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

The processing of different staple strength wools

D.C. MADDEVER, D. SCOBIE[1], A. BRAY[1]

WRONZ, Private Bag 4749, Christchurch, New Zealand.

ABSTRACT

Wool from lines of Romney sheep selected for high and low staple strength and a randomly selected control line were processed into worsted yarn for handknitting (ewe hogget fleeces) and semi-worsted yarn for carpets (adult ewe fleeces). Separate lots of wool were created for each line with the fleeces chosen to ensure that the lots had similar mean fibre diameter, staple length and medullation. Hogget wool yarns were knitted into panels and the adult ewe wool yarns were tufted into carpet.

In the hogget wool processing trial, increased staple strength was associated with greater mean length after carding and higher combing yields, with small improvements in yarn tenacity and in knitted panel abrasion and pilling test results.

The adult ewe wool processing trial also produced a significant difference in length after carding. At high spindle speeds the high strength line performed better in spinning, producing fewer "end-breaks".

The trials indicate there are real advantages for worsted and semi-worsted processing and product performance, warranting premiums for high strength wools.

INTRODUCTION

A research programme was set up in 1986 to evaluate whether single character selection for staple strength would lead to an increase in the average staple strength of a Romney flock (Bray *et al.*, 1992). The ultimate goal of this selection was to produce an increase in fibre length after carding.

At the 1992 shearing the strength of ewe progeny from the low strength line (selected for decreased staple strength) was 43.1 (± 11.1)N/ktex, whereas those of the control (randomly selected) and high strength line (selected for increased strength) were 54.9 (± 15.8) and 70.6 (± 16.5) N/ktex respectively. The average length after carding measured on blends of the midside subsamples were 127.0, 134.8 and 139.9 mm Barbe (98.9, 108.6 and 114.9 mm Hauteur) for the low strength, control and high strength lines respectively.

In many single character selection flocks compensatory changes occur in other characteristics and the staple strength lines are no exception to this. Bray et al. (1992) showed that both staple length and fibre diameter increased with staple strength selection. Medullation is lower in the high strength line than the low strength line (Scobie *et al.*, 1994). Tests carried out on non-medullated single fibres indicate that staple strength differences in the lines were not due to differences in strength of the fibre material and are likely to be due to thinner regions in the fibres. Although there were differences in fibre material strength between animals these appear randomly distributed across the three selection lines (Scobie, unpublished data).The correlated changes in average fibre diameter of the three lines would be expected to offset the improvements in strength and length after carding, and so limit benefits to processing performance (Elliott, 1985). Therefore, to test the hypothesis that the improvement in strength would be of some benefit to processing and end-product performance, a careful selection of individual fleeces from those available within each selection line was made. The two groups, adult ewes and ewe hoggets (from here on called ewes and hoggets, respectively) were used to create two batches each of three blends which were predicted to differ in strength only.

The hogget wools were processed into worsted yarn similar to that used extensively in China for hand knitting, while the ewe wools were used to make semi-worsted yarn similar to that used in Belgium for woven carpet squares or face-to-face Wilton carpets.

METHODS

Based on objective measurements on individual fleeces, skirted fleeces from the staple strength selection lines were allocated to control, low strength and high strength lots of ewe and hogget wools which differed markedly in staple strength, but had similar average fibre diameter, medullation content and staple length (all calculated on a weight biased basis). Because the fleeces were selected, they were not representative of the selection lines.

The three ewe lots were calculated to have an average staple strength of 24.28, 33.15 and 44.95 N/ktex for the low strength, control and high strength lines respectively. Similarly, three blends selected from hogget wools were calculated to have average staple strengths of 38.64, 51.38 and 66.38 N/ktex for the low strength, control and high strength lines, respectively.The blends were processed into end-products in the WRONZ pilot plant. Scoured wool was tested for residual grease, scouring yield, diameter, medullation, vegetable matter content, colour, length after carding, carding waste and core bulk. The carded sliver was also tested for fibre diameter and medullation by projection microscope (IWTO-8-89(E)), and length after carding (NZS 8719:1992). Samples of all yarns were tested for linear density (BS 2010:1963), twist (BS 2085:1973), strength and extension (ISO 2062E), evenness (IWTO-18-67(E)), yarn bulk and set (WRONZ methods).

