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Studies on Pigmented Wool

Part I: "Merino Black"

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ABSTRACT

A small quantity of the best grade of pigmented wool available in South Africa, sometimes referred to as "merino black" was processed on the worsted system and converted into fabric. Processing performance was quite satisfactory and an aesthetically appealing fabric of fairly good wrinkling performance and abrasion resistance was produced. While the light fastness results of the naturally pigmented wool were below-standard, wet fastness results were excellent. In contrast to the karakul fibre, no bleeding of the pigment from the raw wool, the tops or the fabric was observed.

A further quantity of the raw material was re-sorted into three distinctly different shades, processed separately into R52 tex yarns, woven into a selection of 2/2 twill check patterns and compared with an identical fabric made from top-dyed merino wool of the same quality. The physical properties of the fabrics were equal in most respects and there were certain obvious economic advantages derived from the saving in dyestuffs in the case of the pigmented wool.

INTRODUCTION

The shorn production of pigmented fibres represents about 10% of the total shorn production of the South African wool clip and amounts to approximately 80 000 bales per annum[1]. This not insignificant figure can be subdivided into two main categories, namely that pertaining to karakul and comprising about 60 000 bales and that pertaining to pigmented wool (as distinct from karakul wool) and comprising about 20 000 bales.

Karakul is shorn from the karakul sheep and is characterised by having two distinct fibre populations, one comprising the long, coarser, beard hairs or "outer coat" and the other comprising the softer, shorter fibres or "down". Pigmented wool, on the other hand, refers in this context to wool from various breeds and cross-breeds which are marketed under the descriptions referred to in the trade as types 213, 214, 215 and 216 and form part of the types under the broad class description of "Coarse & Coloured". Type 213 is described as "Best Coarse & Coloured", type 214 as "Average Coarse & Coloured", type 215 as "Inferior Coarse & Coloured" and type 216 as "Coloured Kemps". Various prefixes are used with these type numbers by the South African Wool Board to denote length origin, carbonising grades, etc.

The trends in shorn production of pigmented fibres from 1955 to 1977 are shown in Fig 1, this information being extracted from various statistical reviews[1, 2]. It can be seen that pigmented wool accounted for a significant proportion of the total during this relatively long period. Subdivision of the pigmented wool production into the four type descriptions referred to above, namely types 213 to 216 inclusive, is illustrated in Fig 2 for the same time period. This graph shows that production of very best grade declined from 2 000 bales per annum in 1955 to practically nil during the late 60's, but production has since increased again to some 500 bales per annum. This grade contains little to no kemp or beard hair. Production of the next best grade currently runs at about 4 000 bales per annum. This grade contains slight kemp, but much of this can be sorted out and a fairly good grade of pigmented wool obtained. Production of the coarsest grade runs at around 10 000 bales per annum, but the description "coloured kemps" could be rather a pessimistic one since only a proportion of 'true' coloured kemps is actually sorted out. From this type, namely T216, and from the so-called 'inferior' grade, namely T215, a fair grade of pigmented wool can be obtained by careful sorting.

It has been claimed that the revival of handspinning and weaving in Australia has produced a reversal of the century-old effort to eliminate black lambs from among their flocks[3], the craftsmen apparently prefer the naturally black and coloured wool to dyed wool for hand-spinning, weaving and knitting, and it was reported that this created a boom in an otherwise depressed market during 1975[3]. It has further been claimed that in several regions of Australia flocks of black sheep are being expanded as rapidly as possible. It was also reported that young black merino ewes were selling for around $A 50 in 1977 and that wives of many New South Wales wool farmers were now tending their own flocks of black sheep[4].

In view of this interesting development and in the obvious savings in dyestuffs (which are now very expensive) and in dyeing costs, it was decided to investigate the best of our pigmented wool grades, namely the one sometimes referred to as "merino black" and which is produced largely from T213, and to process a small quantity of this through to worsted fabric.

