
THE PROCEEDINGS OF THE
NEW ZEALAND SOCIETY
OF
ANIMAL PRODUCTION
VOLUME 62 2002

ISSN 0370-2731/2000 *Proceedings of the New Zealand Society of Animal Production* **60:** 155-158

Effect of sample preparation method on the validity of an early-life predictor of hogget wool bulk in genotypes used to develop GrowBulk sheep

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ABSTRACT

Selection for wool bulk is normally undertaken in yearlings. In this study, a mixed-sex group of 170 GrowBulk sheep were wool sampled at 6 and 12 months of age. Measurements of fibre curvature and fibre diameter following degreasing a wool sample taken at 6 months of age with either water or solvent, explained 69% and 67% respectively of the variation in core bulk at 12 months of age. A combination of fibre curvature and fibre diameter measured following degreasing by either method was equally effective in predicting core bulk at 12 months of age. Precision of the predicted core bulk values was equivalent to direct core bulk measurement. Early-life prediction of core bulk from measurements of fibre curvature and fibre diameter taken close to the skin using consistent sample preparation methods, is a low-cost objective procedure to rank sheep for culling young sheep on wool bulk.

Keywords: wool bulk; fibre curvature; fibre diameter; Romney; Dorset; Texel.

INTRODUCTION

Bulk, a measure of the ability of a fibre mass to resist compaction and fill a space is positively related to end-product performance for many wool products, particularly those produced from Romcross type wool. Increased wool bulk benefits the insulative capacity of knitted garments and the wearability and appearance retention of carpets (Sumner *et al*., 1991). The expression of bulk is strongly inherited and controlled by relatively few genes (Sumner *et al*., 1995; Wuliji *et al*., 1995). Selective breeding can thus be used to change the mean and variation in wool bulk within a flock such as has been undertaken in developing GrowBulk sheep.

GrowBulk sheep were developed by crossing high-wool-bulk Poll Dorset and Texel rams with high-fleece-weight Romney ewes, in association with intensive selection, to produce a specialty genotype with the capacity to produce high-bulk wool with a minimal reduction in fleece weight. Standards adopted by the current breeders of GrowBulk sheep have set a bulk value of 27cm^3/g at hogget shearing as a minimal level for classification as a GrowBulk sheep. For GrowBulk sheep to be widely adopted by industry it is essential that sheep with the potential to produce high-bulk wool as an adult are able to be identified early in life, with reasonable accuracy, for a minimal measurement cost. Culling early in life will enable the culled sheep to be sold before, or close to, their carcass attains an optimal value.

Sumner (1999) reported the pattern of development of fibre and follicle characteristics within a small group of Romney, Dorset cross Romney, Texel cross Romney and (Dorset x Romney) cross (Texel x Romney) hoggets. This paper validates the procedure of predicting wool bulk as a hogget from measurements of fibre curvature and fibre diameter at the base of wool staples of six-month-old sheep using more sheep than Sumner (1999).

MATERIALS AND METHODS

Sampling

An unselected flock of 83 ram hoggets and 87 ewe hoggets born in 1998 at AgResearch, Whatawhata Research Centre were used. The group comprised Romney control (R) and interbred Dorset x R (DR) and DR x (Texel x R) and (Texel x R) x DR (DTR) sheep with approximately equal numbers of each sex in each genotype group (Table 1). Each sex was grazed as a separate group from weaning/lamb shearing in December 1998.

A wool sample, subsequently called the “autumn” sample, was taken from the left midside region of each sheep in April 1999, 15 weeks after the sheep were shorn as lambs at weaning in December 1998. A second wool sample, subsequently called the “spring” sample, was taken from the right midside region of each sheep immediately prior to shearing the rams in August 1999 and the ewes in September 1999. Both wool samples were taken with a shearing handpiece.

Wool measurements

Two approximately 4 g sub-samples were withdrawn from each autumn wool sample. One sub-sample remained greasy while the other was washed in water and detergent (Teric G9) and dried at 105˚C for 3 h. Snippets of less than 2 mm in length were trimmed from the base of several staples of both the greasy and scoured sub-samples. Snippets trimmed from the greasy staples were washed in organic solvent (Pegasol 925) and vacuum dried before measurement. Mean fibre diameter, fibre diameter variation and mean fibre curvature of fibres in the two sets of snippets were measured by OFDA (Edmunds, 1995) after conditioning for 24 h at 65% RH and 20˚C.

