<td>91.9</td>
<td>90.4</td>
<td>94.0</td>
<td>93.5</td>
<td>93.1</td>
</tr>
<tr>
<td>Bruce Rock (S)</td>
<td>W07</td>
<td>88.6</td>
<td>93.2</td>
<td>86.6</td>
<td>95.7</td>
<td>89.4</td>
<td>91.3</td>
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<tr>
<td>Busselton (S)</td>
<td>W18</td>
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<td>90.0</td>
<td>92.4</td>
<td>93.8</td>
<td>86.6</td>
<td>90.7</td>
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<tr>
<td>Capel (S)</td>
<td>W17</td>
<td>87.8</td>
<td>95.7</td>
<td>83.8</td>
<td>96.7</td>
<td>96.6</td>
<td>92.5</td>
</tr>
<tr>
<td>Carnamah (S)</td>
<td>W06</td>
<td>90.9</td>
<td>88.1</td>
<td>86.3</td>
<td>93.6</td>
<td>89.5</td>
<td>90.0</td>
</tr>
<tr>
<td>Carnarvon (S)</td>
<td>W05</td>
<td>87.9</td>
<td>89.3</td>
<td>89.0</td>
<td>89.6</td>
<td>85.7</td>
<td>88.1</td>
</tr>
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<td>Chapman Valley (S)</td>
<td>W06</td>
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<td>92.1</td>
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<td>91.3</td>
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<td>Chittering (S)</td>
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<td>93.1</td>
<td>93.3</td>
<td>90.9</td>
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<td>93.1</td>
<td>93.6</td>
<td>93.0</td>
<td>92.2</td>
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<tr>
<td>Coolgardie (S)</td>
<td>W19</td>
<td>91.0</td>
<td>89.5</td>
<td>93.4</td>
<td>94.8</td>
<td>94.9</td>
<td>92.8</td>
</tr>
<tr>
<td>Coorow (S)</td>
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<td>86.5</td>
<td>88.7</td>
<td>83.5</td>
<td>92.8</td>
<td>88.7</td>
<td>88.9</td>
</tr>
<tr>
<td>Corrigin (S)</td>
<td>W08</td>
<td>87.6</td>
<td>94.1</td>
<td>81.4</td>
<td>92.7</td>
<td>88.1</td>
<td>89.7</td>
</tr>
<tr>
<td>Cranbrook (S)</td>
<td>W10</td>
<td>92.8</td>
<td>92.0</td>
<td>86.3</td>
<td>92.4</td>
<td>94.1</td>
<td>92.1</td>
</tr>
<tr>
<td>Cuballing (S)</td>
<td>W12</td>
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<td>85.0</td>
<td>93.5</td>
<td>89.9</td>
<td>89.5</td>
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<tr>
<td>Cue (S)</td>
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<td>82.9</td>
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<td>91.4</td>
<td>88.4</td>
<td>89.8</td>
</tr>
<tr>
<td>Cunderdin (S)</td>
<td>W11</td>
<td>88.5</td>
<td>93.6</td>
<td>84.7</td>
<td>94.1</td>
<td>90.2</td>
<td>91.3</td>
</tr>
<tr>
<td>Dalwallinu (S)</td>
<td>W11</td>
<td>87.5</td>
<td>89.2</td>
<td>87.6</td>
<td>91.8</td>
<td>88.8</td>
<td>89.2</td>
</tr>
<tr>
<td>Dandaragan (S)</td>
<td>W14</td>
<td>90.2</td>
<td>89.8</td>
<td>88.0</td>
<td>95.5</td>
<td>90.4</td>
<td>91.6</td>
</tr>
<tr>
<td>Dardanup (S)</td>
<td>W17</td>
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<td>77.9</td>
<td>86.0</td>
<td>93.4</td>
<td>92.8</td>
<td>89.6</td>
</tr>
<tr>
<td>Denmark (S)</td>
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<td>86.8</td>
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<td>92.5</td>
</tr>
<tr>
<td>Donnybrook-Balingup (S)</td>
<td>W17</td>
<td>90.9</td>
<td>92.5</td>
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<td>92.9</td>
<td>92.0</td>
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<td>90.9</td>
<td>84.2</td>
<td>91.8</td>
<td>88.6</td>
<td>89.2</td>
</tr>
<tr>
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<td>W12</td>
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<td>93.0</td>
<td>85.3</td>
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<td>91.3</td>
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<tr>
<td>Dundas (S)</td>
<td>W20</td>
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<td>91.6</td>
<td>89.5</td>
<td>96.2</td>
<td>88.5</td>
<td>92.1</td>
</tr>
<tr>
<td>Esperance (S)</td>
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<td>93.0</td>
<td>92.9</td>
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<tr>
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<td>90.5</td>
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</tr>
</tbody>
</table>

