Agriculture Notes

Variation in and Sampling of Alpaca Fleeces

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Introduction

Evaluating the attributes of alpaca fleeces subjectively by eye is difficult and unreliable as alpaca fleeces show large variations in attributes. In addition, our eyes (and brain) are limited in their ability to discern fibre diameter, the average of other attributes and the extent of naturally occurring contaminants. Alpaca fleeces are also affected by environmental conditions, in particular humidity, but also by storage conditions. These same limitations apply equally to wool, mohair and cashmere.

To assist in the commercial trading of fibre for textile processing, a range of testing procedures have been developed to help reduce the errors associated with subjective assessment. These testing procedures are approved by the International Wool Textile Organisation (IWTO) as the basis for the international trade in wool and other animal fibres. The IWTO Technical Committees take this task very seriously and convene international meetings to assess new or suggested changes to protocols based on new information, new technology or better scientific methods and analyses. Associated with objective tests are a range of errors related to the sampling and testing procedures. With objective testing it is possible to quantify the likely extent of the errors associated with the testing procedures employed.

To help breeders evaluate alpaca fleece attributes the starting point is understanding the types of variation found in and between fleeces; the most appropriate method of sampling alpaca fleeces; and the application of this information for evaluating fibre test results. This article is based on research conducted in Australia.

This Agriculture Note discusses the sources and extent of variation within the alpaca fleece and suggestions are made as to the most appropriate method of sampling alpaca fleeces.

Variation in animal fleeces

The variation in the attributes within the fleece of animals is related to the following components:

Within a staple

Most of the variation in fibre diameter occurs between fibres within a staple. The difference between the fibre diameter of fibres growing from primary and secondary skin follicles in an alpaca may be more than 20 µm. Many medullated fibres in alpaca fleeces are more than 10 µm coarser than the mean fibre diameter (McGregor 1999a).

Along the fibre

Changes occur in the fibre diameter, dust, grease and vegetable matter content as the fleece grows during the year. In the example shown in Figure 1 (McGregor 1999b) diameter varied from a low of 21 µm to a maximum of 27 µm. During the first few months of life the mean fibre diameter ranged from 21 to 23 µm (15 to 11 cm) and then increased to 25 to 27 µm (10 to 4 cm) before declining to 21 to 22 µm. Nutritional changes, weaning, rapid growth, the affects of disease and reproduction all influence fibre diameter along the fibre.

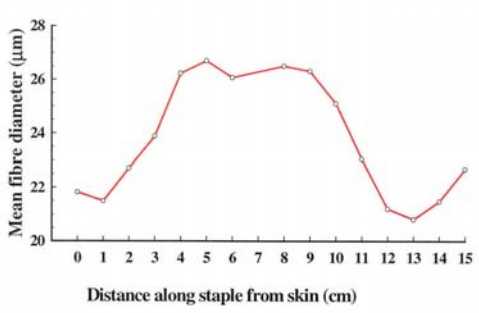

Figure 1.Changes in the mean fibre diameter along a staple from a tui alpaca sampled in November (McGregor 1999b)

Different positions within the fleece

Fibre length, fibre diameter, incidence of medullated fibres, grease, suint, dust and vegetable matter contaminants vary with the position in the fleece. These variations are discussed in greater detail in this Agnote.

Differences between animals and herds

Within a herd of animals, between herds and between properties, alpacas will differ in their fibre diameter attributes and in their level of grease and other contaminants. This is discussed elsewhere for Australian alpacas in greater detail (McGregor and Butler 2004, McGregor 2004).

Briefly, mean fibre diameter (MFD) of alpaca fibre was influenced by farm, year, age, breed, live weight and

colour of fibre. The influence of farm and age are shown in Figure 2. MFD increased to 7.5 years of age.

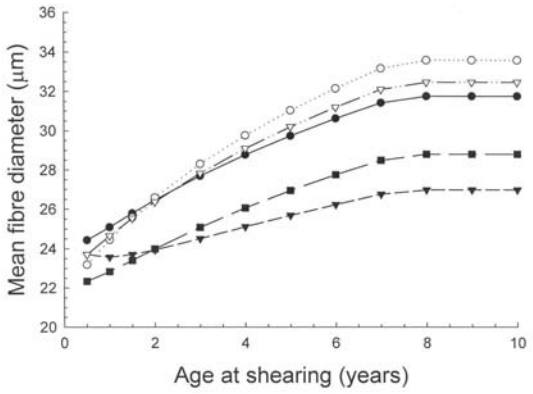

Figure 2. Responses of mean fibre diameter to age at shearing after adjustment for year, live weight, colour of fleece and breed on five different farms (modified from McGregor and Bulter 2004). Each symbol represents a different farm

Coefficient of variation of fibre diameter (CVD) was influenced by farm, year, age, breed, and colour of fibre.

