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Sizing of Singles Wool-Worsted Yarns
Part II: Wool-Blends Processed on the Cotton System

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SIZING OF SINGLES WOOL-WORSTED YARNS PART II: WOOL BLENDS PROCESSED ON THE COTTON SYSTEM

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ABSTRACT

An investigation into the processing and sizing of singles wool blend *yarns showed that a relatively short wool can be blended with cotton and short staple polyester fibres and satisfactorily processed into fabric. The yarn suffered a loss in tensile strength during preparation, i.e. winding, clearing and warping but sizing increased the breaking strength. An all-wool control yarn had the lowest tensile strength and the wool/polyester blends the highest. A standard size mix gave satisfactory results on relatively coarse yarns but less satisfactory results on the finer yarns, indicating that higher add-ons should be applied to these yarns. The size used gave better performance on the wool/cotton and wool/polyester blend yarns rather than on the all-wool yarn indicating that a better size for the wool fibre should be found.*

A comparison between conventional and projectile weaving of these singles yarns resulted in an average warp breakage rate of 2,9 breaks/1 000 ends/100 000 picks on a conventional loom running at 165 picks/min and 4,9 breaks on a projectile weaving machine at 280 picks/min.

INTRODUCTION

An IWS[1] report on a techno-economic feasibility study on the use of wool on the short staple system concluded that there may be a slight cost advantage in favour of this in the U.K. but there are certain strong reasons why this development could be desirable in the future; these are, the gravitation of textile production towards low labour cost countries which are predominantly short staple yarn producers, a possible fall-off in the manufacture of conventional wool processing equipment due to the poor share of wool in the total fibre market, the availability of significant quantities of short wool fibre and the demand for wool to be produced in lightweight fabrics using single yarns. They also reported evidence that many cotton manufacturers were making serious efforts to process wool on short staple machinery and that a significant amount of wool is currently being blended with cotton and polyester in wool-poor blends. The most well known producer of wool/cotton blends is undoubtedly Viyella who use a modified short staple system and produce 55/45 and 20/80 wool/cotton blends.

The cotton spinning industry find it difficult to process wool with a mean fibre length greater than 40 mm without creating excessive fibre breakage. Southern Africa is one of the areas producing short staple wools which can be used on the cotton system without any modification. The total estimated availability of short fine wool (above 58's quality) is about 50 million kg/annum (3% of the world wool clip).

SAWTRI[2] has investigated the use of short wools in a range of blend compositions and found that for maximum blending, broken or open tops used through a normal processing sequence gave the best results.

IWS[1] found that the yarn twist level generally used for these short staple wool/cotton blends is similar to that used for all-cotton yarns, (i.e. tex twist factor 38,0; worsted 3,27; cotton 4,0). They also state that it must not be assumed that yarns spun from short staple wool will result in similar fabrics to those produced from worsted spun yarns of the same count. The shorter fibres will result in a softer, more lofty handle with changes in pilling, wrinkling and drape and in some cases the fabrics will be unsuitable for the same end use as its worsted equivalent, especially if single yarns are used. For woven fabrics from singles wool yarns it is usually necessary to size the warp yarns prior to weaving and sizing is frequently used in the short staple industry (cotton, polyester, etc.) which is much more familiar with the process of sizing than the worsted industry. The preferred sizes for wool yarns are of the polyvinyl alcohol type. Starch sizes are not recommended for use with polyester due to the difficulty of removal after heat setting but could be used in wool/polyester and wool/cotton blends.

Weaving of lightweight wool worsted fabrics from singles yarns has been discussed in earlier reports[3-5]. It was found that singles *all-wool* warps can be sized reasonably satisfactorily using various common size formulations used by the local cotton industry. Low wet pick-ups were obtained with certain sizes on the all-wool worsted warps when compared with the wet pick-ups obtained on cotton/polyester warps and although the type of size used did not significantly affect the general results it was felt that of the size mixes available at the time, a particular size (mixture of polyvinyl alcohol and modified starch), gave reasonably satisfactory results and this size, which is commercially recommended for *staple fibre blends with polyester*, has been chosen for this investigation. It was also found that for piece dyed fabrics, it was advisable to use an enzymatic desizing agent to effectively remove all the size from the fabric *before dyeing* [4].