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Table 3.9.4 (cont.).  Average staple length (mm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average staple length for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingin (S)</td>
<td>W14</td>
<td>86.2</td>
<td>89.8</td>
<td>89.1</td>
<td>92.0</td>
<td>89.7</td>
<td>89.6</td>
</tr>
<tr>
<td>Gnowangerup (S)</td>
<td>W09</td>
<td>93.6</td>
<td>92.9</td>
<td>88.6</td>
<td>94.1</td>
<td>93.5</td>
<td>93.2</td>
</tr>
<tr>
<td>Goomalling (S)</td>
<td>W11</td>
<td>88.9</td>
<td>92.1</td>
<td>87.7</td>
<td>93.6</td>
<td>89.3</td>
<td>90.6</td>
</tr>
<tr>
<td>Greenough (S)</td>
<td>W06</td>
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<td>90.0</td>
<td>87.6</td>
<td>91.1</td>
<td>89.1</td>
<td>89.4</td>
</tr>
<tr>
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<td>93.8</td>
<td>90.1</td>
</tr>
<tr>
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<td>87.4</td>
<td>89.0</td>
<td>89.4</td>
<td>91.2</td>
<td>87.1</td>
<td>89.0</td>
</tr>
<tr>
<td>Jerramungup (S)</td>
<td>W09</td>
<td>90.8</td>
<td>91.4</td>
<td>89.2</td>
<td>96.4</td>
<td>92.9</td>
<td>92.9</td>
</tr>
<tr>
<td>Kalgoorlie/Boulder (C)</td>
<td>W19</td>
<td>95.6</td>
<td>91.8</td>
<td>95.5</td>
<td>96.9</td>
<td>93.3</td>
<td>94.6</td>
</tr>
<tr>
<td>Katanning (S)</td>
<td>W09</td>
<td>94.3</td>
<td>90.4</td>
<td>89.6</td>
<td>90.8</td>
<td>93.3</td>
<td>92.0</td>
</tr>
<tr>
<td>Kellerberrin (S)</td>
<td>W07</td>
<td>88.0</td>
<td>95.1</td>
<td>83.8</td>
<td>93.7</td>
<td>87.9</td>
<td>90.6</td>
</tr>
<tr>
<td>Kent (S)</td>
<td>W09</td>
<td>90.5</td>
<td>93.0</td>
<td>87.8</td>
<td>93.2</td>
<td>95.5</td>
<td>93.0</td>
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<tr>
<td>Kojonup (S)</td>
<td>W09</td>
<td>92.3</td>
<td>91.8</td>
<td>88.7</td>
<td>92.7</td>
<td>94.1</td>
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</tr>
<tr>
<td>Kondinin (S)</td>
<td>W08</td>
<td>90.3</td>
<td>93.5</td>
<td>84.9</td>
<td>94.2</td>
<td>88.1</td>
<td>90.9</td>
</tr>
<tr>
<td>Koorda (S)</td>
<td>W11</td>
<td>86.9</td>
<td>88.5</td>
<td>80.9</td>
<td>95.1</td>
<td>86.4</td>
<td>88.8</td>
</tr>
<tr>
<td>Kulin (S)</td>
<td>W08</td>
<td>89.8</td>
<td>95.2</td>
<td>88.0</td>
<td>94.5</td>
<td>90.4</td>
<td>92.0</td>
</tr>
<tr>
<td>Lake Grace (S)</td>
<td>W08</td>
<td>90.4</td>
<td>93.3</td>
<td>84.4</td>
<td>93.6</td>
<td>90.8</td>
<td>91.4</td>
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Table 3.9.4 (cont.). Average staple length (mm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average staple length for each shire

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3.9.2 Maps of average staple length by shire

The five-year average results for individual shires are displayed on the large map in this Section 3.9, ‘Staple length by shire for 1989/90 to 1993/94’, which is coloured using a three-part colour scale – white for shire results closest to the State average, with the shires supplying longer staple lengths shown in grades of green, and the shires with shorter staple lengths in grades of yellow. This map shows that the longest wool is found in the southern shires around the Albany region and in the Kalgoorlie region. The shorter merino fleece wool is delivered from the northern agricultural and pastoral regions.

The deviations of the individual year average staple length from the long-term average are also shown in the series down the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average staple length from the long-term shire average. These maps are coloured using a three-part colour scale – white for shires with annual results close to their long-term shire average, with increases in the shire annual average length shown in grades of blue, and the decreases in the shire annual average length in grades of red.

3.9.3 Seasonal changes in average staple length by shire

The analysis of variance in staple length showed that the season effect is highly significant in explaining differences in staple length. These differences are shown on a monthly basis for all matched merino combing fleece offered in Fremantle over a five-year period (see Table 3.9.5).

Table 3.9.5. Average staple length for Western Australia over the period July 1989 and June 1994. Results show the long-term average, and the monthly average staple length. Results are for all matched merino combing fleece sale lots sold at auction with staple measurements in Fremantle

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<tr>
<td>August</td>
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<tr>
<td>December</td>
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</table>

To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Western Australia

Staple length by shire for 1989/90 to 1993/94

Five-year State average = 91.6 mm

Percentage change in shire average

- 106.3 and over
- 103.8 to 106.3
- 101.3 to 103.8
- 98.7 to 101.3
- 96.2 to 98.7
- 93.7 to 96.2
- 93.7 and under
- unreported

Five-year shire average

Staple Length Range (mm)

- 94.5 to 96.0
- 93.0 to 94.5
- 91.5 to 93.0
- 90.0 to 91.5
- 88.5 to 90.0
- 87.0 to 88.5
- unreported

Dr John Stanton and Lindy Coles

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.
Table 3.9.6. Average staple length (mm) for individual shires in each quarter between July 1989 and June 1994, and the five-year average staple length for each shire

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<th>Q4</th>
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Table 3.9.6 (cont.). Average staple length (mm) for individual shires in each quarter between July 1989 and June 1994, and the five-year average staple length for each shire

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</table>
3.10 Average percentage mid break

The matched AWC dataset was used to generate the estimated average percentage mid break by shire for the five-year period July 1989 to June 1994. The long-term State average percentage mid break is 57.7 per cent. The effect of year on this average is shown in Table 3.10.1. The average percentage mid break for the individual years ranges from 54.4 per cent to 61.2 per cent.

The SD of the yearly means is the between-sale lots standard deviation, and can be used as a measure of the range of percentage mid breaks in the raw wool sold on an annual basis in Fremantle.