[1]AgResearch, P.O. Box 60, Lincoln, New Zealand.

Hogget wool processing

The hogget wools were carded, gilled, combed, gilled and semi-worsted spun to a count of 110 tex with 170 tpm 'Z' twist. A 4-ply yarn was plyed at 80 tpm 'S' twist to produce an R440/4 yarn. During combing, quantities of top (useful web of wool with short fibre removed) and noil (short fibre waste) were sampled, weighed and the ratio of top to noil (tear) calculated. The yarn made was knitted into panels and tested for pilling, burst strength, abrasion and felting shrinkage performance.

Ewe wool processing

The three lines of ewe wool were each halved for processing. The resulting six lots were processed without the operators knowing which line was which, with constant settings to improve the precision of the results and ensure that no bias occurred. These duplicate lines were carded, gilled and spun into a semi-worsted yarn and tufted into carpet for performance testing. Three ends of a singles yarn at 80 tex with 310 tpm 'Z' twist were plyed at 170 tpm 'S' twist to produce an R240/3 yarn. End breaks and spinning performance were monitored as spindle speed was increased in 1000 rpm steps from 6500 to 10,500 rpm.Four kilograms of each of the three lines of the ewe yarn (duplicates were not taken) were hank-dyed. Carpet was tufted on an 1/8 gauge machine, with two yarn ends per needle (simulating woven carpet densities) to a pile height of 8 mm, producing carpet at 1.1 kg/m^2. Samples taken for testing were measured for: shorn pile weight (IWS TM234), pile thickness (IWS TM142), pile height (IWS TM20), WIRA abrasion resistance (IWS TM122), weight loss by abrasion (IWS TM283), dynamic loading thickness loss (IWS TM123), Hexapod thickness loss, texture change and colour change (IWS TM247).

RESULTS AND DISCUSSION

The appearance of the fleeces was similar for all lines and there were no signs of cotting or a serious tender region in the staples, despite the large differences in staple strength between the three lines. It was found that within the experimental error of the test methods that residual grease, scouring yield, diameter, medullation, vegetable matter content, colour, carding waste, core bulk, yarn linear density, twist, extension at break, evenness and yarn bulk and set were not significantly different between lines. The relatively small differences in all scoured loose wool properties, except length after carding, gave variations in yarn, carpet and knitted fabric properties that showed little, if any, commercially significant differences between lines. Variability of production parameters, such as yarn twist level, is assumed to have outweighed any small effects that the variation in fibre properties may have produced. However, it was noticed that the control and low strength lines often produced test results with a higher degree of variability.Nevertheless the combing yield of the hogget wools was considerably lower for the low strength line, confirming the higher short fibre content and suggesting greater fibre entanglement (Table 1). This 2.4% lower waste level at combing equates to almost 20c/kg, based on an estimated value of $8/kg for combed sliver at today's prices. The removal of the noil would be expected to produce top in all three lines that would spin equally as well.

Knitted panel test results showed no significant difference for burst strength and felting shrinkage, but some differences in abrasion and pilling performance (Table 1).