Impact of variation in animal fleeces

The large variation in animal fleeces affects fibre preparation (fleece classing), fleece value, processing and the interpretation of fibre testing results.

Variation due to position in alpaca fleeces

Components of the alpaca fleece

The physical attributes of alpaca fleeces vary considerably over the body. During the preparation of alpaca for sale, the fleece is commonly divided into three components:

1. Saddle;
2. Neck;
3. Skirtings.

According to standard industry practice, the skirtings consist of the fibre shorn from the belly, the top of the back legs, the top of the front legs and apron (area between front legs and neck) providing it is free of guard hair (Figure 3).

The site used for taking mid side samples, which is discussed in the next section, is part of the saddle component of the fleece (Figure 3).

Variation in fleece attributes

Australian alpaca fleeces show large differences between the attributes of fibre from the mid side, saddle, neck, and the remainder of the fleece (pieces) and the mean for the entire fleece (Tables 1 and 2, Aylan-Parker and McGregor 2002).

In these alpacas there was significant variation in the mean fibre diameter over the body and this variation was associated with high variation in the coefficient of variation of fibre diameter (CVD).

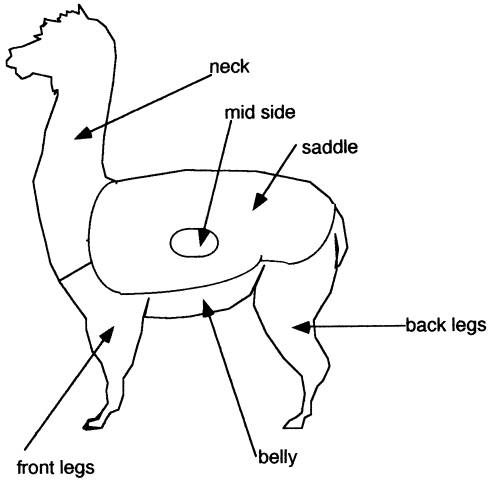

Figure 3. Location of the saddle, neck and fleece components that form the pieces (front legs including apron, belly and back legs) in alpacas and the site for mid side sampling.

Table 1. Variation in attributes of Alpaca fleece measured from mid side samples and fleece component grid samples including mean fibre diameter (MFD) and coefficient of variation of MFD (CVD).

Sampling site	MFD# µm	CVD %	Clean washing yield %
Mid side site	27.5[a]	24.3[a]	90.2[a]
Saddle	28.8[b]	27.0[b]	91.4[b]
Neck	28.7[b]	28.6[b]	88.9[a]
Pieces	37.6[d]	30.6[d]	92.8[b]
Mean entire fleece	31.2[c]	28.1[c]	

 # Within attributes, sampling site values with a different superscript are significantly different.

The fibre from the mid side site was 1.2 µm finer than fibre from the saddle and neck, 3.7 µm finer than the mean for the entire fleece and 10.1 µm finer than fibre from the pieces. Fibre from the saddle was 2.4 µm finer than the mean for the entire fleece and 8.8 µm finer than fibre from the pieces.

There was a large variation in the over the body. The CVD of mid side fibre was 2.7% lower than fibre from the saddle, 3.8% lower than the mean for the entire fleece and 4.3% lower than for neck fibre.

The significantly lower clean washing yield of the mid side and neck compared with that of the saddle and pieces shows that the distribution of dust, dirt and grease content are not equally distributed over the body of alpacas.

Table 2. Variation in medullated fibre attributes of white Alpaca fleece measured from mid side samples and fleece component grid samples.

Sampling site	Incidence by number[#] %	Medullated fibre diameter µm
Mid side site	24.4[a]	32.7[a]
Saddle	33.1[b]	34.4[b]
Pieces	44.5[d]	41.1[d]
Mean entire fleece	35.2[c]	36.0[c]

 # Within attributes, sampling site values with a different superscript are significantly different.

The incidence of medullated fibres at the mid side site was 8.7% less than in the saddle, 10.8% less than the mean of the entire fleece and 20.1% less than in the pieces. Similar differences were seen in the diameter of medullated fibres.