Table 3.10.1. Average percentage mid break for Western Australia over the period July 1989 to June 1994. Results show the long-term average, and the annual average percentage mid break. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-year average</td>
<td>57.7</td>
<td>24.9</td>
</tr>
<tr>
<td>89/90</td>
<td>54.4</td>
<td>24.6</td>
</tr>
<tr>
<td>90/91</td>
<td>61.0</td>
<td>24.4</td>
</tr>
<tr>
<td>91/92</td>
<td>49.8</td>
<td>25.2</td>
</tr>
<tr>
<td>92/93</td>
<td>61.2</td>
<td>24.4</td>
</tr>
<tr>
<td>93/94</td>
<td>57.3</td>
<td>25.1</td>
</tr>
</tbody>
</table>

3.10.1 Variation in percentage mid break due to year, season and WSA, shire effects

The change in percentage mid break evident in the above table is due to differences between years. It is assumed also that differences also exist between seasons. The existence of differences also needs to be quantified between WSAs, and between shires within WSA.

Table 3.10.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance of percentage mid break between sale lots. The model is significant, and explains 17.7 per cent of the total variance. So 82.3 per cent of the total variance has been included in the error variance. This error variance contains effects not included in the model and random effects.

Therefore the results in Table 3.10.2 suggest that only a small proportion of variance in percentage mid break is due to macro effects such as year, season and region, and the majority of variance is due to factors other than those included in the model. These other factors could include between-flock and between-property differences within shires, for example, strain differences and other flock management effects, and between-month differences within season.
Table 3.10.2. Analysis of variance in percentage mid break due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>192</td>
<td>9809262</td>
<td>51089.91</td>
<td>99.40</td>
<td>0.0001</td>
</tr>
<tr>
<td>Error</td>
<td>88656</td>
<td>45566113</td>
<td>513.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected total</td>
<td>88848</td>
<td>55375375</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The relative importance of the individual terms included in the model in explaining the variance in percentage mid break is shown in Table 3.10.3. All sources of variance included were highly significant. However the most important contribution (using the F values) is season within years. This accounts for most of the accounted variance in Table 3.10.2.

Table 3.10.3. Components of variance in percentage mid break-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selling year</td>
<td>4</td>
<td>24796</td>
<td>6198.88</td>
<td>12.06</td>
<td>0.0001</td>
</tr>
<tr>
<td>Season (within selling year)</td>
<td>15</td>
<td>6244285</td>
<td>415285.68</td>
<td>809.95</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA</td>
<td>18</td>
<td>150415</td>
<td>8356.40</td>
<td>16.26</td>
<td>0.0001</td>
</tr>
<tr>
<td>Shire nested in WSA</td>
<td>84</td>
<td>442349</td>
<td>5266.06</td>
<td>10.25</td>
<td>0.0001</td>
</tr>
<tr>
<td>WSA x selling year</td>
<td>71</td>
<td>1245420</td>
<td>17541.13</td>
<td>34.13</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

The average percentage mid break of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.10.4.
Table 3.10.4. Average percentage mid break for individual shires for five selling years between July 1989 and June 1994, and the five-year average percentage mid break for each shire