Whereas the hogget wools had short fibre removed at combing, the carded sliver from the ewes was spun without combing. An anomalous fibre diameter result appeared for the ewe high strength line at the loose wool stage, which is likely to be a random sampling error. A more reliable result is expected from the carded sliver since at that stage the wool has been well mixed in the card. Spinning performance of the ewe wools (Table 2) was similar at normal spinning speeds but the high strength line could be spun about 1000 rpm faster without producing significantly more spinning breaks. Given that the marginal costs of spinning yarn is about $1/kg (IWS personal communication) and the increase in throughput of 10% and more depending on the operational speed, at least 10c/kg would be saved by this speed increase. Variability of the yarn properties from the ewe lines was similar to that in the hogget lines, with carpet weight loss by abrasion, dynamic loading thickness loss, Hexapod thickness loss, texture change and colour change results showing no significant differences between lines. However, the high strength line performed well in the WIRA abrasion test (Table 2), which suggests that this wool may better resist bending, flexing and abrasion across the axis of the fibre despite the fact that there were no differences in tensile strength (Scobie unpublished data) or

TABLE 1: Staple fibre, yarn and knitted fabric properties of the hogget wools from the control, low strength and high strength lines.

	Control	Low Strength	High Strength	95%CI
Calculated SS (N/Ktex)	51.4	38.6	66.4	3
Diameter scoured wool (μm)	33.6	33.4	34.7	0.7
CV% Diameter	23.0	25.2	20.2	
Carded length - Barbe (mm)	116.5	116.6	123.1	6.0
Short fibre (%<40mm Barbe)	5.5	5.8	4.6	6.0
Singles tenacity (N/ktex)	35.6	44.9	44.5	3
4-ply tenacity (N/ktex)	61.4	59.3	63.1	2
Combing Tear (ratio)	25.2	19.6	37.5	-
Noil (%)	3.94	5.07	2.67	-
Knitted fabric performance				
Rubs to end point	57,000(1900)*	61,500(4400)	62,000(2100)	-
Pilling grades (5-good, 1-poor)	3 - 4	3	4	-

* SEM given in brackets

TABLE 2: Staple fibre, yarn and carpet properties of the ewe wools from the control, low strength and high strength lines.

	Control	Low Strength	High Strength	95%CI
Calculated SS (N/Ktex)	33.2	24.3	45.0	4
Diameter scoured wool (μm)	38.1	38.1	36.8	0.5
Diameter sliver (μm)	36.1	36.0	36.2	0.5
CV% Diameter	25.2	24.5	23.0	0.4
Carded length-Barbe (mm)	121.5	113.6	122.2	4.2
Short fibre (%<40mm Barbe)	7.1	8.5	7.4	4.2
Spinning breaks/100 spindle hrs				
@6500 rpm	16.50	11.15	21.85	16
@7500 rpm	21.15	28.25	25.55	14
@8500 rpm	29.45	60.50	26.10	27
@9500 rpm	108.25	153.00	60.80	23
@10500 rpm	478.00	912.50	299.00	88
Singles tenacity (N/ktex)	53.7	52.9	56.8	3
3-ply tenacity (N/ktex)	79.7	76.6	76.1	2
WIRA abrasions (rubs)	10125	12750	16750	1800

medullation.For both the ewe and hogget wools, the CV% of diameter was lowest in the high strength line. This is in good agreement with measurements on individual animals from these flocks (Scobie *et al.*, 1994) and provides further evidence that fibre weaknesses and staple strength arise from fibre diameter variations along fibres and between fibres.

CONCLUSIONS

The low strength lines selected for these trials would not have been discounted as cotted or tender by wool buyers. Large staple strength differences transpose into smaller length after carding differences due to the severe action of the carding machine. Nevertheless, these trials indicate that very high strength wools produce a more uniform product with real advantages in the forms of processing and products made. These warrant worsted and semi-worsted processors paying premiums of at least 20c/kg clean.

REFERENCES

Bray, A.R; Smith, M.C; Woods, J.L and Baird, D.B; 1992. Responses to selection for wool staple strength in Romney sheep. *Proceedings of the New Zealand Society of Animal Production*, **52:** 285-7.

Elliott K.H. 1985. The development of a computer simulation model of the manufacture of semi-worsted wool yarns. PhD Thesis University of Canterbury.

Scobie D.R., Merrick N.C. and Saville D.J. 1994. Measurement of fibre diameter in Romney sheep which differ in staple strength. *Proceedings of the New Zealand Society of Animal Production*, **54:** 155-158.