A COMPARISON OF METHODS FOR ESTIMATING THE AREA OF CLIPPED WOOL PATCHES ON THE MID-SIDE OF SHEEP

G.J. LEE[AB], R.V. GORDON[AB], J.L. SMITH[AC] and G.C. UPHILL[AC]

[A] Australian Sheep Industry Cooperative Research Centre
[B] NSW Agriculture, Orange Agricultural Institute, Forest Rd, Orange, NSW 2800
[C] CSIRO Livestock Industries, Locked Bag 1, Armidale, NSW 2350

SUMMARY

A study was conducted comparing 3 methods of measuring the skin area of a clipped patch on sheep to determine the most appropriate technique in terms of its precision, repeatability and ease of measurement. The methods were: 1) using callipers to take 3 measurements of both dimensions, 2) tracing the patch outline onto plastic, and 3) photographing the patch with an object of known area. Two clipped patches on the mid-side of 20 weaner sheep at each of 2 geographic locations were measured 2-3 times by each of the 3 methods.

Linear relationships, and high correlations (0.83-0.89), between the patch area estimates by each of the methods indicate consistency between the methods in discriminating relative differences in patch size. The mean patch area was larger (P<0.01) when measured using callipers (21.0 ± 3.2 cm^2) than when estimated by the tracing technique (18.5 ± 2.7) or photography (18.7 ± 2.7), although the overall coefficients of variation (CV) were similar (14.7-15.1%). The between-patch variance was also larger with callipers than tracing or photography, having between-patch CVs of 14.3, 13.6 and 13.9 %, respectively. However, the within-patch CVs of callipers and photography were lower (4.7 and 5.0%) than that for tracing (5.9%). All methods were associated with a high degree of repeatability. Callipers provided the highest level of repeatability (t=0.90), followed by photography (0.88) with tracing the least repeatable (0.84).

Keywords: variance components, wool, mid-side patch measurement

INTRODUCTION

Wool growth on the mid-side has long been used to monitor wool production between periods, both within- and between-animals. To allow for differences between patch sizes, the area of the patch needs to be determined, especially for comparisons between sheep or between patches within sheep. This has usually been calculated using repeated calliper measurements, which is a time and labour consuming process (Short and Chapman 1965). The method is quickest if 3 operators are available to hold the skin within the patch taut, to measure the patch and to record the measurements, respectively.

The time in the field might be reduced if an image of the patch could be created for later determination of its size. At least 2 alternatives to the calliper method that establish an image of the patch are available. Firstly, the outline of the patch could be traced onto a transparent medium. A second alternative is the use of photography to create an image of the patch, while including a reference object of known area (to enable adjustment for variation between images in the relative size of the object in the resulting image). Both alternatives require later calculation of the patch size, but require only 2 operators in the field. The aim of this study was to ascertain a suitably precise method for measuring the area of mid-side patches, with a high repeatability, that minimised the handling and restraint of individual animals.

MATERIALS AND METHODS

Measurement

At each of 2 sites (Murringo and Niangala), 2 patches (each approximately 4-5 cm square) were created by clipping the wool at skin level from the right mid-side of 20 weaner sheep using Oster small animal clippers fitted with a No. 40 cutting assembly. A total of 80 patches were thus created. Two operators were used to measure patch size with each of 3 methods, with operator 1 holding the skin within the patch taut by hand, in order to reduce skin wrinkle, but not to the extent of stretching (Short and Chapman 1965).

Callipers. The length and width of each patch were each measured by operator 2 to the nearest millimetre at 3 locations using callipers, and the mean for each dimension determined prior to calculating the area (Short and Chapman 1965). This procedure was repeated twice more for each patch.

Tracing. Operator 2 traced the outline of each patch with a permanent marker pen (0.7 mm tip) on to a clear plastic film held over the patch by the operator 1. This procedure was repeated once at Murringo and twice at Niangala. The tracings were later photocopied, from which the patch outline was excised and weighed using an analytical balance (0.1 mg). The area of each patch was calculated using the relative weights of the copy of the patch and a reference paper square of known area.

Photography. An opaque plastic reference tile of known area (6.25 cm^2) was placed on the skin within the patch and photographed using a digital camera. This procedure was repeated once at Murringo and twice at Niangala. Two prints of each photograph were later produced from which the prints of the patch and of the reference tile were each excised, respectively, and the weights determined. The patch area was then calculated from the relative weights of the complete patch and the reference tile. One photo for 1 patch at Murringo was unavailable.