In summary, for each fleece attribute, fibre at the mid side site had lower values than fibre from the saddle and the mean of the total fleece. For each fleece attribute, except for clean washing yield, the saddle had lower values than fibre from the pieces and the mean of the total fleece.

Sampling methods

There are two main methods of fleece sampling available for alpaca breeders: the mid side and the grid sampling methods. Each method has it own advantages and disadvantages.

Mid side sample method

Since 1947, the accepted method for testing sheep wool has been to take a mid side sample (Turner et al. 1953). The mid side sample has been used to test characteristics of importance such as fibre diameter, fibre population, staple length, density of fibres per unit area and staple crimp.

In sheep, the theory behind using a mid side sample is that a mid side sample test result is close to the mean of both the top to underside and the front to rear variation found in a fleece. For this to be true the mid side sample has to be either mini-cored or tested after carding.

If a mid side sample is tested after butt cutting, as is common in the United States of America, then this assumption is incorrect. A butt cut is a fibre sample taken only at the end of the fibre closest to the skin. A butt cut sample does not include any of the along the fibre variation or differences due to position within the fleece.

Location of mid side sample

The site for taking the mid side sample in sheep is located over the third last rib, halfway between the mid-line of the belly and the mid-line of the back (Figure 1).

The mid side site is convenient to use for sampling because it can be easily located during shearing and can even be shorn without removing the entire fleece.

Problems with mid side sampling

In alpacas, if the mid side sample is taken to close to the belly, it may include fibre that is really part of the pieces component. If this happens the test results for mean fibre diameter and other fibre attributes will be seriously over estimated.

The mid side sample mean fibre diameter has been reported in Merinos and Alpacas to actually test finer than the average for the whole fleece. In the study of the Merino wool, this was particularly so for the finer sheep in the population. It was suggested that in Merino sheep this was due to intense selection over the years for finer fleece based on the mid side sample rather than selection for a finer entire fleece (Stadler and Gillies 1994).

While the mid side sample is highly correlated with the mean fibre diameter of wool top (wool processed up to the spinning stage), the mid side sample can be finer and the differences may not be consistent (Fleet et al. 1993). This suggests that the mid side sample may not be a reliable predictive tool for the diameter of top.

Some of these differences may be due to the effect of fibre breakage and subsequent loss during carding and noil removal (combing).

Grid sample method

Grid sampling has been used for more than 20 years. The grid sample includes differences due to position within the fleece and so can detect variations in the fleece that the mid side sample does not detect. For example, Butler et al. (1991) found that processed wool top produced from Merino wool was better predicted by grid sampling than by mid side samples.

Grid sampling is the best method for taking samples from cashmere goats as the mid side sample overestimates the commercial yield of cashmere and underestimates cashmere fibre diameter (McGregor 1994).

Method used for grid sampling

The grid sampling technique involves:

1. laying out the shorn fleece to be tested on a flat surface, ideally on a table measuring about 3 m^2. The fleece needs to laid out evenly.
2. take 16 to 32 random grab samples from the surface of entire fleece. To help this process it is common for breeders to lay a physical grid over the fleece and to take a sample from each grid. A suitable grid can be made from plastic garden trellis mesh with a mesh size of approximately 10 cm x 10 cm. The idea is to take unbiased samples by pulling a tuft of sample from each square in the grid.

Potential benefits of using grid sampling

Grid sampling can be completed while the next alpaca is being shorn or can be undertaken after a fleece has been stored.

Grid sampling avoids the problems found with core sampling of entire fleeces. Core sampling is time consuming but does include variation due to position within the fleece. However core sampling cuts staples in the fleece thus reducing the fibre length.

Sampling and testing variability

If repeat samples are taken from a fleece, differences in the reported test measurement will usually be reported. These differences are related to two main causes.

Variation between samples

Each sample submitted for testing is different. These differences are related to the variation in animal fleeces discussed earlier but in this case are due to sampling variation. Samples are also frequently sub-sampled once or twice and variation also occurs during these processes.

Variation between tests

Variation occurs between tests. This variation can be related to preparation of the sample and the operation of the equipment. Each sample tested by the equipment is different, so some differences in the reported measurement are to be expected. Scientific test laboratories regularly monitor their testing procedures to ensure the reliability of the test results.

Interpreting test results

Alpaca growers need to be aware that each test has an inherent error related to the variability associated with sampling and testing procedures. This measurement error exists even if only one sample is taken and measured.