Each spring fleece sample was individually washed in water and detergent (Teric G9), dried at 105˚C for 3 h, conditioned for 24 h at 65% RH and 20˚C and a cored (15 mm diameter) sub-sample taken. Core bulk of the cored sub-sample was measured by automated bulkometer (Standards Association of New Zealand, 1994). The cored sub-sample was further sampled by a mini-corer (2 mm diameter) and mean fibre diameter, fibre diameter variation and mean fibre curvature fibre in the mini-cored sample measured by OFDA (Edmunds, 1995).

Statistical analysis

Individual measurements were analysed by least-square regression analysis, fitting effects of sex, and genotype. The proportion of variation in core bulk explained by the measured characteristics was assessed by multiple regression using GENSTAT (Lawes Agricultural Trust, 1993). Linear combinations of measured fibre curvature and fibre diameter of the autumn wool samples were used to generate predictive models for measured core bulk at the spring shearing and compared with prediction estimates derived from the spring samples themselves.

RESULTS

Sex and grazing management were confounded as each sex was grazed separately. Thus, although the sex effect cannot be directly interpreted, a sex and a sex x genotype effect were inserted into all analyses to reduce the error variance for testing other effects. The sex x genotype interaction term was not significant for any of the measured characteristics.

Least-square means for each of the measured characteristics are given in Table 1. The R group had a significantly lower core bulk and a lower fibre curvature then either the DR or DTR groups, which were not different. There was no significant difference between genotypes for either mean fibre diameter or fibre diameter standard deviation at either occasion.

Autumn samples washed with water had a higher fibre curvature and were less variable in fibre diameter than autumn samples washed in solvent. The method of washing did not significantly affect mean fibre diameter. Correlation coefficients between individual measurements of the autumn samples washed by water or solvent were 0.94, 0.92 and 0.92 for fibre curvature, mean fibre diameter and fibre diameter variation respectively.

The proportion of variation in core bulk of the spring sample explained by each of the measured characteristics individually and a combination of fibre curvature and fibre diameter at each sampling, and the residual mean square are given in Table 2. There was no significant increase in explained variation following the inclusion of fibre diameter standard deviation in the combined relationship at any occasion.

The estimated slopes and constant for the relationship between core bulk and a combination of fibre curvature and fibre diameter for the autumn and spring samples are given in Table 3. It was not possible to give a formal hypothesis test as to whether the two lines derived from the autumn sample were similar because the value for core bulk of the spring sample was common to both prediction lines. This commonality of the Y value results in a complex correlation structure between the respective variates. However as both the slopes and the intercept for each equation were within the 95% confidence limits of the other equation, it may be concluded that the prediction equations associated with the two washing methods do not differ. The slopes and intercept for the water washed autumn sample were, however, equal to, or outside of, the confidence limits derived from the water-washed spring data. Notwithstanding this, the overall predictability of the respective equations is very high.

The relative effectiveness of the derived prediction equations when applied to a sheep culling situation can be gauged from a plot of predicted bulk derived from the autumn sample washed in water versus the same sample washed in solvent (Figure 1). The status of each individual sheep whether it should be retained or culled based on its measured wool bulk at the spring shearing is indicated by the symbol used. Numbers of sheep retained in error or culled in error through the use of the respective prediction methods are indicated in Table 4. The number of sheep incorrectly classified on the basis of a predicted bulk value was less than 5% of the flock in each case. On the other hand, the difference between the predicted and measured core bulk values for each of the incorrectly classified sheep was within the confidence limits of the bulkometer at ± 7% of the measurement (Edmunds and Sumner, 1996). The impact of these incorrectly classified sheep, all of which had bulk values close to 27 cm^3/g, would not significantly affect the overall genetic merit of the retained sheep.

TABLE 1: Least square means of measured characteristics. R = Romney, DR = Dorset x R, DTR = DR x (Texel x R) and (Texel x R) x DR.

Characteristic	R	DR	DTR	SED[1]	Signif.
Number of sheep	9	61	100		
Autumn sample					
Water wash					
Fibre curvature (°/mm)	42.1	63.0	62.2	4.3	***
Fibre diameter (mean) (mm)	29.3	30.3	29.8	1.2	NS
Fibre diameter (SD) (mm)	6.6	6.5	6.4	0.4	NS
Solvent wash					
Fibre curvature (°/mm)	40.7	59.4	58.6	4.0	***
Fibre diameter (mean) (mm)	30.6	30.6	30.5	1.1	NS
Fibre diameter (SD) (mm)	7.1	6.9	6.8	0.4	NS
Spring sample					
Core bulk (cm^3/g)	25.3	29.7	29.4	0.9	***
Fibre curvature (°/mm)	59.8	74.4	73.3	3.5	***
Fibre diameter (mean) (mm)	29.1	29.6	29.6	0.8	NS
Fibre diameter (SD) (mm)	6.9	6.7	6.6	0.3	NS

[1] Standard error of difference.

