

Predicting Hauteur from the Fibre-diameter Profiles of the OFDA2000

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Summary

This paper describes the refinement of a prediction system to estimate the hauteur of 287 individual sale lots gathered from many parts of Australia and processed at CSIRO Textile and Fibre Technology, Geelong, Victoria.

The fibre-diameter profile of greasy staples was measured using the OFDA2000 in a laboratory. Using information only derived from the fibre-diameter profile, a multiple regression was developed that predicted the hauteur of the sale lots. The multiple regression explained 72% of the variation in actual hauteur while the TEAM equation explained 68% of the variation in hauteur.

The hauteur prediction equation was validated on a separate set of 144 mini-processing consignments with known fibre-diameter profiles measured by the OFDA2000. The hauteur prediction equation explained 82% of the variation in actual hauteur of these consignments.

The results confirm that measurements from the fibre-diameter profile of a sale lot can be used to predict the hauteur of the lot after processing to top. As a result, it is possible to predict the two most important parameters of top (mean fibre diameter and hauteur) before the wool leaves the shearing shed. Furthermore, wool producers may find it easier to manage for fibre diameter and hauteur by manipulating the fibre-diameter profile through sheep management.

Introduction

On-farm fibre testing has become widely adopted in Australia as a sheep selection tool and method for differentiating lots, primarily using mean fibre diameter (MFD). One fibre testing instrument, the OFDA2000 (Brims *et al.* 1999), is able to measure the change in fibre diameter along the length of the staple, and this measurement is known as the fibre-diameter profile. Previous research (Peterson *et al.* 1998; Peterson *et al.* 2000) has shown that the fibre-diameter profile influences staple strength and the position of break in the staple. Furthermore, a simple model was developed that could account for 75% of the variation in actual hauteur of 54 mini-processing consignments using the measurements from fibre-diameter profiles (Peterson and Oldham 2000). The model was able to explain more of the variance in hauteur than the TEAM equation (TEAM 1988). The TEAM equation uses standard raw-wool measurements of sale lots to predict the hauteur, or mean fibre length, of commercial tops produced from them. The TEAM equation is generally accepted as the best starting point for specifying the expected hauteur in raw-wool purchases.

Fibre-diameter profile can be easily measured on lines of wool on-farm, so there is scope to predict the hauteur of wool before it leaves the farm. There may be marketing advantages, as well as cost savings, if the predicted hauteur of lots is known before they are transported from the shearing shed. This paper investigates the development and verification of a hauteur prediction model for sale lots using the fibre-diameter profile measurements of the OFDA2000.

Materials and Methods

Initial Sale Lots

Processing lots consisted of either grab samples from sale lots, composite samples from a range of fleeces or groups of entire fleeces. Each lot was processed at CSIRO's mini-mill designed for preparation of miniature lots through to top. A total of 287 lots were processed to tops ranging in size from 100g to 127kg (average 2.35kg). The average and range in wool properties of these processing lots are shown in Table 1.

Table 1. The mean, range and standard deviation of various wool properties for 287 processing lots used to generate the profile prediction equation and 144 processing lots used to validate the profile prediction equation. The Laserscan has been used for top measurements.

	VM (%)	SL (mm)	SS (N/ktex)	Top MFD (mm)	Top CvD (%)	Top Curve (deg/mm)	Hauteur (mm)	CvH (%)	Team H (mm)	Noil (%)
Fitted model data set (n=287)										
Mean	1.2	89	34	20.5	21.3	75	71	46	72	6.2
Max	11.6	126	63	25.4	26.9	132	94	63	103	18.9
Min	0.0	57	15	15.1	16.1	56	49	26	52	0.0
Stdev	1.9	13.6	8.2	2.2	1.9	10.3	10.3	7.6	9.6	2.8
Validation data set (n=144)										
Mean	0.8	91.2	32.4	20.6	21.8	76	72	49	68.3	5.8
Max	1.5	104.6	44.3	24.1	27.2	95	85	60	77.2	16.3
Min	0.4	73.6	15.1	16.2	17.9	64	52	30	48.8	2.5
Stdev	0.3	5.3	6.6	1.8	1.7	6.0	6.9	7.0	4.6	2.3

Validation Consignments

The hauteur prediction equation was validated on 144 consignments/lots that were processed at CSIRO as part of several WA Department of Agriculture experiments (Table 1). The lots were all processed using similar carding, gilling and combing settings. The average size of processing lots was 30kg greasy. For 56 processing consignments, 10 greasy staples were measured on the OFDA2000 per sale lot (10 to 11 sale lots per consignment) equating to over 100 staple profiles measured per processing consignment. For the remaining processing lots, 30 staples were measured per processing lot.