In this investigation a range of blend yarns comprising short wools blended with short staple fibres (cotton and polyester), were produced and the single yarn properties, the effect of sizing on these yarns and their weavability are discussed.

EXPERIMENTAL

It was decided that the investigation should be conducted using the same

TABLE I

DETAILS OF FIBRES USED

Fibre	2,5% Span length (mm)	Mean Fibre Length		Fibre fine-ness	Fibre Bundle Test (3,2 mm gauge length)	
		(mm)	(CV %)		Tenacity (cN/tex)	Extension (%)
Worsted System Wool * (Control)	52	54,0	24,0	4,8	11,5	20
Cotton System Wool	33	35,5	40,1	5,3	11,5	20
Trevira type 120 (dull)	33,1	33,0	20,0	1,7	41,7	10,5
Trevira type 330 (Special cut)	31,6	32,4	21,1	3,6	43,4	14,7
Cotton (Acala 1517/70)	31,4	26,0	37,7	1,7	26,2	6,2
Trevira type 340 (semi-dull, low pilling type)	33,6	37,3	12,0	1,7	27,1	16,2

* Details obtained from T.R. No. 377

three yarn linear densities namely 44, 37 and 27 tex as used before[4]; also that the same three qualities of trousering fabric should be woven and that comparisons should be made in respect of the weaving of these fabrics.

Fibre

Details of the fibres used in the blends are given in Table I. The ®Trevira type 330 is a wool-type polyester, 3,6 dtex, normally produced at 75 mm but in this case cut to 38 mm .

A set of all-wool control fabrics[4] woven from yarns processed from normal wool on the worsted system (mfl 54 mm and mfd 21 mm) was used for a comparison throughout.

Blending

Combed wool tops containing 0,5% dichloromethane extractable matter were converted into *open top* form by recombing at as close a gauge as possible (so as to remove practically no noil) and by collecting the combed fibres without coiling. The wool in this form was then regarded as the raw material and was blended with cotton and polyester fibres in the following proportions.

60% wool/40% either cotton or synthetic fibre
40% wool/60% either cotton or synthetic fibre

giving a total of 8 blends plus the all-wool control used in the experiment.

All the blend lots were processed on the *cotton system* and only the all-wool (control) lot was processed on the *worsted system* [4].

Processing on the cotton system

All the blend lots were prepared by layer blending and processed along normal blowroom procedure with the exception that due to the bulkiness caused by the presence of the wool, smaller laps were made than normally used in the case of all cotton or synthetic. Any extra pressure applied at the calender rollers resulted in extreme difficulty removing the lap pin from the lap but this may not present any difficulty where automatic lap pin removal is used. In order to reduce sliver bulkiness the sliver mass from the card was reduced to between 2,8 - 3,3 ktex.

The short fibre length of the wool (35,5 mm) necessitated a drawframe roller setting of 40 mm front to middle and 47 mm middle to back. Processing presented no problems. The slivers were converted to rovings of between 340-390 tex with 36 turns/m and all blends performed well. The rovings were spun on a Platt M1 cotton spinning ring frame equipped with a Casablanca drafting system.

Processing on the worsted system

The all-wool (control) lot was processed as described earlier[4].

Quantitative fibre analysis

The blended slivers were tested quantitatively by chemical means to determine the exact percentage of each fibre in each blend. These results (based on the clean dry mass with percentage additions for moisture of 18,25% for wool, 0,40% for polyester and 8,5% for cotton) indicated that the blends were 60/40 and 40/60 respectively within the limits of ± 1,3%.

Spinning

All the rovings were spun into either 27, 37 or 44 tex yarns using a tex twist factor of 38,3 (to give 733, 630 and 560 turns/m respectively). The spindle speeds used in spinning the blend yarns were a little lower than normal in order to keep the end breakage rates within reasonable work load limits of 5 end breaks/100 spindle hours. Excessive fibre shedding was observed during the spinning of the wool/polyester blend yarns which may have altered the blend composition of the yarns, but this was not measured.