TABLE 2: Proportion of variation in core bulk in the spring (hogget fleece) sample explained by individual measured characteristics at each sampling and a combination of fibre curvature and mean fibre diameter. Mean residual standard deviation for core bulk remaining is included.

Characteristic	Proportion of variation explained (%)	Residual standard deviation (cm^3/g)
Autumn sample		
Water wash		
Fibre curvature	53.0	1.7
Fibre diameter (mean)	2.2	2.4
Fibre diameter (SD)	0.0	2.4
Fibre curvature + mean fibre diameter	68.8	1.4
Solvent wash		
Fibre curvature	58.1	1.6
Fibre diameter (mean)	0.2	2.4
Fibre diameter (SD)	0.0	2.4
Fibre curvature + mean fibre diameter	65.8	1.4
Spring sample		
Fibre curvature	53.9	1.6
Fibre diameter (mean)	1.1	2.4
Fibre diameter (SD)	0.0	2.4
Fibre curvature + mean fibre diameter	66.8	1.4

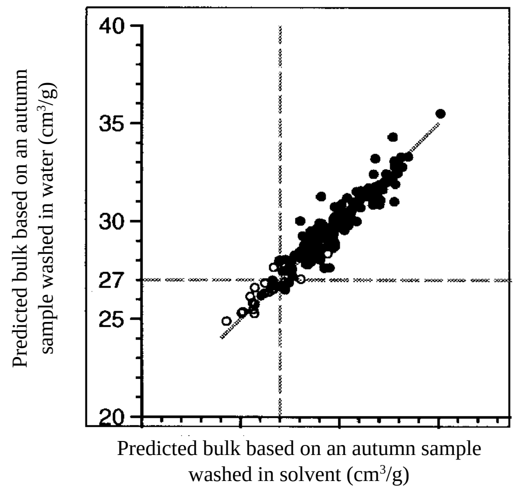
TABLE 3: Individual constants ±SE and slopes ±SE for the relationship between core bulk and a combination of fibre curvature and fibre diameter for the autumn (both wash methods) and spring (water washed) samples for the model combining fibre curvature and fibre diameter.

Sample	Coefficient		Constant
	Fibre curvature	Fibre diameter	
Autumn			
Water wash	+0.16 ± 0.01	+0.33 ± 0.04	+9.5 ± 1.3
Solvent wash	+0.17 ± 0.01	+0.25 ± 0.04	+11.8 ± 1.5
Spring			
Water wash	+0.20 ± 0.01	+0.42 ± 0.05	+2.1 ± 2.0

TABLE 4: Number of sheep retained in error or culled in error relative to their measured spring (hogget) core bulk if they had been culled on the basis of predicted bulk estimated from a sample taken in the autumn and either washed in waster or solvent. Number of sheep retained on measured bulk = 148, number culled on measured bulk = 22. A 5% error in judgement is equivalent to 8.5 sheep.

Status	Total based on predictions using water wash data	Total based on predictions using solvent wash data	Common to predictions based on both water and solvent wash data
Retained in error	8	7	6
Culled in error	5	6	4

FIGURE 1: Plot of predicted bulk derived from an autumn sample washed in water versus an autumn sample washed in solvent. Dotted line equals GrowBulk threshold value of $27cm^3/g$ measured in the spring sample. Solid line equals line of perfect agreement. Solid symbols indicate sheep whose measured core bulk was $\geq 27cm^3/g$ at the spring (hogget) shearing and open symbols indicate sheep whose measured core bulk was $<27cm^3/g$ at the spring (hogget) shearing.



DISCUSSION

Although this trial reports measurements for similar genotypes to those reported by Sumner (1999), considerably more sheep were sampled and measured in a different year to obtain this data set. Results between the two trials show excellent agreement.

As no significant genotype effects were again evidenced in this trial, data derived from the control group of Romney sheep were included with that from the GrowBulk sheep to extend the variation in core bulk on which to base culling decisions to evaluate the effectiveness of the prediction equations.