Measurements

A grab sample from each sale lot was cored (IWTO-47) and measured for mean fibre diameter using the Laserscan (IWTO-12). Staples were drawn from the grab sample as per IWTO-38-98 for measurement of staple length, strength and proportion of mid-breaks. A small 50g keeper sample from each processing lot was used to select 20 staples for OFDA2000 measurement. The diameter profiles of the 20 greasy staples per keeper sample were measured using the OFDA2000 in a laboratory at 20°C and 65% RH. A grease correction factor of 1.7µm was used for all measurements.

Analysis

Every fibre-diameter profile was reduced to 15 measurements along the staple. This was done by selecting every n th profile segment using the calculation n th segment = integer (total number of segments ÷ 15). For example, a profile with 20 segments (20 x 5mm) would miss out diameter values from segments 3, 7, 11, 15 and 19. The 20 profiles from each lot were then combined to one average diameter profile for the lot. The MFD and staple length for the 20 staples were also calculated for each lot. An algorithm identical to that described by Peterson and Oldham (2000) was applied to each average fibre-diameter profile per lot to calculate a value (Model2 value). Described briefly, the Model2 value was calculated by determining the proportion of all possible fibre lengths after breaking fibres at two points along the fibre-diameter profile. The fibre diameter and position of the break points were used to determine the probability of fibre breakage. The Model2 value, combined with MFD and break position, was used in a multiple regression equation to explain the actual hauteur of the processing lot.

The MFD was calculated from the 15 diameter measurements along the staple profile. The break position value was calculated according to the segment, or position, on which the minimum diameter was located. The value was calculating according to the following Microsoft Excel equation:

$$\text{BreakPos} = 0.5333 - (\text{ABS}(\text{position of minimum diameter} - 8) * 0.0666)$$

The position of the minimum diameter was a value between 1 and 15 and corresponds to the segment of the diameter profile that has the lowest fibre diameter.

Results

A multiple regression including the terms MFD, break position, and Model2 value explained 71.6% of the variation in the actual hauteur of 287 processing lots. In the same data set, the TEAM equation explained 68.3% of the variation in actual hauteur. There was a systematic decrease in the difference between predicted and actual

hauteur values with increasing hauteur (Figure 1). The profile prediction equation explained 84.3% of the variation in hauteur on the validation data set (n = 144). The 95% confidence limits of predicting hauteur was $\pm 5.5\text{mm}$ for the validation processing lots. There was no change in the difference between predicted and actual hauteur with increasing hauteur (Figure 2). The TEAM equation explained 45.4% of the variation in hauteur for the validation processing lots.