EXPERIMENTAL

One bale of sorted "merino black" was scoured on a pilot scale scouring plant, carded on a double-swift worsted card, gilled three times, combed and finished. The tops were then passed through the normal worsted drawing operations and were spun on a worsted ring frame into a 21 tex Z715 yarn (tex twist factor 32,8). The yarn was then folded to give R42 S476/2Z715. The yarns were then steamed, cleared and tested before being woven into a 2/2 twill fabric and finished in the form of a milled flannel having a mass per unit area of about 235 g/m^2. Some physical and chemical tests were carried out on the finished piece.

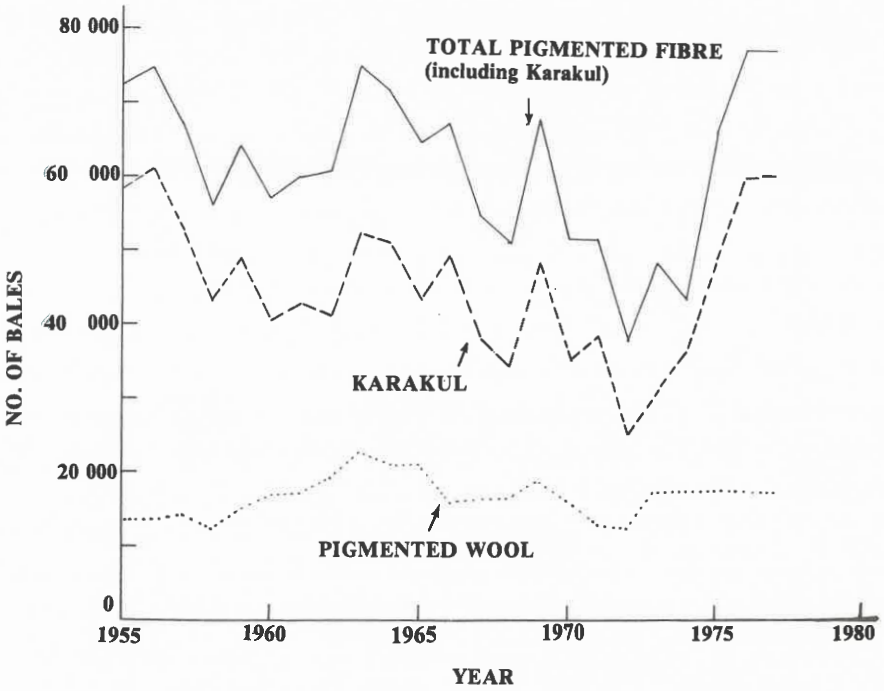


Fig 1 Shorn production of pigmented fibres in South Africa

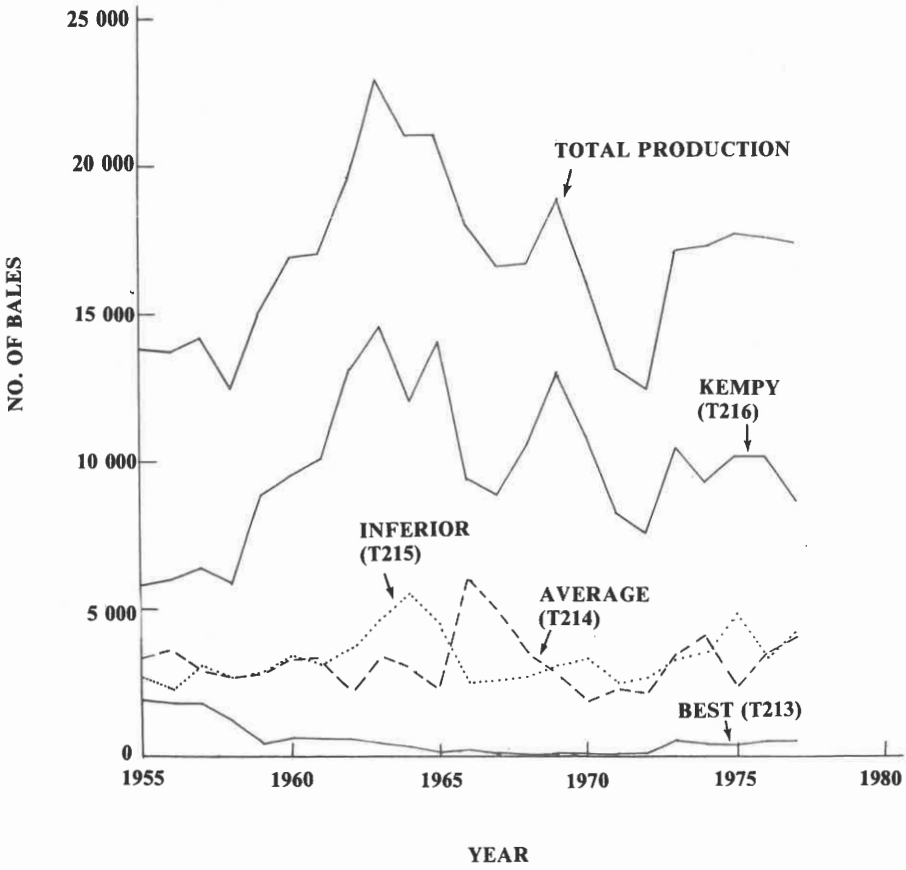


Fig 2 Shorn production of the various class descriptions of pigmented wool

The results (see discussion below) prompted further trials, and to this end a further quantity of another lot of "merino black" was selected. In this case, however, the wool was re-sorted into 3 distinctly different shades, namely black, dark brown and light brown. These shades were processed separately into R52 tex S510/2Z530 yarns and woven into a selection of 2/2 twill check patterns. Three warps of 4260 ends were drawn into pattern on four heald shafts and dented 14,5/4 (14,5 dents/inch) over 186,5 cm and woven in a 216 cm Sulzer VSK weaving machine running at 280 picks/min.