<table>
<thead>
<tr>
<th>Shire</th>
<th>WSA</th>
<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany (S)</td>
<td>W10</td>
<td>51.9</td>
<td>48.8</td>
<td>47.9</td>
<td>56.4</td>
<td>60.9</td>
<td>54.5</td>
</tr>
<tr>
<td>Ashburton (S)</td>
<td>W03</td>
<td>63.9</td>
<td>86.9</td>
<td>78.0</td>
<td>80.3</td>
<td>79.8</td>
<td>78.2</td>
</tr>
<tr>
<td>Augusta-Margaret River (S)</td>
<td>W18</td>
<td>55.8</td>
<td>47.0</td>
<td>40.8</td>
<td>71.0</td>
<td>48.9</td>
<td>52.6</td>
</tr>
<tr>
<td>Beverley (S)</td>
<td>W11</td>
<td>54.6</td>
<td>65.0</td>
<td>52.9</td>
<td>70.0</td>
<td>55.6</td>
<td>60.4</td>
</tr>
<tr>
<td>Boddington (S)</td>
<td>W12</td>
<td>53.8</td>
<td>53.8</td>
<td>47.7</td>
<td>63.1</td>
<td>61.5</td>
<td>57.8</td>
</tr>
<tr>
<td>Boyup Brook (S)</td>
<td>W13</td>
<td>63.9</td>
<td>56.7</td>
<td>60.7</td>
<td>58.1</td>
<td>60.8</td>
<td>60.1</td>
</tr>
<tr>
<td>Bridgetown-Greenbushes (S)</td>
<td>W13</td>
<td>65.1</td>
<td>59.3</td>
<td>31.0</td>
<td>58.8</td>
<td>65.8</td>
<td>60.3</td>
</tr>
<tr>
<td>Brookton (S)</td>
<td>W12</td>
<td>53.4</td>
<td>69.6</td>
<td>57.2</td>
<td>63.4</td>
<td>54.3</td>
<td>58.9</td>
</tr>
<tr>
<td>Broomehill (S)</td>
<td>W09</td>
<td>52.5</td>
<td>59.2</td>
<td>37.6</td>
<td>52.5</td>
<td>50.8</td>
<td>51.3</td>
</tr>
<tr>
<td>Bruce Rock (S)</td>
<td>W07</td>
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<td>40.6</td>
<td>71.8</td>
<td>51.3</td>
<td>58.6</td>
</tr>
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<td>52.0</td>
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<td>67.8</td>
<td>50.4</td>
<td>55.9</td>
</tr>
<tr>
<td>Capel (S)</td>
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<td>85.0</td>
<td>70.3</td>
<td>65.0</td>
<td>62.2</td>
</tr>
<tr>
<td>Carnamah (S)</td>
<td>W06</td>
<td>56.6</td>
<td>57.2</td>
<td>41.5</td>
<td>66.8</td>
<td>45.2</td>
<td>54.6</td>
</tr>
<tr>
<td>Carnarvon (S)</td>
<td>W05</td>
<td>59.8</td>
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<td>44.8</td>
<td>57.7</td>
<td>53.8</td>
</tr>
<tr>
<td>Chapman Valley (S)</td>
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<td>63.8</td>
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<td>60.8</td>
<td>49.4</td>
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<tr>
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<td>W17</td>
<td>74.1</td>
<td>79.9</td>
<td>71.6</td>
<td>63.3</td>
<td>62.7</td>
<td>71.0</td>
</tr>
<tr>
<td>Coolgardie (S)</td>
<td>W19</td>
<td>53.2</td>
<td>58.2</td>
<td>63.4</td>
<td>54.0</td>
<td>63.6</td>
<td>58.3</td>
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<td>Coorow (S)</td>
<td>W06</td>
<td>58.3</td>
<td>62.4</td>
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<td>68.5</td>
<td>50.4</td>
<td>59.2</td>
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<td>49.3</td>
<td>68.3</td>
<td>40.8</td>
<td>68.5</td>
<td>49.2</td>
<td>56.9</td>
</tr>
<tr>
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<td>W10</td>
<td>61.5</td>
<td>58.3</td>
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<td>57.5</td>
<td>65.4</td>
<td>58.9</td>
</tr>
<tr>
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<td>56.6</td>
<td>57.3</td>
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<td>Cue (S)</td>
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<td>42.3</td>
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<td>Cunderdin (S)</td>
<td>W11</td>
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<td>76.9</td>
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<td>62.5</td>
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<td>65.9</td>
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<td>62.0</td>
<td>52.7</td>
<td>56.6</td>
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<tr>
<td>Dandaragan (S)</td>
<td>W14</td>
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<td>58.2</td>
<td>54.2</td>
<td>71.5</td>
<td>52.7</td>
<td>60.2</td>
</tr>
<tr>
<td>Dardanup (S)</td>
<td>W17</td>
<td>34.8</td>
<td>65.8</td>
<td>32.0</td>
<td>35.0</td>
<td>51.0</td>
<td>44.1</td>
</tr>
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<td>W10</td>
<td>60.7</td>
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<td>45.3</td>
<td>54.3</td>
<td>59.8</td>
<td>53.6</td>
</tr>
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<td>62.3</td>
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<td>65.4</td>
<td>71.7</td>
<td>64.3</td>
</tr>
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<td>Dowerin (S)</td>
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<td>66.6</td>
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<td>70.7</td>
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<td>W20</td>
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<td>58.2</td>
<td>57.5</td>
<td>55.1</td>
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</tr>
<tr>
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<td>90/91</td>
<td>91/92</td>
<td>92/93</td>
<td>93/94</td>
<td>Average year</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td>--------------</td>
</tr>
<tr>
<td>Gingin (S)</td>
<td>W14</td>
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<td>58.3</td>
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<td>59.9</td>
<td>48.6</td>
<td>53.5</td>
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<tr>
<td>Gnowangerup (S)</td>
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<td>60.4</td>
<td>71.6</td>
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<td>58.8</td>
<td>62.0</td>
<td>61.9</td>
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<td>72.5</td>
<td>57.1</td>
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<td>52.6</td>
<td>58.4</td>
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<td>58.5</td>
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<td>Jerramungup (S)</td>
<td>W09</td>
<td>47.1</td>
<td>62.2</td>
<td>48.0</td>
<td>62.1</td>
<td>62.5</td>
<td>58.2</td>
</tr>
<tr>
<td>Kalgoorlie/Boulder (C)</td>
<td>W19</td>
<td>53.7</td>
<td>50.1</td>
<td>55.5</td>
<td>57.1</td>
<td>55.3</td>
<td>54.3</td>
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<td>Katanning (S)</td>
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<td>69.6</td>
<td>54.1</td>
<td>54.5</td>
<td>60.8</td>
<td>60.3</td>
</tr>
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<td>Kellerberrin (S)</td>
<td>W07</td>
<td>51.8</td>
<td>71.8</td>
<td>50.7</td>
<td>74.1</td>
<td>54.8</td>
<td>62.7</td>
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<td>54.4</td>
<td>67.6</td>
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<td>72.0</td>
<td>71.0</td>
<td>66.8</td>
</tr>
<tr>
<td>Kojonup (S)</td>
<td>W09</td>
<td>55.3</td>
<td>55.2</td>
<td>48.8</td>
<td>54.4</td>
<td>61.8</td>
<td>56.6</td>
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<tr>
<td>Kondinin (S)</td>
<td>W08</td>
<td>50.4</td>
<td>61.6</td>
<td>40.9</td>
<td>65.2</td>
<td>49.0</td>
<td>55.5</td>
</tr>
<tr>
<td>Koorda (S)</td>
<td>W11</td>
<td>45.9</td>
<td>53.1</td>
<td>48.7</td>
<td>69.9</td>
<td>48.1</td>
<td>54.7</td>
</tr>
<tr>
<td>Kulin (S)</td>
<td>W08</td>
<td>55.5</td>
<td>70.0</td>
<td>57.4</td>
<td>64.6</td>
<td>56.3</td>
<td>60.8</td>
</tr>
<tr>
<td>Lake Grace (S)</td>
<td>W08</td>
<td>51.0</td>
<td>66.3</td>
<td>39.1</td>
<td>62.6</td>
<td>55.9</td>
<td>57.6</td>
</tr>
<tr>
<td>Laverton (S)</td>
<td>W19</td>
<td>61.8</td>
<td>74.5</td>
<td>na</td>
<td>46.9</td>
<td>51.0</td>
<td>60.7</td>
</tr>
<tr>
<td>Leonora (S)</td>
<td>W19</td>
<td>43.7</td>
<td>48.2</td>
<td>52.8</td>
<td>43.7</td>
<td>41.9</td>
<td>44.6</td>
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<tr>
<td>Manjimup (S)</td>
<td>W13</td>
<td>58.5</td>
<td>46.5</td>
<td>50.7</td>
<td>65.0</td>
<td>60.0</td>
<td>56.5</td>
</tr>
<tr>
<td>Meekatharra (S)</td>
<td>W04</td>
<td>48.6</td>
<td>52.0</td>
<td>38.5</td>
<td>37.6</td>
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<tr>
<td>Menzies (S)</td>
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<td>43.2</td>
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<td>63.0</td>
<td>34.7</td>
<td>68.2</td>
<td>51.8</td>
<td>56.8</td>
</tr>
<tr>
<td>Mingenew (S)</td>
<td>W06</td>
<td>55.1</td>
<td>55.7</td>
<td>49.4</td>
<td>63.7</td>
<td>55.0</td>
<td>56.7</td>
</tr>
<tr>
<td>Moora (S)</td>
<td>W14</td>
<td>56.2</td>
<td>68.1</td>
<td>50.6</td>
<td>71.3</td>
<td>55.2</td>
<td>61.8</td>
</tr>
<tr>
<td>Morawa (S)</td>
<td>W06</td>
<td>48.1</td>
<td>57.6</td>
<td>41.3</td>
<td>50.9</td>
<td>47.8</td>
<td>49.9</td>
</tr>
<tr>
<td>Mount Magnet (S)</td>
<td>W04</td>
<td>53.2</td>
<td>58.6</td>
<td>63.8</td>
<td>45.2</td>
<td>46.5</td>
<td>51.4</td>
</tr>
<tr>
<td>Mount Marshall (S)</td>
<td>W07</td>
<td>58.0</td>
<td>62.6</td>
<td>47.0</td>
<td>65.4</td>
<td>50.5</td>
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Table 3.10.4 (cont.). Average percentage mid break for individual shires for five selling years between July 1989 and June 1994, and the five-year average percentage mid break for each shire