Some growers have submitted fleece samples to different fibre testing services and expressed criticism at the "difference in results" they receive. Such an outcome is to be expected. But do these "different" results really differ?

Sampling variance in Australian alpaca

By determining the sampling variance, the 95 percent confidence limits can be calculated for a particular sampling and testing procedure. The sampling variance and confidence limits for mid side and saddle grid samples has been measured in Australian alpacas (Table 3, Aylan-Parker and McGregor 2002).

The sampling variance for the alpaca fibre mean diameter attributes are similar to values reported for Merino wool.

Except for clean washing yield, the sampling variance for saddle grid samples was generally 2 to 4 times greater than the sampling variance for mid side samples. As a consequence, for most fleece attributes, the 95% confidence limits for the saddle grid sample were about double those of mid side samples (Table 3).

Table 3. The 95% confidence limits for fibre attributes measured from mid side or saddle grid samples in Australian alpacas.

Attribute	Mid side	Saddle
Mean fibre diameter,	1.6	3.7
Mean fibre diameter CV	2.3	3.6
Incidence medullated fibres, % weight	5.7	19.1
Medullated fibre diameter	2.0	3.8
Clean washing yield	4.1	4.8

Sampling variance for the incidence of medullated fibres in saddle grid samples was very high, possibly due to the difficulty in sampling and measuring these fibres. Contamination of saddle fleece samples with fibres from the pieces and by coloured fibres will also increase the sampling variance of medullated fibres.

Evaluating and undertaking alpaca fibre testing

Use of mid side sample

The mid side sample was found to be an appropriate sample from which to predict the mean fibre diameter and the clean washing yield.

The mid side sample does not measure a large enough area of the fleece to detect sufficient variation in mean fibre diameter coefficient of variation (CVD) or in the incidence of medullated fibres.

Use of the saddle grid sample

Breeders wishing to improve CVD and/or spinning fineness measurements of the alpaca saddle, in the most efficient way, should use the saddle grid sample, since the mid side sample is not as accurate for use in the selection of stock for breeding programs.

Breeders using either mid side samples or saddle grid samples to improve total fleece CVD, will improve neck CVD at the same time with similar effectiveness.

The saddle grid sample was found to be the appropriate sample to predict the incidence of medullated fibres in the entire fleece.

Sampling procedure

The large 95% confidence limits for all the tested fibre attributes indicate that alpaca breeders and advisers need to consider taking suitable duplicate measurements and other precautions during breeding and animal selling programs.

Using the confidence limits

The 95% confidence limits for mean fibre diameter (± 1.6 µm) show that alpaca breeders and advisers need to exercise caution when interpreting absolute fibre test results. This data indicates that breeders cannot confidently distinguish between animal test results where the mean fibre diameter differs by less than 1.6 µm. See examples below.

There is only a 5% chance that two alpacas with the following mid side test results are different:

a) 19.7 µm compared with 21.2 µm

b) 25.9 µm compared with 27.4 µm

Small differences in MFD are unlikely to be valid grounds upon which to discriminate against animals. This interpretation has even greater weight when using saddle grid samples to select animals, as the sampling variance for these samples is at least twice that of mid side test results.

Differences between years and properties

It is not valid to compare the fibre testing results obtained among properties or between years unless special precautions are taken during the collection and analysis of data. Large between year differences in the environment

will affect alpaca fibre attributes (McGregor 2002) and property and year affects can interact (See Figures 2 and 3, McGregor and Butler 2004). Thus during the design of genetic improvement programs, arrangements must be made to account for these influences if serious attempts are to be made at identifying real genetic differences.

Correct fibre classing

It is essential that alpaca fibre be harvested and prepared for sale in accordance with the guidelines laid down by the industry. Correct fleece preparation is needed prior to the taking of saddle grid samples. These guidelines can change from time to time. New guidelines can be obtained from your industry association.

Conclusions

If alpacas are to be selected for characteristics such as low mean fibre diameter and high fleece weight then the mid side sampling site is recommended.

If alpacas are to be selected for low mean fibre diameter coefficient of variation, low incidence of medullated fibres and other characteristics of medullated fibre, then the saddle grid sampling technique is recommended.

Alpaca breeders and advisers need to exercise caution when interpreting absolute fibre test results. Evaluation of fibre attributes among alpacas should take into account the 95% confidence limits of the sampling procedure.

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