Warp Preparation

The yarns were cleared and wound onto cones on a Schlafhorst IKN winder fitted with Uster electronic clearers and Classimat recorder. The yarns were tested for breaking strength, extension, irregularity and thick and thin places and the results are shown in Table II.

Two warps were made from each yarn lot of each yarn linear density and warping was carried out on a Hergeth sample warping machine. The warps were transferred onto the swift of a Hergeth sample sizing machine and sized using a 10% mix of ®Bevaloid 4032 (a blend of polyvinyl alcohols and modified starch plus auxiliaries) as described earlier[4].

TABLE II

PHYSICAL PROPERTIES OF YARNS DIRECTLY AFTER SPINNING

Fibre Blend (%)	Yarn Linear Density (tex)	Goodbrand Breaking Strength (cN)	Tenacity (cN/tex)	Extension (%)	Irregu- larity (CV %)	Thin Places/ 1 000 m	Thick Places/ 1 000 m	Neps 1 000 m
All-wool* (Control)	44 37 27	306 241 170	7,0 6,5 6,3	23,9 24,4 19,7	15,3 16,5 18,2	4 19 80	12 23 52	8 14 16
60/40 wool/cotton	44 37 27	384 345 233	8,7 9,3 8,6	6,9 7,4 6,6	14,8 15,4 15,8	3 4 18	22 7 9	42 43 48
40/60 wool/cotton	44 37 27	493 427 305	11,2 11,5 11,3	7,8 8,1 7,4	14,0 14,4 15,3	17 1 6	12 12 9	56 85 60
60/40 wool/Trevira type 120	44 37 27	570 452 321	13,0 12,2 11,9	15,6 17,1 15,8	14,7 15,5 16,7	4 10 29	11 11 15	2 18 27
40/60 wool/Trevira type 120	44 37 27	792 621 446	18,0 16,8 16,5	15,7 17,6 16,2	13,9 14,5 15,7	1 5 11	11 11 18	3 11 32
60/40 wool/Trevira type 330 (Special)**	44 37 27	389 357 263	8,8 9,6 9,7	15,8 17,3 16,0	15,8 16,6 17,6	11 16 86	34 12 35	19 18 74
40/60 wool/Trevira type 330 (Special)**	44 37 27	540 471 347	12,3 12,7 12,9	16,5 18,0 16,9	16,2 16,5 16,9	9 22 37	28 18 32	7 52 44
60/40 wool/Trevira type 340	44 37 27	508 443 277	11,5 12,0 10,3	14,0 14,2 12,8	14,1 14,1 15,6	0 1 23	18 9 69	17 7 48
40/60 wool/Trevira type 340	44 37 27	701 598 412	15,9 16,2 15,3	14,1 14,5 14,1	12,2 12,9 14,2	— 1 7	— 2 28	— 0 58

* Previously processed on the worsted system[4]
** Short staple 38 mm

Weaving

The specifications of the three basic constructions are given in Table III.

TABLE III

SPECIFICATIONS OF FABRICS WOVEN FROM VARIOUS WOOL BLEND YARNS

Yarn linear density	44 tex Z 560	37 tex Z 630	27 tex Z 733
Total ends	3752	4740	6162
Ends x picks (grey) (per cm)	22,0 x 23,2	28,3 x 28,3	36,2 x 29,1
Approx. finished mass g/m^2	240-260	220-240	200-220

One warp from each yarn lot was drawn in on eight heald shafts in straight draft order. Flat steel wire healds were used. The warp ends were dented 4 ends/dent. Thereafter all warps were knotted in the loom using an Ustermatic warp tying machine.

Two sets of warps were woven:

(a) on a 190 cm Saurer 100 W automatic loom running at 165 picks/min and

(b) on a 216 cm (85″) Sulzer VSK weaving machine running at 280 picks/min.

The selvedges used on both cases were formed by using 32 ends each side reverse drafted.