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<td>55.9</td>
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</table>
3.10.2 Maps of average percentage mid break by shire

The five-year average results for individual shires are displayed on the large map for this Section 3.10, 'Proportion of mid breaks by shire for 1989/90 to 1993/94', which is coloured using a three-part colour scale – white for shire results closest to the State average, with the shires supplying high mid break wool shown in grades of green, and the shires with low mid break wool in grades of yellow. This map shows a diffuse pattern between shires (as suggested in Table 3.10.3). However a generalisation could be that the western shires tend to have higher mid break results, and the northern pastoral shires have lower mid break results.

The deviations of the individual year average mid breaks from the long-term average are also shown in the series down the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average mid breaks from the long-term shire average. These maps are coloured using a three-part colour scale – white for shires with annual results close to their long-term shire average, with increases in the shire annual mid break results shown in grades of blue, and the decreases in the shire annual average mid break results in grades of red. It should be noted that response in 1991/92, when diameter was lower and strength was lower, was for mid break results also to be lower, illustrating the sensitivity of mid break results to seasonal differences, and possibly to be independent of the strength result. In 1993/94 the southern shires increased the mid break result, and the shires to the north and east of Perth reduced the mid break result.

3.10.3 Seasonal changes in average percentage mid breaks by shire

The analysis of variance in percentage mid breaks showed that the season effect is highly significant in explaining differences in percentage mid breaks. These differences are shown on a monthly basis for all matched merino combing fleece offered in Fremantle over a five-year period.

Table 3.10.5. Average percentage mid break for Western Australia over the period July 1989 to June 1994. Results show the long-term average, and the monthly average percentage mid break. Results are for all merino combing fleece sale lots sold at auction in Fremantle

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<td>June</td>
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<tr>
<td>July</td>
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</tr>
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<td>August</td>
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<td>September</td>
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<td>November</td>
<td>71.9</td>
</tr>
<tr>
<td>December</td>
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</tbody>
</table>
Western Australia

Proportion of mid breaks by shire for 1989/90 to 1993/94

Five-year State average = 57.7 %

Five-year shire average

Proportion Mid Breaks (%)
- 70 to 75
- 65 to 70
- 60 to 65
- 55 to 60
- 50 to 55
- 45 to 50
- 40 to 45
- 35 to 40
- unreported

Dr John Stanton and Lindy Coes

Percentage change in shire average
- 120.8 and over
- 112.5 to 120.8
- 104.2 to 112.5
- 95.8 to 104.2
- 87.5 to 95.8
- 79.2 to 87.5
- 79.2 and under
- unreported

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS
To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Table 3.10.6. Average percentage mid break for individual shires in each quarter between July 1989 and June 1994, and the five-year average percentage mid break for each shire

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Table 3.10.6 (cont.). Average percentage mid break for individual shires in each quarter between July 1989 and June 1994, and the five-year average percentage mid break for each shire

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Table 3.10.6 (cont.). Average percentage mid break for individual shires in each quarter between July 1989 and June 1994, and the five-year average percentage mid break for each shire

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3.11 Average hauteur

The matched AWC dataset was used to generate the estimated average hauteur by shire for the five-year period from July 1989 to June 1994. The long-term State average hauteur is 69 mm. The effect of year on this average is shown in Table 3.11.1. The average hauteur for the individual years ranges from 65.8 mm to 70 mm.