The fabrics were inspected, burled and mended and finished commercially. The three fabrics were joined end to end and finished in an identical manner, the procedure being greasy blowing, scouring, crabbing, tenter drying, steaming and pressing before finally KD decating. The final milled flannel had a mass of about 445 g/running metre. An identical commercial fabric produced from top dyed merino wool 64s quality (21,8 μm) was used as a control and the fabric properties compared.

RESULTS AND DISCUSSION

Properties of the "merino black" in the raw state are given in Table I.

TABLE I

GREASE WOOL CHARACTERISTICS

Mean fibre diameter (μm)	21,3
CV (%)	23,1
IWTO Scoured yield (%)	61,5
Crimp frequency (per cm)	4,4
CV (%)	17,8
Unstretched staple length (mm)	77,0
CV (%)	27,6
Stretched staple length (mm)	87,6
CV (%)	25,2
Grease content (%)	7,9
Methanol insoluble portion of the grease (%)	57,5
Suint content (%)	12,6
pH of suint	7,5

It can be seen from Table I that the wool was long and fine and that the CV of mean fibre diameter was about the same as one would find in a farmer's classing lot of merino wool. The wool appeared to be about 12% overcrimped by the Duerden standard. The estimated yield appeared moderately high. The grease content of the wool, on the other hand, appeared to be rather low.

During scouring of the above wool it was noted with interest that the wash water did not appear to become coloured due to the bleeding of pigment, even though it has been suspected that this might happen in the light of reports of the bleeding of the melanin pigment in alkaline medium in the case of karakul[5].

Some performance data were noted during topmaking and spinning, and these are given in Table II.

