Do objective measurements or subjective assessments explain more of the variation in strong wool auction prices?

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ABSTRACT

Auction prices of a total of 74,134 lots of wool in the strong wool segment of the New Zealand wool clip sold between 1 July 2005 and 30 June 2007, were analysed by multiple regression analysis to estimate the proportion of variation in wool price explained by four objectively measured characteristics and by subjective assessments of length and colour with up to five additional codes. The objective characteristics were vegetable matter content, mean fibre diameter CIE Y (brightness), and CIE Y-Z (yellowness). Changes in the New Zealand dollar exchange rate were adjusted for by covariance against the exchange rate of the US dollar on the day of the auction. The residual standard deviation for the objectively measured characteristics was 22.2 c/kg clean, explaining 80.2% of the variation in price. In contrast, the residual standard deviation for the subjectively assessed codes identifying "outlier" lots in terms of characteristics deemed to be important by scourers and processors was 21.4 c/kg clean, explaining 81.6% of the variation in the auction price. It will thus benefit wool growers to prepare their wool such that lots conform to the recommended best practice guidelines rather than for them to conform solely to objective specifications.

Keywords: strong wool; objective measurements, subjective assessments, wool auction price.

INTRODUCTION

Traditionally wool has been subjectively assessed by merchants, scourers and processors using hand and eye appraisal to establish suitability for a particular use. The potential end-use is in turn related to the price received by the grower. To provide a degree of standardisation and quality control throughout the "wool pipeline" between the farm and the processor, a series of objective measurement procedures have been approved in recent years by the International Wool Textile Organisation (IWTO) to measure a range of characteristics of processing importance. These include yield and vegetable matter contamination (IWTO-19), mean fibre diameter (IWTO-12; IWTO-28; IWTO-47), staple length and strength of Merino wool (IWTO-30), yellowness and brightness (IWTO-56), wool bulk (NZS-8716), degree of medullation (IWTO-57) and presence of pigmented fibres in partially processed wool (IWTO-13). Undertaking the full range of available tests for individual lots of strong wool is seldom justified.

Past research has shown that the processing performance of coarse wool destined for use in carpets, can be predicted with knowledge of mean fibre diameter, mean fibre length after carding, intensity of yellowing, brightness, wool bulk and vegetable matter contamination (Carnaby *et al*., 1983).

Objective measurements of brightness, yellowness, vegetable matter contamination and mean fibre diameter are all relatively robust, with measurements of these characteristics routinely available for all lots of wool sold at auction in New Zealand. Objective measurements of staple length and strength, bulk and degree of medullation, are not in routine use. Instead these characteristics are subjectively assessed.

Records of objective measurements, a subjective description and the price of each lot of wool sold at auction are stored in an industry data base. The research question addressed in this paper is whether auction prices of individual lots of wool are better explained by a series of "average" objective measurements or a subjective description with identification of "outlier" lots?

MATERIALS AND METHODS

Samples for evaluation

Subsamples of wool are routinely drawn by both a corebore and a mechanical set of jaws thrust into a predetermined number of bales (IWTO-38) in each lot of wool offered for sale by auction. In the case of strong wool, the core samples are used for objective measurement of wool base and vegetable matter contamination, mean fibre diameter, CIE Y (brightness) and CIE Y-Z (yellowness). Wool base is the oven-dry weight of wool fibre in a sample free from all impurities of moisture grease, dirt and vegetable matter. It is expressed as a percentage of the greasy weight of the analysed sample and used to calculate commercial yields and hence the clean price. Measurements of these characteristics are printed in the sale catalogue while the grab sample is displayed in a "sample box" for prospective

TABLE 1: A descriptive summary of the subjectively assessed characteristics considered in deriving a Wool Services International Ltd. valuing code (Wool Services Internal Ltd., Personal Communication).