Table 3.11.1. Average hauteur for WA over the period July 1989 to June 1994. Results show the long-term average, and the annual average hauteur. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle

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3.11.1 Variation in hauteur due to year, season and WSA, shire effects

The differences of hauteur evident in the above table are due to between-year effects. It is assumed also that differences exist between seasons. The existence of differences also needs to be proved and quantified between WSAs, and between shires within WSA.

Table 3.11.2 contains the results of a statistical analysis done to examine the ability of the model (using time (year, season) and regional (WSA, shire) effects and their interactions) to explain the variance of hauteur between sale lots. The model is highly significant, and explains 13.9 per cent of the total variance in hauteur. So 86.1 per cent of the total variance has been included in the error variance which contains both effects not included in the model and random effects.

Therefore the results in Table 3.11.2 suggest that only a small proportion of variance in hauteur is due to macro effects such as year, season and region, and the majority of variance may occur at a more local level, and finer time frame. However hauteur is calculated using both staple and core test results. As each of these individual test results have a particular set of factors contributing to their variance, identifying single factors which provide a clear description of the variance in a compound predicted term such as hauteur is always going to be difficult.

Table 3.11.2. Analysis of variance in hauteur due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

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The relative importance of the individual terms in explaining the variance in hauteur is shown in Table 3.11.3. All terms had a significant impact on the variance in hauteur. However season and WSA were the strongest terms in the model for explaining the variance in hauteur.

Table 3.11.3. Components of variance in the model to explain the variance in hauteur: year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

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The average hauteur of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.11.4.
### Table 3.11.4. Average hauteur (mm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average hauteur for each shire

<table>
<thead>
<tr>
<th>Shire</th>
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<th>91/92</th>
<th>92/93</th>
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<th>Average year</th>
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Table 3.114 (cont.). Average hauteur (mm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average hauteur for each shire

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Table 3.11.4 (cont.). Average hauteur (mm) for individual shires for five selling years between July 1989 and June 1994, and the five-year average hauteur for each shire

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3.11.2 Maps of average hauteur by shire

The five-year average results for individual shires are displayed on the large map for Section 3.11, ‘Estimated hauteur by shire for 1989/90 to 1993/94’, which is coloured using a three-part colour scale – white for shire results closest to the State average, with the shires supplying longer hauteur results shown in grades of green, and the shires with a shorter hauteur in grades of yellow. This map shows that the longer hauteur wool is found in the Albany region, and from Esperance and north through the Eastern Goldfields (around Kalgoorlie).

The deviations of the individual year average hauteur from the long-term average are also shown in the series down the right hand side of this map for the selling years 1989/90 to 1993/94. These maps are designed to show the pattern of change in shire annual average hauteur from the long-term shire average. These maps are coloured using a three-part colour scale – white for shires with annual results about their long-term shire average, with increases in the shire annual average hauteur shown in grades of blue, and the decreases in the shire annual average hauteur in grades of red.

The 1991/92 results show a general depression of hauteur across all shires but a recovery in the next two years.

3.11.3 Seasonal changes in average hauteur by shire

The analysis of variance in hauteur showed that the season effect is highly significant in explaining differences in hauteur. These differences are shown on a monthly basis for all matched merino combing fleece offered in Fremantle over a five-year period (Table 3.11.5).

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<td>August</td>
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<td>December</td>
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Table 3.11.5. Average hauteur for Western Australia over the period July 1989 to June 1994. Results show the long-term average, and the monthly average hauteur. Results are for all matched merino combing fleece sale lots sold at auction in Fremantle.

To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Western Australia
Estimated Hauteur by shire for 1989/90 to 1993/94

Five-year State average = 69.0 mm

Five-year shire average

Estimated Hauteur Range (mm)
- 74 to 76
- 72 to 74
- 70 to 72
- 68 to 70
- 66 to 68
- 64 to 66
- unreported

Percentage change in shire average
- 106.1 and over
- 103.7 to 106.1
- 101.2 to 103.7
- 98.8 to 101.2
- 96.3 to 98.8
- 93.9 to 96.3
- 93.9 and under
- unreported

Dr John Stanton and Lindy Coes

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.
Table 3.11.6. Average hauteur (mm) for individual shires in each quarter between July 1989 and June 1994, and the five-year average hauteur for each shire

<table>
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</table>
3.12 Average hauteur by micron group

The above hauteur results were supplemented with estimates of hauteur of matched merino combing fleece wool of particular diameters coming from these shires. This was done using the matched AWC datasets, and the following diameter classes:

- **fine**: average of 19.5 μm with a range from 18.6 μm to 20.5 μm (Table 3.12.2)
- **medium**: average of 21.5 μm with a range from 20.6 μm to 22.5 μm (Table 3.12.3)
- **broad**: average of 23.5 μm with a range from 22.6 μm to 24.5 μm (Table 3.12.4)

The hauteur was predicted using the TEAM equations from the raw wool staple measurements. Therefore the estimates were done on a reduced number of sale lots which had this staple information available.

Results were calculated annually for the five-year period for each shire. The first years of the analysis had low numbers of staple measurement results available for the State. Therefore some shires had very low numbers of staple test results available for the analysis. The actual number of staple measurements used in the analysis is shown in Appendix 4. The results are shown in Tables 3.12.1 to 3.12.4 and in the accompanying maps.