TABLE II

SOME PERFORMANCE DATA DURING TOPMAKING AND SPINNING

Tear	15,9
Percentage noil	5,9
Mean fibre diameter of top (μm)	20,9
CV (%)	23,6
Mean fibre length of top (mm)	66,3
CV (%)	52,8
Fibres shorter than 25 mm (%)	7,9
5% length (mm)	123
Tail length: mean length ratio	1,85
Neps (per 20 g)	3
Vegetable particles (per 20 g)	4
Dichloromethane extractable matter after combing (%)	0,6
Withdrawal force after combing (N/g)	88
Felt ball density of tops (g/cm^3)	0,172
Compressibility of steamed tops (mm)	17,5
Mean spindle speed (MSS) at break (rev/min) for	
15 tex	9 700
16,5 tex	10 900
18 tex	12 000
19,5 tex, and	12 700
21 tex yarns	12 400

It is clear from Table II that performance of this wool through topmaking and spinning was satisfactory, a fine top of good spinning potential having been produced. This top was of a very subtle darkish brown colour having the appearance expected of an intimate blend of various tones of brown. The finished fabric also had an appealing multi-tone brown appearance and a relatively soft handle. Compressibility appeared normal for a wool of this diameter and crimp. The physical properties of the fabric are given in Table III.

TABLE III

PHYSICAL PROPERTIES OF FINISHED FABRIC

Mass per unit area (g/m^2)		236
Fabric thickness (mm)		0,57
Sett (Threads/cm):	Warp	26,9
	Weft	26,8
Air permeability ($m\ell/s/cm^2/cm$):		
Measured at 98 Pa		9,4
Measured at 490 Pa		8,6
Martindale abrasion (% mass loss after 10 000 cycles)		7,6
Martindale pilling (IWS pill rating after 2 000 cycles)		3,8
Bursting strength (kN/m^2)		1018
Breaking strength (N):	Warp	362
	Weft	351
	Mean	357
Fabric extension at break (%):	Warp	29,0
	Weft	35,3
	Mean	32,2
Drape coefficient (%)		54,3
Monsanto crease recovery angle (Deaged, 20°C, 65% RH):		
	Warp	157
	Weft	160
	Warp + Weft	317
Bending length (cm):	Warp	1,61
	Weft	1,58
	Mean	1,59
Flexural rigidity (mN.mm):	Warp	9,65
	Weft	9,12
	Mean	9,39
AKU wrinkling (SD of wrinkling curve in mm):		
	Warp	0,21
	Weft	0,25
	Mean	0,23

The results indicate that a relatively soft fabric of fairly good wrinkling performance and abrasion resistance could be produced from this quality of pigmented wool.

Tests were carried out to ascertain the degree of fastness to washing, alkali perspiration and acid perspiration. Rubbing fastness and light fastness were also assessed. These results are given in Table IV.

TABLE IV

FASTNESS PROPERTIES OF THE FABRICS

	Rating
Fastness to Washing (ISO 2):	
Effect on shade	5 (sl. trace darker)
Staining of Wool	5
Staining of Cotton	5
Fastness to Washing (ISO 3):	
Effect on shade	5 (sl. trace darker)
Staining of Wool	5
Staining of Cotton	5
Alkali perspiration:	
Effect on shade	5
Staining of Wool	5
Staining of Cotton	5
Acid perspiration:	
Effect on shade	5
Staining of Wool	5
Staining of Cotton	5
Rubbing fastness:	
Dry	4-5
Wet	4-5
Light Fastness	4

While the light fastness results showed that the fabric had a below-standard rating for worsted end-use in the normal sense, the other fastness ratings were both excellent and somewhat unexpected. However, these results confirm the observation reported earlier with regard to the *absence of bleeding* during the scouring of the raw wool. The possibility that whatever bleeding there may have been possibly took place during finishing treatments, was ruled out by the results of tests carried out on the *tops* from which the fabric was made. These were subjected to an ISO 3 wash test and compared with *karakul* tops which had been produced from a type known as T220. Bleeding into the liquor from the karakul was considerable, whereas that from the "merino black" tops was only extremely slight, if any. Ratings of 5 were again recorded for the wash fastness results in respect of effect on shade and both on staining wool and cotton. A repeat test on the *finished fabric* also revealed little or no bleeding into the test liquor.

Further tests were carried out to determine the fastness of the fabric to chlorination and to washing and alkaline perspiration after chlorination. The results of these tests are given in Table V and indicate that chlorination could be carried out with little or no detrimental effect on the fastness characteristics of the fabric.