Component	Description
Category	A code related to a breed with extreme characteristics (such as Down or Drysdale), age of sheep (such as Lambs), position on the body from which the wool was harvested (such as Fleece, Belly or Crutchings), or wool type indicating a severe fault (such as Cott or Stain). (33 classes).
Colour	A category based assessment (1–5 or 0–6) of the degree of unscourable discolouration present. Tied to CIE Y-Z standard values. Emphasis is placed on the presence of small pieces of heavily discoloured wool in a sample with little background discolouration.
Length	A subjectively based assessment of staple length considering fibre length range and an assessment of the degree and position of an area of tensile weakness along the staple. Referred to as assessed barbe length. (22 classes).
Descriptor	A graded comment (1–4 or 1–6) of the presence of up to three characteristics considered to be of processing significance. (25 classes). These encompass: unscourable stain or pigmented fibres; unsatisfactory preparation with mixed diameter, mixed length or containing visible amounts of oddments and/or stains; visible amounts of vegetable matter of different types; fibres tangled to varying degrees; bulky for type; lustrous for type and medullated for type.

buyers to value immediately prior to the auction. The lots are also assessed by a suitably qualified member of Wool Services International Ltd. (WSI), a major scourer and exporter of the New Zealand clip, with the WSI valuing code data stored in the wool industry database for statistical purposes.

Wool industry database

Data describing each lot of strong wool sold at auction between 1 July 2005 and 30 June 2007 were extracted from the New Zealand wool industry data base. Strong wool is defined as wool shorn from adult sheep that is coarser than 32 μm and wool shorn from lambs that is coarser than 27 μm, where the lambs do not contain any Merino blood. These lots comprised approximately 85% of the wool sold by auction over this period.

The data included the objective measurements of mean fibre diameter, CIE Y, CIE Y-Z and vegetable matter contamination, plus the WSI valuing code and the auction price expressed on a clean fibre weight basis (c/kg clean). Components included in the valuing code are summarised in Table 1. The various characteristics included in the valuing code are all attributes deemed by the practical experience of scourers and processors to be of importance in wool processing. Barbe length is defined as the weight biased mean of fibre length after carding. As such it is a continuous rather than a categorical subjective measure.

The objective measurement procedures were all undertaken by an IWTO-licenced, industry approved wool test house. Estimates of the schlumberger dry combing yield, which approximates the washing yield obtained with scouring, and vegetable matter content, were calculated from the wool base measurement (IWTO-19).

Wool type classification

To take account of the potential different end-uses of different wool types within the strong segment, each lot was allocated a type classification according to the following criteria, namely

- Adult fleece; being body wool derived from adult sheep.
- Adult oddments; being oddments derived from adult sheep.
- Lamb fleece; being body wool derived from lambs.
- Lamb oddments; being oddments derived from lambs.

Data for 1,658 lots of "off-type" wool that did not fit these four main classifications were not analysed.

The extent of unscourable discolourations, particularly yellow discolouration, was an important consideration in this study. When measured objectively there can be a potential interaction between pigmentation, medullation and measured brightness and yellowness. As a consequence lots recorded as having either a Down type category code (n = 2,355), which indicated that they potentially contained a high proportion of pigmented fibre, or a Drysdale type category code (n = 80), which indicated they were heavily medullated, were rejected from the analysis.

Statistical analysis

With the bulk of the New Zealand wool clip traded in US dollars the exchange rate between the NZ dollar and the US dollar was used to adjust for currency fluctuations.

TABLE 2: Mean ± standard deviation and pooled standard error of difference (SED) for the routinely measured objective characteristics and the subjective assessment of colour for the analysed lots of strong wool recorded in the wool industry auction database for sales between 1 July 2005 and 30 June 2007. Colour grade is 0 – 6 for fleece wool and 1 – 5 for most oddment types.

Characteristic	Wool type classification				Pooled SED	Significance of difference between types
	Adult		Lamb			
	Fleece	Oddments	Fleece	Oddments		
Barbe length (mm)	95 ± 18	72 ± 19	76 ± 16	55 ± 11	13	<0.001
Mean fibre diameter (μm)	36.6 ± 2.6	36.2 ± 2.5	30.2 ± 1.6	29.2 ± 1.4	2.0	0.022
CIE Y value	63.6 ± 2.4	56.8 ± 4.2	66.0 ± 2.0	59.0 ± 3.4	2.7	0.098
CIE Y-Z value	2.6 ± 2.0	6.8 ± 2.7	1.1 ± 1.3	5.3 ± 2.0	1.9	0.105
Vegetable matter contamination (%)	0.14 ± 0.18	0.21 ± 0.26	0.11 ± 0.15	0.21 ± 0.29	0.05	0.114
Colour grade	0.7 ± 1.2	2.4 ± 1.0	0.7 ± 0.9	2.8 ± 1.1	5.2	0.050

TABLE 3: Proportional use of codes describing the presence of grouped attributes (Table 1), for lots of strong wool recorded with a descriptor code in the wool industry auction database for sales between 1 July 2005 and 30 June 2007.