**Table 3.12.1.** Average hauteur for the micron groups in Western Australia over the period July 1989 to June 1994. Results are for all matched merino combing fleece sale lots sold at auction with staple measurement in Fremantle

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<th>Broad</th>
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Table 3.12.2. Average hauteur of the fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 61.2 mm

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<th>91/92</th>
<th>92/93</th>
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Table 3.12.2 (cont.). Average hauteur of the fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 61.2 mm

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Table 3.12.2 (cont.). Average hauteur of the fine wool (averaging 19.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 61.2 mm

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Table 3.12.3. Average hauteur of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 67.0 mm

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Table 3.12.3 (cont.). Average hauteur of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 67.0 mm

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Table 3.12.3 (cont.). Average hauteur of clean medium wool (averaging 21.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 67.0 mm

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Table 3.12.4. Average hauteur of clean broad wool (averaging 23.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 71.4 mm

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Table 3.12.4 (cont.). Average hauteur of clean broad wool (averaging 23.5 \( \mu \text{m} \)) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 71.4 mm

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Table 3.12.4 (cont.). Average hauteur of clean broad wool (averaging 23.5 μm) available at auction by shire for five selling years between 1989/90 and 1993/94, and the five-year average hauteur for each shire. The State average for this diameter group was 71.4 mm

<table>
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<tr>
<th>Shire</th>
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<th>89/90</th>
<th>90/91</th>
<th>91/92</th>
<th>92/93</th>
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<td>70.0</td>
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<td>69.4</td>
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</table>
3.12.1 Maps of average hauteur by shire by micron group

The maps of average hauteur by micron group show the lower hauteur range for the fine micron group (from Table 3.12.1) is evident in nearly all shires. A potential pattern might be present where the 19.5 micron group in the shires of the eastern wheatbelt are in the lowest hauteur range, and the higher rainfall shires move into the second lowest hauteur range. Conversely the 23.5 micron group is in the high hauteur ranges in all shires.

The 21.5 micron group is predominantly in the middle hauteur range (65 to 70 mm) with the exception of some northern agricultural and pastoral shires which are slightly shorter in this fibre diameter group.

Overall, these results suggest that there is a correlation in the State supply profile between increasing diameter and increasing hauteur, and that this effect is applicable across most shires.
Western Australia

Estimated Hauteur by shire by micron group for 1989/90 to 1993/94

Five-year shire average

Estimated Hauteur Range (mm)
- 75 to 80
- 70 to 75
- 65 to 70
- 60 to 65
- 55 to 60
- unreported

Dr John Stanton and Lindy Coss

These maps are drawn using ABS boundaries and these boundaries remain the property of ABS.
3.13 Average CV(H)

The matched AWC dataset was used to generate the estimated average CV(H) by shire for the five-year period from July 1989 to June 1994. The long-term State average CV(H) is 51.2 per cent. The effect of year on this average is shown in Table 3.13.1. The average CV(H) for the individual years ranges from 50.3 per cent to 51.8 per cent.

The SD of the yearly means is the between-sale lots standard deviation, and can be used as a measure of the range of CV(H) in the raw wool sold on an annual basis in Fremantle.

Table 3.13.1. Average CV(H) for WA over the period July 1989 to June 1994. Results show the long-term average, and the annual average CV(H). Results are for all matched merino combing fleece sale lots sold at auction with staple measurements in Fremantle.

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<th>Period</th>
<th>Average CV(H) (%)</th>
<th>Mean</th>
<th>SD</th>
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<tr>
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<tr>
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</tr>
<tr>
<td>93/94</td>
<td>50.98</td>
<td>5.67</td>
<td></td>
</tr>
</tbody>
</table>

3.13.1 Variation in CV(H) due to year, season and WSA, shire effects

The differences of CV(H) evident in the above table are due to between-year effects. It is assumed also that differences exist between seasons. The existence of differences also needs to be proved and quantified between WSAs, and between shires within WSA.

Table 3.13.2 contains a statistical analysis done on time (year, season), regional (WSA, shire) effects and their interactions to examine their contributions to the variance of CV(H). The model used to explain the variance in CV(H) is highly significant, although it explains only 20.4 per cent of the total variance. So 79.6 per cent of the total variance has been included in the error variance. This error variance contains effects not included in the model and random effects.

Therefore the results in Table 3.13.2 suggest that a small proportion of variance in CV(H) is due to macro effects such as year, season and region, and the majority of variance is due to factors other than those included in the model. These other factors could include between-flock and between-property differences within shires, for example, strain differences and other flock management effects, and between-month differences within season. Also CV(H) is calculated using both staple and core test results. As each of these individual test results has a particular set of factors contributing to their variance, identifying single factors which provide a clear description of the variance in a compound predicted term such as CV(H) is unlikely.

Table 3.13.2. Analysis of variance in CV(H) due to year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

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<th>Source</th>
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<th>Sum of Squares</th>
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<th>F value</th>
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The relative importance of the individual terms in explaining the variance in CV(H) are shown in Table 3.13.3. All sources of variance included were highly significant. However the season effect (within a year) dominates the other terms of the model, to such an extent that season would account for the majority of the variance explained by the model.

Table 3.13.3. Components of variance in CV(H)-year and season (nested within year), WSA and shires (nested within WSA) and WSA by year interaction

<table>
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<th>Source</th>
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<th>Mean Square</th>
<th>F value</th>
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<td>381390</td>
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<tr>
<td>WSA</td>
<td>18</td>
<td>10390</td>
<td>577.20</td>
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<td>Shire nested in WSA</td>
<td>84</td>
<td>18515</td>
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<td>WSA x selling year</td>
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<td>29595</td>
<td>416.83</td>
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The average CV(H) of merino combing fleece wool sold at auction and matched by brand from each shire in each of the five years, and the five-year average are shown in Table 3.13.4.
Table 3.13.4. Average CV(H) (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average CV(H) for each shire

<table>
<thead>
<tr>
<th>Shire</th>
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<th>91/92</th>
<th>92/93</th>
<th>93/94</th>
<th>Average year</th>
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### Table 3.13.4 (cont.). Average CV(H) (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average CV(H) for each shire

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<th>92/93</th>
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Table 3.13.4 (cont.). Average CV(H) (%) for individual shires for five selling years between July 1989 and June 1994, and the five-year average CV(H) for each shire

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<th>92/93</th>
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Stanton and Coss 1997
3.13.3 Seasonal changes in average CV(H) by shire

The analysis of variance in CV(H) showed that the season effect (within a year) is highly significant in explaining differences in CV(H). These differences are shown on a monthly basis for all matched merino combing fleece offered in Fremantle over a five-year period (Table 3.13.5).