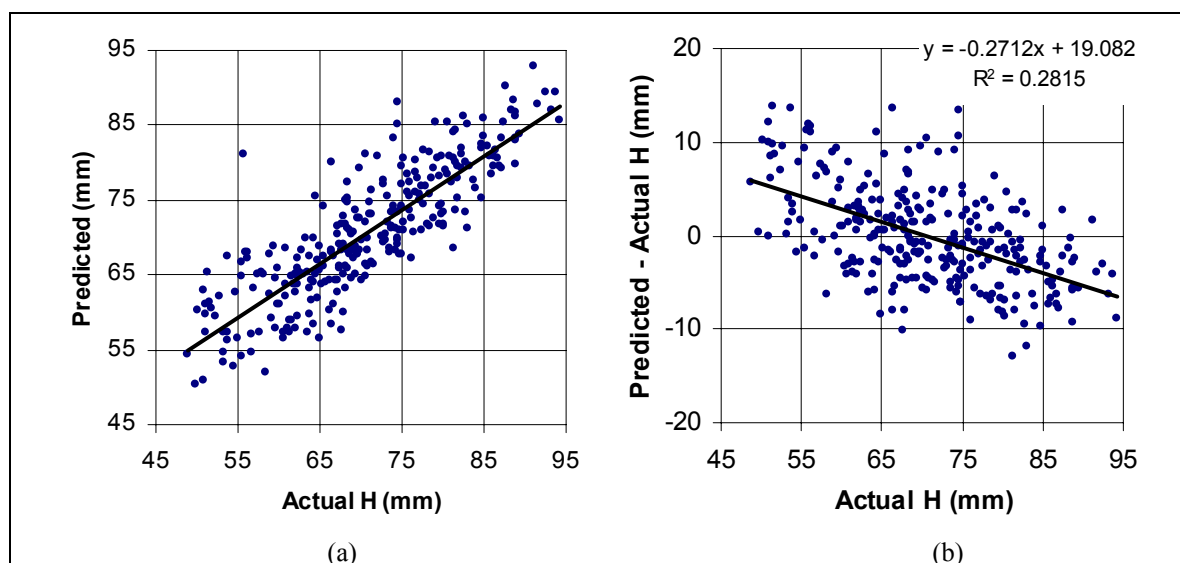


Figure 1. The relationship between (a) actual and predicted hauteur and (b) actual hauteur and the difference between actual and predicted hauteur for 287 processing lots.

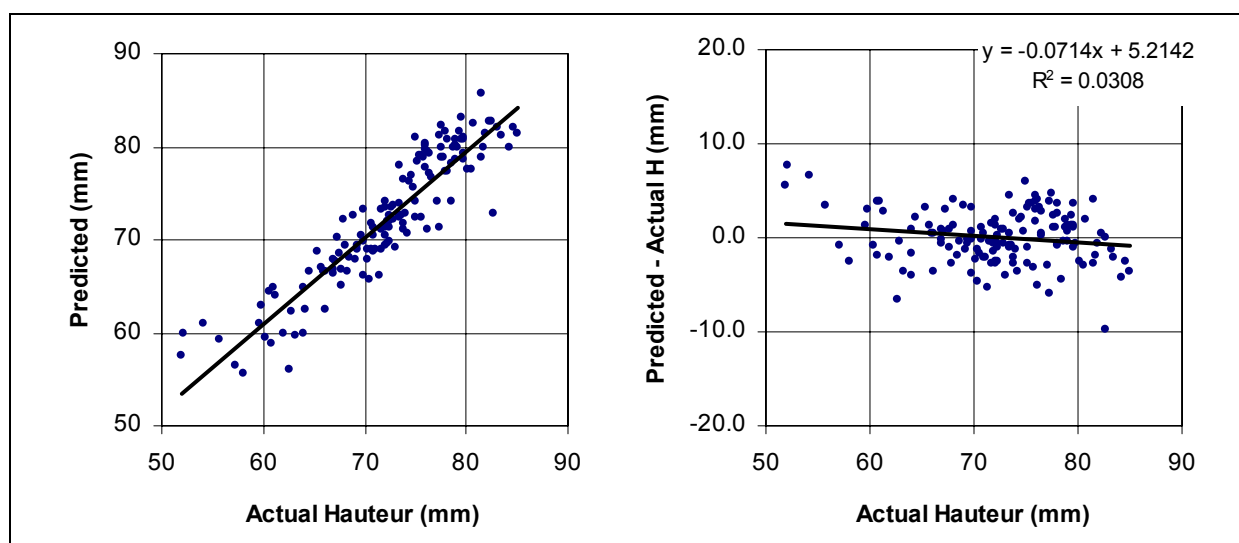


Figure 3. The relationship between actual hauteur and the difference between actual and predicted hauteur for 144 processing lots used to validate the hauteur prediction equation.

The hauteur prediction equation was:

$$\text{Hauteur} = 1.4062 (0.0857) \text{ Model2} + 1.73 (0.18) \text{ MFD} - 14.77 (2.21) \text{ BreakPos} - 0.08 (3.79)$$

(n = 287; $r^2 = 71.6$; s.e. = 5.47). Figures in brackets are standard errors.