Described attribute	Wool type classification			
	Adult		Lamb	
	Fleece	Oddments	Fleece	Oddments
Unscourable stain	19.4	36.3	45.2	11.3
Unsatisfactory preparation	8.9	12.9	24.0	11.7
Visible vegetable matter	14.0	45.3	15.0	73.3
Fibres tangled	40.5	2.8	0.0	0.0
Bulky	14.1	2.0	15.1	3.3
Lustrous	3.0	0.3	0.5	0.3
Medullated	0.1	0.4	0.2	0.1
Total	100.0	100.0	100.0	100.0

The proportion of variation in clean wool auction price associated with considering either the standard objective auction specifications plus barb length, or a subjective description (Table 1), was analysed with multiple regression analysis using Genstat (Payne *et al.,* 2007). This provided an estimate of the proportion of variation in clean wool price explained by the objectively measured characteristics of length, vegetable matter content, mean fibre diameter, CIE Y, CIE Y-Z and subjectively assessed descriptor codes.

RESULTS

There was a strong pooled within season correlation of -0.83 (r^2 = 0.70) between the exchange rate of the US dollar and the strong wool indicator price across the 89 wool auctions during the 2005/06 and 2006/07 seasons. The mean indicator price for the strong wool segment of the New Zealand clip was 350 c/kg clean for the 2005/06 season and 343 c/kg clean for the 2006/07 season.

Data from a total of 74,094 lots of wool sold by auction were analysed with 51.3% sold in Napier and 48.7% sold in Christchurch. Sixty three percent (46,576) were Adult fleece, 19% (14,062) were Adult oddments, 15% (11,266) were Lamb fleece and 3% (2,190) were Lamb oddments. Mean ± standard deviation and the pooled standard error of difference for the routinely measured objective characteristics and the subjectively assessed colour of all the analysed lots of strong wool, are shown in Table 2.

Sixty three percent of the Adult fleece lots were allocated one of more descriptor codes whereas the proportion of lots of Adult oddments, Lamb fleece and Lamb oddments that were allocated one or more descriptor codes was 38%, 47% and 30% respectively. The maximum number of descriptor codes allocated to a single lot was five.

The proportional allocation of descriptor codes grouped according to sets of described attributes (Table 1), are shown in Table 3.

A summary of the residual standard deviations in auction price for the four wool types individually and combined, for the three Models used to incorporate different sets of factors likely to affect wool auction price are given in Table 4. Model 1

TABLE 4: Residual standard deviation in clean auction price (c/kg clean) explained by models including either the five base objective measurements, or a series of subjective assessments including the suite of descriptor codes. The data were for lots of strong wool recorded in the wool industry auction database for sales between 1 July 2005 and 30 June 2007. Data in brackets is the proportion of the variation in clean auction price explained by each model.

Model number	Model terms	Wool type classification				Wool type classifications combined
		Adult		Lamb		
		Fleece	Oddments	Fleece	Oddments	
1 (Base)	Season + Category x (Sale location/Centre where wool held) + US$	26.0 (35.1%)	29.3 (34.3%)	25.3 (49.5%)	29.3 (8.4%)	27.6 (69.2%)
2 (Objective)	Season + Category x (Sale location/Centre where wool held) + US$ + (Length + Vegetable matter content + Mean fibre diameter + CIE Y-Z + CIE Y)	19.0 (65.5%)	23.2 (58.8%)	21.9 (62.3%)	17.6 (67.0%)	22.2 (80.2%)
3 (Subjective)	Season + Category x (Sale location/Centre where wool held) + US$ + (Length+ Mean fibre diameter + Colour + Presence of unscourable stain + Unsatisfactory preparation + Visible vegetable matter + Fibre entanglement + Bulk + Lustre + Medullation)	18.3 (67.9%)	22.9 (59.9%)	20.2 (67.8%)	18.5 (63.5%)	21.4 (81.6%)

contained factors for season, category, sale location, centre where the wool was held and the exchange rate between the NZ dollar and the US dollar. Model 2 contained the factors in Model 1 plus factors for the four standard objective fibre measurements and length as a standard continuous subjective assessment available for each lot offered for sale. Model 3 contained the factors in Model 1 plus factors for an objective measurement of mean fibre diameter, which is now widely accepted within the wool industry, plus the subjective assessment of length, and the categorical assessments of colour the other descriptors recorded in the WSI valuing code (Table 1). Included in brackets in the table is the proportion of the total variation in price explained by each model. The very large number of observations in this study makes tests of significance between models meaningless. In this case, comparisons should be made on the basis of whether the differences in residual standard deviation are of practical significance.