All the fabrics were woven under ambient conditions of 20°C and 70% RH. For each lot, samples of warp yarn before and after sizing were tested for size add-on, strength and abrasion resistance. During the weaving trials all the weaving machine stoppages were recorded. Stoppages unrelated to warp breakages were eliminated and the warp weaving performance assessed from the number of warp yarn breakages/1000 ends/100 000 picks woven, and these are shown in Table IV. Each weaving trial was of average duration of about 90 000 picks.

TABLE IV

PROPERTIES OF WARP YARNS BEFORE AND AFTER SIZING (10% MIX BEVALOID 4032)

Fibre Blend (%)	Yarn Linear Density (tex)	Actual Size Add-on (%)***	Goodbrand Single Thread Breaking Strength (cN)	Tenacity (cN/tex)	Extension at Break (%)	Abrasion Resistance (cycles to break)	End Breaks/1000 Ends/100 000 picks****	
							Saurer	Sulzer
All-wool*	44	Unsized 8,1	304 292	6,9 6,6	18,6 21,0	76 55	— 1,5	— 1,6
	37	Unsized 6,3	202 279	5,5 7,5	17,5 16,8	44 39	— 1,3	— 30,8
	27	Unsized 9,9	156 183	5,8 6,8	9,3 13,1	54 42	— 9,5	— 15,2
60/40 wool/cotton	44	Unsized 7,7	348 420	7,9 9,5	6,8 4,6	53 107	— 0	— 0
	37	Unsized 7,8	304 366	8,2 9,9	6,4 5,4	45 58	— 0,8	— 0
	27	Unsized 8,8	224 290	8,3 10,7	7,5 5,4	51 50	— 0	— 0,5
40/60 wool/cotton	44	Unsized 8,8	344 552	7,8 12,5	7,1 6,3	50 156	— 1,0	— 1,0
	37	Unsized 6,4	384 467	10,4 12,6	6,6 6,4	44 88	— 1,0	— 0
	27	Unsized 9,3	252 385	9,3 14,3	5,2 5,1	39 68	— 0	— 0
60/40 wool/Trevira type 120	44	Unsized 9,7	464 480	10,5 10,9	15,2 15,7	33 85	— 0	— 0
	37	Unsized 6,4	404 444	10,9 12,0	18,6 14,6	51 70	— 0,9	— 0
	27	Unsized 9,0	336 350	12,4 13,0	18,6 15,7	76 60	— 1,5	— 0,5
40/60 wool/Trevira type 120	44	Unsized 11,8	604 760	13,7 17,3	16,7 17,2	43 193	— 0	— 0
	37	Unsized 7,0	470 602	12,7 16,3	15,4 16,2	75 107	— 0,3	— 0,8
	27	Unsized 7,4	456 522	16,9 19,3	17,6 16,5	64 64	— 0,5	— 0
60/40 wool/Trevira type 330**	44	Unsized 8,9	208 428	4,7 9,7	11,8 16,0	20 57	— 40,0	— would not weave
	37	Unsized 7,4	240 416	6,5 11,2	13,8 16,3	20 50	would not weave	would not weave
	27	Unsized 8,7	234 296	8,7 11,0	17,7 16,0	54 64	— 1,6	— 6,0
40/60 wool/Trevira type 330**	44	Unsized 10,2	364 560	8,3 12,7	14,2 18,8	19 89	— 2,1	— 8,0
	37	Unsized 6,8	286 506	7,7 13,7	15,8 18,1	33 64	— 2,3	— 22,0
	27	Unsized 8,2	320 414	11,9 15,3	17,2 15,9	64 61	— 3,5	— 5,9
60/40 wool/Trevira type 340	44	Unsized 10,8	420 538	9,5 12,2	14,4 13,2	81 101	— —	— —
	37	Unsized 6,6	448 466	12,1 12,6	16,0 18,4	71 53	— 1,5	— —
	27	Unsized 7,7	278 326	10,3 12,1	12,2 11,8	50 43	— 0	— —
40/60 wool/polyester Trevira 340	44	Unsized 8,7	594 668	13,5 15,2	15,5 14,9	117 170	— 0	— 1
	37	Unsized 7,3	560 572	15,1 15,5	15,7 15,2	73 78	— 4,6	— —
	27	Unsized 8,2	344 382	12,7 14,1	14,4 14,9	58 54	— 0	— —