IWTO standard test methods for measuring fibre diameter by either OFDA (IWTO, 1998) or Laserscan (IWTO, 1995) specify that the samples be degreased before measurement by washing in water. Hence, all International Accreditation New Zealand-(IANZ) accredited test houses are equipped for water washing of their test specimens. Sets of previously measured standard samples are also available from IWTO to check the calibration of individual instruments used to measure fibre diameter. As yet no standard method for measuring fibre curvature has been accepted by the wool industry and no calibration samples for fibre curvature are available. Industry requirements dictate a quick turnaround of samples within the test house necessitating the sample be dried as quickly as possible at as low a temperature as possible to minimise dimensional or chemical changes to the fibre. A. R. Edmunds (personal communication), in support of common observations, has shown, using an OFDA, that fibre curvature increased with increasing temperature of drying after washing in water. Solvent-scoured samples, on the other hand, can be dried effectively at a lower temperature with a reduced likelihood of the drying temperature affecting fibre curvature. These results have, however, shown the method of washing *per se* has not affected the relationship of fibre curvature and fibre diameter with core bulk. Nevertheless, calculation of a “universal” prediction equation must await development of a standard method for fibre curvature measurement to complement the standard method in use for fibre diameter.

Although the two prediction equations derived from the two washing methods could not be shown to differ in ranking samples with respect to their predicted wool bulk, a combined equation is technically impractical because of the commonality of the Y value for the two relationships. Instead an appropriate equation relating to the specific washing method used should be employed when estimating actual predicted bulk values.

Shearing can influence voluntary feed intake for up to 6 weeks post-shearing and, therefore, also potentially influence the dimensional characteristics of that part of the staple grown over that period (Sumner and Bigham, 1993). Until the potential effect can be quantified, it would be advisable to allow a period of approximately 6 weeks between lamb shearing and sampling for predicting wool bulk at a later shearing.

Efficient use of available pasture dictates that only replacement stock entering the flock be farmed through the winter when feed supplies are limited and that all surplus stock be culled during the preceding autumn. To assist wool growers producing high-bulk wool, these results have further confirmed the use of predictive relationships combining fibre curvature and fibre diameter as a low-cost objective procedure to rank sheep for core bulk as a hogget, using wool samples taken during the preceding autumn. The method of degreasing the wool sample prior to measurement has an insignificant effect on the ranking of samples with respect to their predicted wool bulk. In addition culling decisions based on predicted bulk values have an acceptable precision equivalent to direct core bulk measurement at hogget shearing.

ACKNOWLEDGEMENTS

To Peter Evans for management of the sheep and Shane Hill and Alf Richards for sample collection at Whatawhata Research Centre; Paul Turner for fibre metrology; and Catherine Cameron for statistical analysis. The work was jointly funded by the Foundation for Research, Science and Technology and WoolPro.

REFERENCES

Edmunds, A.R. 1995. OFDA measurement of additional fibre parameters; some preliminary results. International Wool Textile Organisation Technical Committee. Report Number 19, June 1995.

Edmunds, A.R and Sumner, R.M.W. 1996. Further data on the use of OFDA for estimating raw wool core bulk. International Wool Textile Organisation Technical Committee. Report Number 7, December 1996.

IWTO, 1995. Specification IWTO-12-95. Measurement of the distribution and mean fibre diameter using the Sirolan-Laserscan fibre diameter analyser. International Wool Secretariat, London.

IWTO, 1998. Specification IWTO-47-98. Measurement of the mean and distribution of fibre diameter using an optical fibre diameter analyser (OFDA). International Wool Secretariat, London.

Lawes, Agricultural Trust, 1993. GENSTAT 5, Release 3. Reference Manual, Rothamsted Experimental Station, Harpenden, Clarendon Press, Oxford. pp796.

Standards Association of New Zealand 1994. Measurement of the bulk of raw wool. NZS 8716: 1994.

Sumner, R.M.W. 1999. Development of fibre and follicle characteristics related to wool bulk in hoggets of genotypes used to develop GrowBulk sheep. *Proceedings of the New Zealand Society of Animal Production* **59**: 39-42.

Sumner, R.M.W. and Bigham, M.L. 1993. Biology of fibre growth and possible genetic and non-genetic means of influencing fibre growth in sheep and goats–a review. *Livestock Production Science* **33**: 1-29.

Sumner, R.M.W., Clarke, J.N. and Cullen, N.G. 1995. Responses to selection for and against loose wool bulk and the associated effect on clean fleece weight and objective fleece characteristics in yearling Perendale and Cheviot sheep. Proceedings of 9th International Wool Textile Research Conference, Biella, Italy. **IV**: 3-10.

Sumner, R.M.W., Maddever, D.C. and Clarke, J.N. 1991. Effect of selecting Perendale hoggets for loose wool bulk on fleece characteristics and wool end-product performance. *Proceedings of the New Zealand Society of Animal Production* **51**: 347-351.

Wuliji, T., Montgomery, G.M., Dodds, K.G. Andrews, R.N., Beattie, A.E., Turner, P.R. and Rogers, J. 1995. Establishing a flock for gene mapping in wool traits. *Proceedings of the New Zealand Society of Animal Production* **55**: 285-288.