DISCUSSION

With approximately half of the adult wool sold at auction being only shorn once-yearly (R.M.W. Sumner, Unpublished data) this longer wool has a greater opportunity to be influenced by a range of environmental factors than lamb's wool. Hence it would be expected that a greater proportion of adult wool would be recorded with a code describing "outlier" characteristics.

Individual descriptors that were combined to indicate the presence of unscourable stain include comment on the presence of urine stain, water stain, heavy mud that may obscure water stain, pen stain and the presence of an occasional pigmented fibre in other than Down type wool. With poor preparation short stained pieces can become mixed in the main fleece lines, particularly in lines of 'second shear' and lamb's fleece wool. In the case of objective colour measurement sampling can be a source of problem as the clumps of short stained pieces are invariably localised and may not be sampled. If they are sampled, they can have a disproportionately small effect on overall yellowness after the scoured fibres have been blended during processing because of their small mass, relative to the sample as a whole. On the other hand they are clearly visible as a fault in a commercially scoured product. This has traditionally been a problem within the wool trade where scoured lots may be visually perceived as not meeting a required specification. The wool trade considers small pieces of discoloured wool important because dyeing has an additive effect. Thus lots of wool containing unscourable stains can only be dyed to darker shades.

The lots of wool used in this analysis were separated according to type to align with their potential end-uses of adult fleece wool for semi-worsted and woollen carpet yarn, adult oddments for woollen carpet yarn, lamb's fleece for knitting yarn and lamb oddments for woollen yarns for a range of uses. The proportion of variation in price explained by the various models was higher when the types were combined than when considered separately. This is due more to the overlapping characteristics within the type classifications than to the increase in group size when all the types are combined.

In the case of lots shorn from adult sheep, approximately a third of the variation in auction

price was explained by the basic descriptive factors of season, sale location, centre where the wool was held, and the exchange rate of the US dollar at the time of the wool sale. The centre where the wool was held was a reflection of the region of the country where the wool was grown. A comparison of the r^2 value (coefficient of determination) between the exchange rate of the US$ and the strong wool indicator price with the proportion of variation in auction price across the combined wool type classifications explained by Model 1, suggests that almost all the variation in Model 1 is explained by the exchange rate. Adding factors describing the five basic objective measurements reduced the residual standard deviation explaining approximately 60% of the variation in auction price within each analysed wool type classification. Replacement of some of the objective terms with subjective descriptors and additional categorical assessment variables further reduced the residual standard deviation of the auction price explaining slightly more of the variation in auction price. While lamb fleece wool showed a similar trend, more of the variation in auction price in lamb oddments was explained by objective measurements than subjective assessments. This may be a reflection of the lower number of lots of lamb oddment wool sold in combination with less clearly defined end-uses for short, and potentially discoloured, finer type wools. Such wool is less suited for inclusion in carpet yarn than coarser wool. When all types were combined, a total of 81.6% of the variation in auction price was explained by the basic descriptors and the subjective assessments.

While these results show that the mean values of the five basic objectively measured characteristics explain almost as much of the variation in auction price as the wide range of subjectively assessed descriptors used by the wool industry, the buyers who view the samples and subsequently bid at the auction are influenced by their perception of "outlier" samples, and adjust their prices accordingly. In doing this the buyer is potentially protecting himself that the sample will 'look right' when delivered to the processor, as well as meeting their objective specifications. Once purchased, lots are combined into export consignments solely on the basis of their objective measurements.

Although the effect may appear to be small for an export consignment, relative to the prevailing mean indicator wool prices, it can be significant for an individual lot within the consignment. It is thus important that wool growers prepare their clips for sale to align with the recommended preparation guidelines (New Zealand Wool Classers' Association, 2007). This will minimise the chances of lines in their clip being downgraded by being subjectively assessed as "outlier" lots and thus receiving a lower auction price than if their clip had been prepared to an appropriate standard. While wool prices may currently be low, clip preparation standards are as important now as they were when wool prices were higher.

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