* Previously processed on the worsted system

** short staple 38 mm

*** size add-on corrected for residual foreign matter

**** See weavibility index below

0	=	excellent
0 to 2,5	=	very good
2,5 to 5,0	=	good
5,0 to 7,5	=	fair
7,5 to 10,0	=	poor
10 and over	=	very poor

— not determined

Physical properties

The physical properties of the yarns and the measurement of size pick-up was carried out as described in an earlier report[4]. The results are given in Table IV.

RESULTS AND DISCUSSION

Table II gives the yarn physical properties (before preparation) of the 44, 37 and 27 tex yarns respectively and Table IV the yarn physical properties after preparation and after sizing in respect of weaving properties. From the warp breakages occurring during the weaving trials, the end breaks/1 000 ends/100 000 picks were calculated and from these results an assessment of the warp weavability was made. This assessment is based on the authors' experience and does not necessarily correspond to other similar assessments.

Fig 1 presents the yarn breaking strength data in graphic form. From Fig 1 it can be seen that, as would be expected, there was a reduction of yarn breaking strength as the yarn linear density decreased. In every case the yarns suffered a loss in breaking strength due to preparation (preparation included winding and clearing the yarn, warping and beaming). It is apparent from the results that the tensions, friction and handling involved in these processes have a detrimental effect on the breaking strength of the yarn. It is also apparent that there was an increase in yarn breaking strength effected by sizing of the yarn and it would appear that, in general, the yarn recovered or even improved in yarn breaking strength after sizing.

In respect of the various blends it can be seen that the all-wool yarn (the control, spun from a longer staple wool) was the weakest. The wool/cotton blends were slightly stronger, the wool/Trevira 330 intermediate and the wool/Trevira 340 and 120 being the strongest. In every case the wool-poor blends were superior to the wool-rich blends in terms of breaking strength.

Fig 2 shows the effect of preparation on yarn extension at break. It can be seen that the all-wool control generally had the highest extension and that during preparation the yarn was stretched and damaged so that after preparation but before beaming, there was a reduction in the extension of the yarn. Sizing did seem to improve the extension but it is possible that this was because of the wet treatment which allowed the yarn to recover some of its extension. The yarn extension was found to decrease with increasing yarn linear density. The wool/cotton blends had significantly lower yarn extension than the other yarns and, in general, sizing of the yarn further reduced the extension. The wool/polyester blends appeared to have moderate extensions with no definite differences between them.