Table 3.13.5. Average CV(H) for Western Australia over the period July 1989 and June 1994. Results show the long-term average, and the monthly average CV(H). Results are for all merino combing fleece sale lots sold at auction in Fremantle

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<td>February</td>
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<tr>
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<td>July</td>
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</tr>
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<td>September</td>
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<td>December</td>
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To reduce the volume of information being presented in the following tables, the 12 months were condensed into four seasons:

- Months 1, 2 & 3 = Q1
- Months 4, 5 & 6 = Q2
- Months 7, 8 & 9 = Q3
- Months 10, 11 & 12 = Q4
Table 3.13.6. Average CV(H) (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average CV(H) for each shire

<table>
<thead>
<tr>
<th>Shire</th>
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<th>Q3</th>
<th>Q4</th>
<th>Average year</th>
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Table 3.13.6 (cont.). Average CV(H) (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average CV(H) for each shire

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Table 3.13.6 (cont.). Average CV(H) (%) for individual shires in each quarter between July 1989 and June 1994, and the five-year average CV(H) for each shire

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4. Conclusion

The tabulation and mapping of the Western Australian wool characteristics has been completed for the period June 1989 to July 1994.

The analysis was designed to quantify the average specifications, and the changes to these specifications over time and between regions. The analyses showed that the behaviour of the individual characteristics differed over time and between regions, and generalisations were therefore difficult across characteristics.

During the period of the analysis, the total wool production for the State fell significantly. It has been assumed that the reduction in wool production was not the cause for changes in the individual characteristics. However, if the reduction in wool production was not evenly distributed across all types of sheep (such as ewe flocks, wether flocks and weaners and lambs), this assumption would need to be re-evaluated. In addition, there may have been changes in the average results due to the large increases in the adoption of the staple measurements during this period, and these also may be correlated with the type of wool being tested.

The design of the analyses also assumed that there was no underlying trend in the data being analysed. So no attempt was made, for example, to identify long-term changes in fibre diameter or staple strength. This type of analysis would need annual effects (as short term cyclical or seasonal effects) and other irregularities (or background noise) to be removed before trend information could be identified. It was assumed that an extended period would be needed for such an analysis.

No attempt has been made to explain the biology or the economic rationalisation which gave rise to these changes. The biology referred to is not only at the individual sheep level, but would include flock and property responses within regions. Hence the biology would need to be interacted with the resource capability of the properties to understand the changes being described. Economic analyses over this period would also need to incorporate elements of the wool producers’ expectations about the future of the wool industry as the Minimum Reserve Price Scheme was removed in the middle of the period being analysed.

Furthermore, no attempt has been made to prepare and analyse detailed correlations between these changes in characteristics, because without specific relationships to analyse, such work would generate large amounts of redundant information. However, initial divisions of the wool production on a diameter classification were attempted to explore the quality of information that was available. The results showed regional differences in the correlated staple strength and hauteur results for these diameter categories. These examples suggest two possibilities: (a) where these relationships are expected to exist, the use of the average result needs to be handled with care, and (b) the data would support further analysis based on classifications such as diameter class.
Potential applications

The information generated in this report also has application for individual producers or regional groups of wool producers. The results allow producers to compare their production to the average for the region, and for the season of production. They can also use the information from neighbouring regions or from the State for extended comparisons. So while their result may be satisfactory for the shire, comparisons over a wider group may indicate a different level being achieved by other groups. However, it must be emphasised that these results do not represent benchmarks which generally concentrate on the top levels of performance.

The analyses showed the relative importance of the shire and WSA in explaining the differences for single characteristics. If the shire exceeded the WSA in relative importance, then presumably localised effects may be the cause of these differences. If the WSA was more important, then the cause is wider than shire and presumably covers a number of neighbouring shires.

Similarly the changes over time (monthly or annual differences) can be used to identify if the effect is seasonal, or is dependent on the year being described. If the major effect is monthly, then it is assumed the effect will be repeated across years (as the analysis nested month within year). If the effect was heavily modified by year, then the cause is not appearing regularly, but irregularly on a yearly basis. Further analysis of some of these causes of effects may yield useful information.
Appendix 1.

A list of WA shires and their respective wool selling area (WSA) sorted by WSA. The shire number relates these shires to Map A1 at the end of this section.

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A list of WA shires and their respective wool selling area (WSA) sorted by WSA. The shire number relates these shires to Map A1 (cont.).

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Map A1  Maps of Western Australia showing the WA shires and their boundaries. The lower map is an expansion of the boxed section defined in Map 1 (page 3).
Appendix 2.
Number of brands used in the analyses by year by shire. Where small numbers of brands have been matched to shire the averages will have lower precision.

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Appendix 3.

Number of sale lots with core measurements by year by shire. Where small numbers exist, the averages derived for core measurements will have lower precision.

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Number of sale lots with core measurements by year by shire. Where small numbers exist, the averages derived for core measurements will have lower precision (cont.).

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Number of sale lots with staple measurements by year by shire. Where small numbers exist, the averages derived for staple measurements or predicted top characteristics will have lower precision (cont.).

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