Term	Correlation with hauteur (r)	Significance	Stepwise correlation (r^2) with hauteur
Model2	0.73	P<0.001	0.53
MFD	0.64	P<0.001	0.67
BreakPos	-0.40	P<0.001	0.72

Discussion

This paper supports earlier research that has shown that hauteur can be predicted using only the fibre-diameter profile measurement of greasy staples. The range and types of wool used in the generation of the prediction equation were much greater than the data set used by Peterson and Oldham (2000). The range in processed lots was similar to those used to generate the TEAM equation from processing consignments (TEAM 1988). A better relationship between predicted and actual hauteur when the hauteur prediction equation was validated is probably explained by the greater number of staples measured by the OFDA2000 per processing lot. Results indicate that hauteur can be estimated for both single sale lots and for commercial consignments consisting of many sale lots.

While, for both data sets, the hauteur prediction equation performed better than the TEAM equation, there is still insufficient evidence to suggest that the TEAM equation should be replaced. The prime reason for developing the TEAM equation was to provide wool buyers and topmakers with a simple equation for predicting processing performance of consignments. Since 1988, the TEAM equation has been widely adopted by the topmaking sector. However, with the advent of on-farm fibre testing, there is now a desire to predict processing performance before the wool leaves the farm. This would preferably require a technique that uses on-farm fibre measurement to predict the processing performance of a sale lot. Furthermore, there has been minimal success in attempts to predict several terms used in the TEAM equation (staple strength and proportion of mid-breaks) for sale lots. The hauteur prediction equation has advantages over the TEAM equation because it enables producers to grow wool to a pre-determined diameter and hauteur specification. The fibre-diameter profile can be measured at shearing and monitored throughout the year (Oldham *et al.* 2002). As a result, the fibre-diameter profile can be managed so that a diameter and hauteur target can be reached (House *et al.* 2002). This would be particularly advantageous when wool would be sold directly to a processor. Software has now been developed by the WA Department of Agriculture that allows growers to determine effects on predicted hauteur when the shape of the fibre-diameter profile is altered by grazing management.

The hauteur prediction equation is based on sampling grab samples and not individual staples from a sample site of the fleece. While the mid-side sample is generally the best representative sample site for fleece diameter and staple length (Turner 1956), corrections may need to be made to the prediction when measuring the staples of every fleece, as is the normal practice with routine OFDA2000 fibre testing. Furthermore, good tracking is required of fleeces to their ultimate bale lines if a meaningful estimate of hauteur is to be calculated for the sale lot.

There is still a requirement for equations that predict romaine and coefficient of variation of hauteur using on-farm wool measurements. The TEAM equation already predicts these parameters for processing consignments using sale-lot measurements. Further research is being conducted that utilises the fibre-diameter profile and other fibre measurements being delivered by current on-farm testing equipment to predict the important properties of wool top.

Acknowledgments

We would like to thank Dr Bill Humphries and Dr Peter Lamb (CSIRO) for providing keeper samples from lots processed at Textile and Fibre Technology, Geelong.

References

- Brims, M.A., Peterson, A.D. and Gherardi, S.G. (1999). *IWTO Meeting*, June, South Africa.
- House, R., Bilney, R., Ladyman, D., Oldham, C.M. and Yelland, M. (2002). *Proc. Aust. Soc. Anim. Prod.* **24**: (in press).
- Peterson, A.D., Gherardi, S.G. and Doyle, P.T. (1998). *Aust. J. Agric. Res.* **49**: 1181–6.
- Peterson, A.D., Greeff, J.C., Oldham, C.M., Masters, D.G. and Gherardi, S.G. (2000). *Proc. Asian. Aust. Anim. Prod.* **23**.
- Peterson, A.D. and Oldham, C.M. (2000). *10th Int. Wool Tex. Res. Conf.*, Aachen.
- Oldham, C.M., Gherardi, S.G., Paganoni, B.R. and Yelland, M.R. (2002). *Proc. Aust. Soc. Anim. Prod.* **24**: (in press).
- TEAM (1988) Australian Wool Corporation, Melbourne.
- Turner, H.N. (1956). *Animal Breeding Abstracts* **24**(2) 87–110.