Statistical analyses

Individual patches were treated as independent units. The effects of method of measurement on mean patch area were determined by analysis of variance using the least squares methods (REG; Gilmour 1988), and accounting for site and individual patch differences (fitted as a random factor). For each measurement technique, the between-patch (σ_B^2) variance was estimated as:

$$\sigma_B^2 = (MS_b - MS_w)/k$$

where k is the weighted mean number of records per patch, MS_b is the between-patch mean square, and MS_w is the within-patch mean square (σ_W^2). The within-patch repeatability (Turner and Young 1969) was calculated from the between-patch variance and the within-patch variance as:

$$t = \sigma_B^2 / (\sigma_B^2 + \sigma_W^2).$$

RESULTS

Bias

Site, method, and between-patch differences, and the interaction of site and method, had significant effects on the patch area. The area estimated with callipers was larger (P<0.01) than the estimates of either tracing or photography, and these differences were greater at Niangala (Table 1). The correlations (at the between patch level) of the areas estimated using callipers and tracing were 0.86, 0.89 for callipers and photography, and 0.83 for tracing and photography. The relationships of the areas estimated by the different methods were linear.

Table 1. Mean size (cm^2) and variation in size of mid-side patches measured by 3 different methods at Niangala and Murringo.

	Niangala				Murringo				Overall			
	Mean	s.d.	CV	n	Mean	s.d.	CV	n	Mean	s.d.	CV	n
Calliper	21.4	2.8	12.9	120	20.5	3.5	16.9	120	21.0	3.2	15.1	240
Trace	18.5	2.2	11.7	120	18.4	3.4	18.5	80	18.5	2.7	14.7	200
Photo	18.2	2.5	13.5	120	17.9	2.9	16.4	79	18.1	2.7	14.7	199

Precision

Although the overall coefficients of variation (CV) were similar for all techniques (Table 1), the between-patch variance was least in estimates obtained by tracing the patch, compared with photography and callipers (Table 2). Conversely, the within-patch variance was greatest using the tracing method compared with photography and callipers.

Repeatability

All techniques had a high repeatability with that of callipers, being 0.90 compared with 0.88 and 0.84 for photography and tracing, respectively.

Table 2. Components of variance and repeatability for patch size measured by callipers, tracing or

photography.

	df	Sum Square	Mean Square	F-ratio		CV	*t*
Callipers							
Site	1	51.89	51.89	52.95	**		
Between Patch	78	2176.20	27.90	28.47	**	14.3	
Within Patch	160	156.82	0.98			4.7	0.902
k = 3.000							
Tracing							
Site	1	0.34	0.34	0.29			
Between Patch	78	1331.37	17.07	14.14	**	13.6	
Within Patch	120	144.84	1.21			5.9	0.840
k = 2.499							
Photography							
Site	1	4.01	4.01	4.82	*		
Between Patch	78	1293.87	16.59	19.95	**	13.9	
Within Patch	119	98.95	0.83			5.0	0.884
k = 2.486							

*P<0.05; **P<0.01

DISCUSSION

Linear relationships, and high correlations, between the area estimates of each of the methods indicate consistency between the methods in measuring relative differences in size between the patches. Biases were evident between the techniques, with the calliper measurement consistently giving a higher estimate than the other techniques. This would cause estimates of wool production per unit area to be lower than those estimated from areas determined by tracing or photography. However, for comparisons between treatments or animals, the relative differences would not be affected provided the bias is consistent.

A number of factors may have contributed to the biases between treatments. Despite care in clipping the patches, irregularities in patch shape occur and these become evident when the skin is held taut to smooth wrinkles. It might be expected that both the photography and tracing methods are better suited to estimate the area of irregularly shaped patches (including non-linear margins) than measurement of linear dimensions (which assumes the patch is rectangular).

Difficulty in holding the skin within the patch taut, given the low friction coefficient of the plastic film and the wool surrounding the patch, may have contributed to the lower area estimate with the tracing technique, and may also have contributed to the higher within-patch variance for this technique.

Although the overall differences in the precision of the techniques were small, the relative differences in the within- and between-patch components of the variance favoured the calliper and photography techniques. The tracing of the patch had the least between-patch variance indicating this technique had least discrimination between patches. Tracing was also the least precise of the methods as indicated by having the greatest within-patch variance. The precision of photography and tracing is likely to decline if the size of the image that is printed is reduced, as any errors in excising will be proportionately larger.

Although there was a high degree of repeatability between measurements within-patch, the tracing method was at a small disadvantage, having the lowest repeatability. With 2 measurements, the relative precision of the estimate of patch size would be virtually identical for callipers or photography given the values of *t* (Turner and Young 1969), whereas a third measurement would be required to achieve the same relative precision ($\geq$0.94) with tracing the patch.

While callipers were more precise and repeatable, photography appears an acceptable alternative with little loss in precision and a similar repeatability. Photography also requires a shorter period of restraint of the animal and as such would be the quickest of the 3 methods in the field. Both the tracing and photography methods require similar additional assessment of the patch image in the laboratory/office. The time required for the additional assessment with the tracing and photographic methods may be reduced if image analysis was used to assess the relative areas of the resulting images. The time required to complete measurement of the patch area using the calliper method would be reduced if an additional operator were available to record the dimensions, but would still require longer restraint than photography.

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Email: greg.lee@agric.nsw.gov.au