After sizing the yarns were tested for abrasion resistance, and the effect of

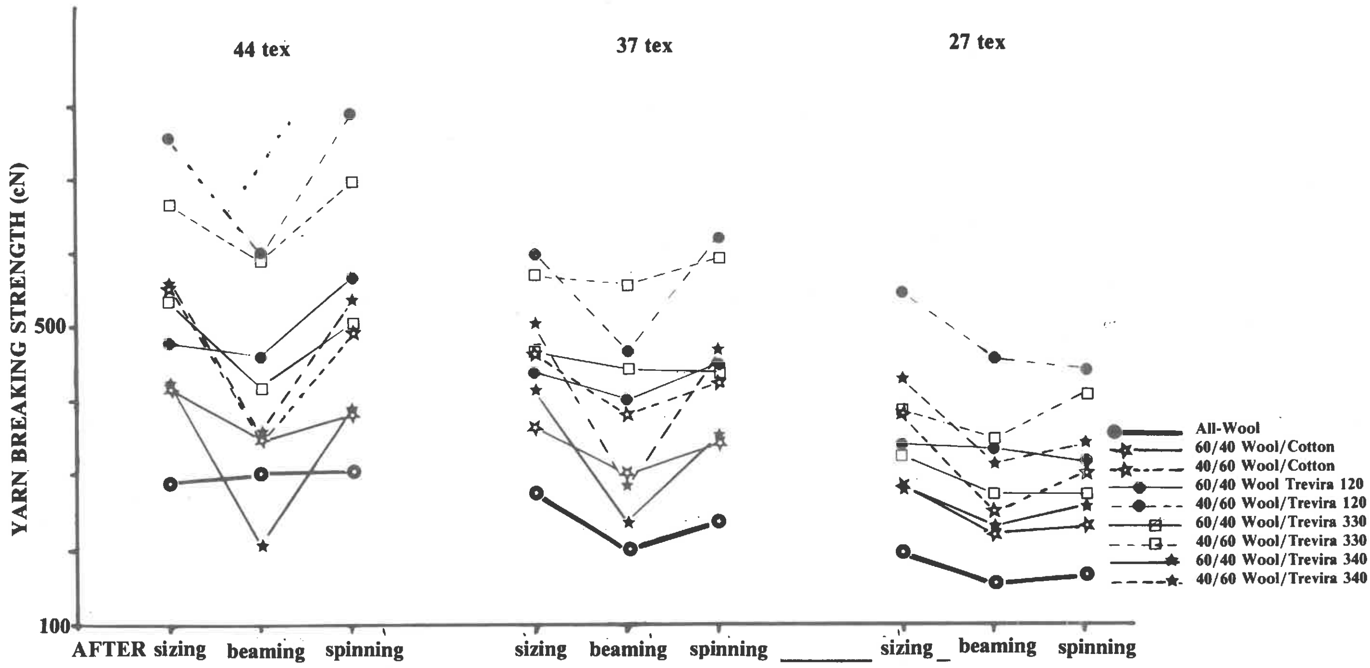

Fig 1 The effect of yarn preparation on yarn breaking strength for various blends of yarn spun to various yarn linear densities

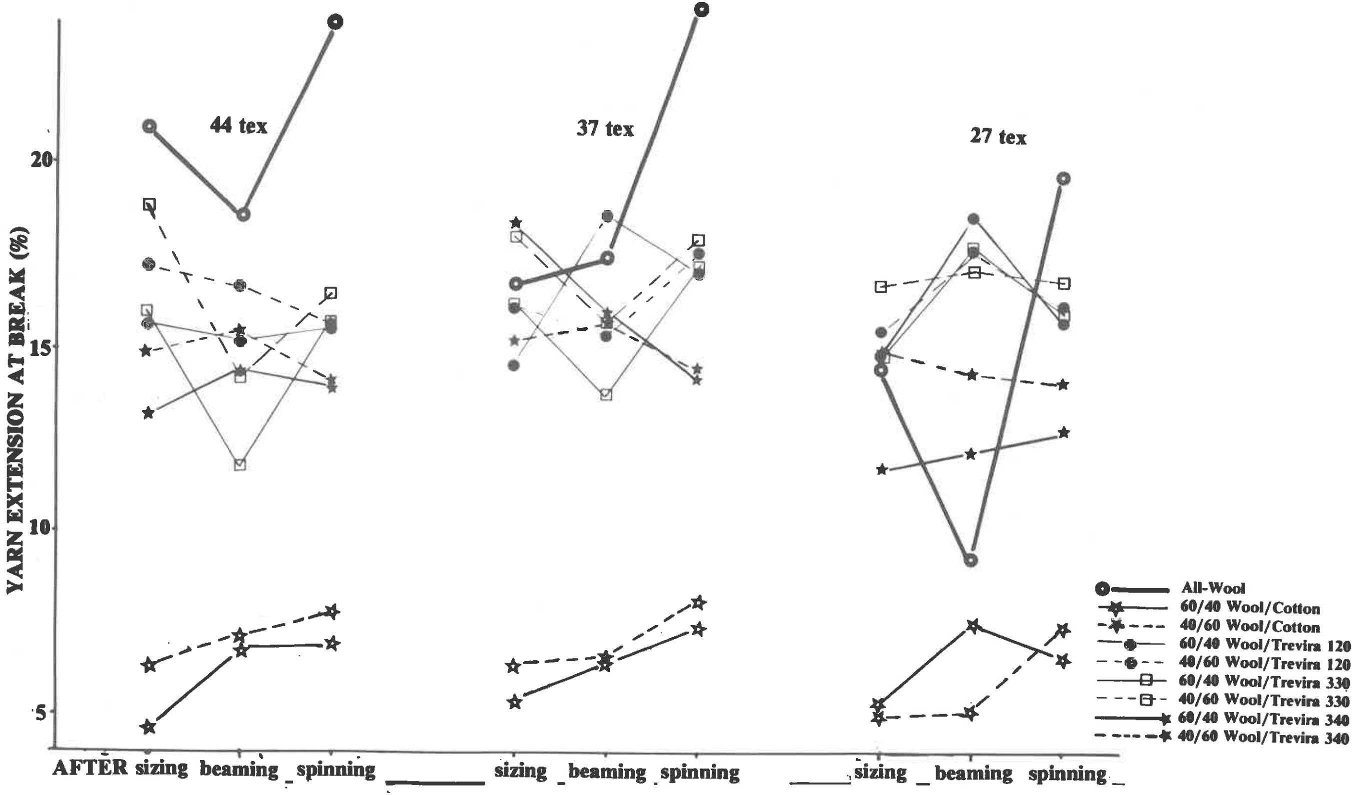

Fig 2 The effect of yarn preparation on yarn extension of various blends of yarn spun to various yarn linear densities

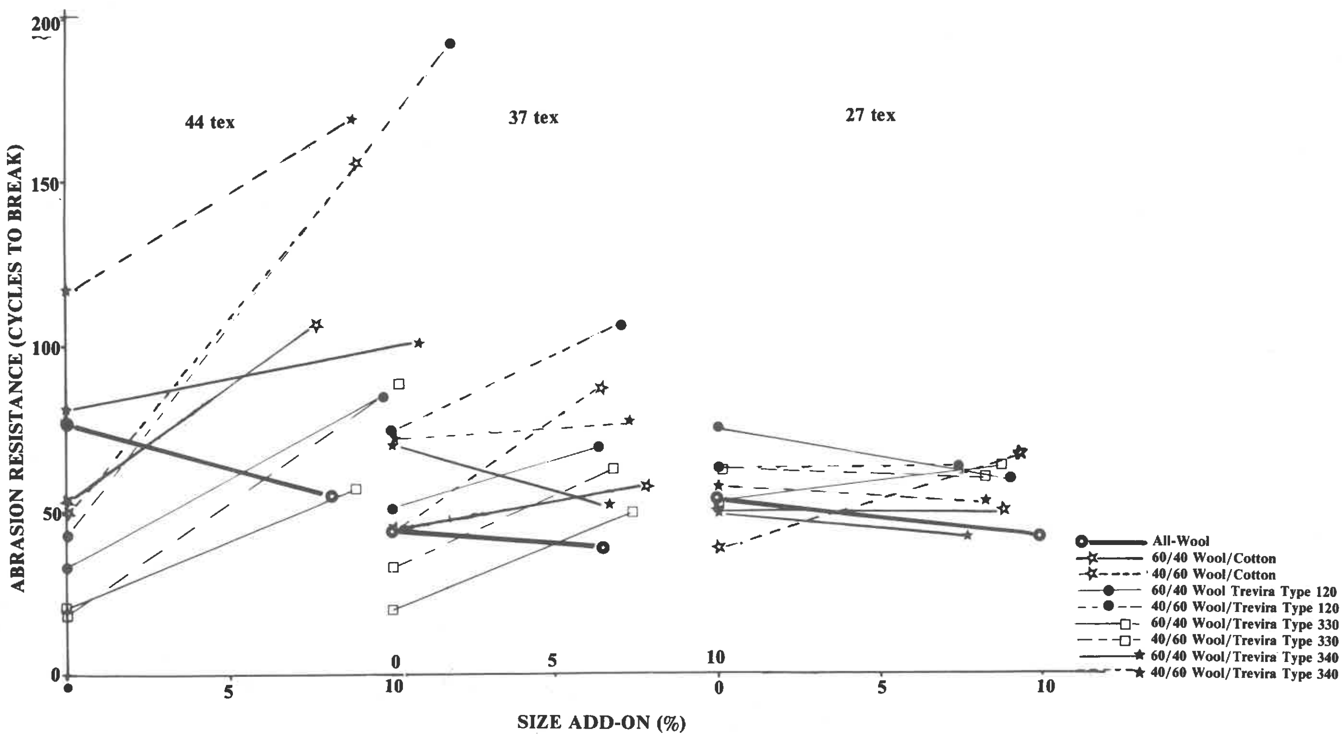

Fig 3 The effect of percentage size add-on on the abrasion resistance of various blends of yarn spun to various yarn linear densities

sizing on the abrasion resistance of various blend yarns can be seen in Fig 3. The wool did not gain in abrasion resistance after sizing whereas in general all the other blend yarns did show an improvement. In particular, the coarser yarns improved significantly in abrasion resistance after sizing. A standard size mix of 10% concentration had the most advantageous effect on the 44 tex yarn, with a smaller improvement on the 37 tex yarns and little or no improvement in abrasion resistance on the 27 tex yarns. This indicates that a much higher add-on may be necessary for finer yarns. In all cases the 40/60 wool-blends showed much greater improvement than the 60/40 blends indicating once more that the size mixture used was more effective on the cotton and polyester components than on the wool component and that some further investigations should be carried out to find a more suitable size mixture for wool and wool blends where there are less fibres in the cross-section of the yarn.

From the weaving trials carried out it can be adjudged that in this investigation the average end breakage observed per 1 000 ends/100 000 picks on the Saurer weaving machine running at 165 picks/min was 2,9 whereas the comparative figure on a Sulzer weaving machine running at 280 picks/min was 4,9. These results indicate that the weaving of sized singles wool-blend yarns spun from short staple fibres on the cotton system give satisfactory performance in production.

SUMMARY AND CONCLUSIONS

The physical properties of singles wool blend yarns and the preparation, sizing and weaving of warps produced from these yarns were investigated. Short wool was blended with short staple polyesters and cotton and spun into three standard linear densities (44, 37 and 27 tex). These yarns were compared with a normal singles all-wool worsted yarn used as a control. The yarns were woven on both conventional and projectile weaving machines and an assessment of warp weavability was carried out.

It was found that there was a general reduction of yarn strength as the yarn linear density decreased and in every case the yarns suffered a loss in breaking strength during warp preparation, i.e. winding, clearing and warping. It was shown, however, that sizing increase the breaking strength. The all-wool control, although of longer staple length, produced the weakest yarn of all, the wool/cotton blends next and the wool/polyester blends the strongest. In every case the wool-poor blends were superior to the wool-rich blends in breaking strength. The all-wool yarn had the highest extension at break and the wool/cotton blends the lowest. The standard size mix (10% solids) used, produced the best results on 44 tex yarn (the coarsest) and relatively poorer results on the all-wool control and wool/Trevira 330 (37 tex and 27 tex yarn) which suggested that a higher size add-on may be required for finer yarns. The size used appeared to be more effective on the cotton and polyester components than on the wool and further work is necessary to find a more suitable size for use with wool or wool type polyester where there is a reduced number of fibres per cross-section in the yarn.

The average warp breakage rate during weaving was 2,9/1 000 ends/100 000 picks on a conventional loom running at 165 picks/min and 4,9/1 000 ends/100 000 picks on a projective loom running at 280 picks/min which indicates that the weaving performance of sized singles wool-blend yarns spun from short staple fibres on the cotton system gave satisfactory results.

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USING OF PROPRIETARY NAMES

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The fact that chemicals with proprietary names have been mentioned in this report does not in any way imply that SAWTRI recommends them or that there are not substitutes which are of equal or better strength.

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