TABLE V

FASTNESS OF THE FABRIC TO CHLORINATION AND TO WASHING AND ALKALINE PERSPIRATION AFTER CHLORINATION

Fastness to chlorination	4
Fastness to washing after chlorination (TM 193)	
Effect on shade	5
Staining of Wool	4-5
Staining of Cotton	5
Fastness to alkaline perspiration after chlorination (TM 174)	
Effect on shade	5
Staining of Wool	4-5
Staining of Cotton	4-5

In view of the obvious advantages with respect to *savings on dyestuffs* and the excellent wet fastness results, it was considered that the work could be usefully extended. To this end a further quantity of another lot of "merino black" was selected (see experimental), this being about one micron coarser than the original lot. Some of the characteristics of the tops which were produced from this lot are given in Table VI:

TABLE VI

SOME PHYSICAL CHARACTERISTICS OF THE TOPS FROM THE SECOND LOT OF "MERINO BLACK"

	Shades of Tops		
	Black	**Dark Brown**	**Light Brown**
Mean fibre diameter (μm)	22,9	22,1	21,8
Mean fibre length (mm)	65,7	63,2	64,2
CV (%)	49,3	49,7	53,1
Tail length (5% length) (mm)	121	115	123
Fibres shorter than 25 mm (%)	7,1	7,6	9,9
Neps per 20 g	23	24	15
Vegetable particles per 20 g	4	6	11

The physical properties of the finished fabrics are given in Table VII. The results of the tests carried out on the three fabrics were so similar that for the purpose of comparison only the average results are given.

TABLE VII

PHYSICAL PROPERTIES OF 2/2 TWILL MILLED FABRICS PRODUCED FROM PIGMENTED WOOLS COMPARED WITH A NORMAL COMMERCIAL FABRIC

Fabric Property	Fabric identification	
	Pigmented wools (average)	Commercial control
Mass per unit area (g/m^2)	295	291
Fabric thickness (mm)	0,64	0,74
Sett (Threads/cm):		
warp	27,7	27,4
weft	24,4	24,7
Air permeability ($m\ell/s/cm^2/cm$)		
measured at 98 Pa	6,44	9,96
measured at 490 Pa	6,15	9,17
Martindale Abrasion (% mass loss after 10 000 cycles)	5,16	5,19
Martindale pilling (IWS pill rating after 2 000 cycles)	4,3	3,8
Bursting strength (kN/m^2)	1140	1234
Breaking strength (N):		
warp	484	465
weft	406	511
mean	445	488
Fabric extension at break (%):		
warp	36,1	34,5
weft	38,2	37,6
mean	37,2	36,1
Drape coefficient (%)	53,4	52,6
Monsanto crease recovery angles (deaged 20°C, 65% RH):		
warp	153	155
weft	157	170
warp + weft	310	325
Bending length (cm):		
warp	1,76	1,74
weft	1,61	1,69
mean	1,69	1,72
Flexural rigidity (mN.mm):		
warp	15,7	15,0
weft	12,2	13,8
mean	14,0	14,4
AKU wrinkling (SD of wrinkling curve in mm):		
warp	0,24	0,22
weft	0,24	0,23
mean	0,24	0,23
Handle (subjective assessment)	Very soft	Softest

From the results in Table VII it can be seen that the average values of the various physical properties of the pigmented wool fabrics are virtually identical to the control fabric. The only significant differences that could be observed were that the control fabric was slightly thicker and yet had a higher air permeability, it pilled slightly more but had higher tensile and bursting strengths and higher crease recovery angles and was adjudged to have the softest handle. Other parameters such as abrasion resistance, drape, stiffness and wrinkling propensity were considered to be similar to those of the pigmented wools and, therefore, the pigmented wool fabrics were considered to be quite satisfactory.

Samples of the pigmented wool fabrics are shown in the appendix.

SUMMARY AND CONCLUSIONS

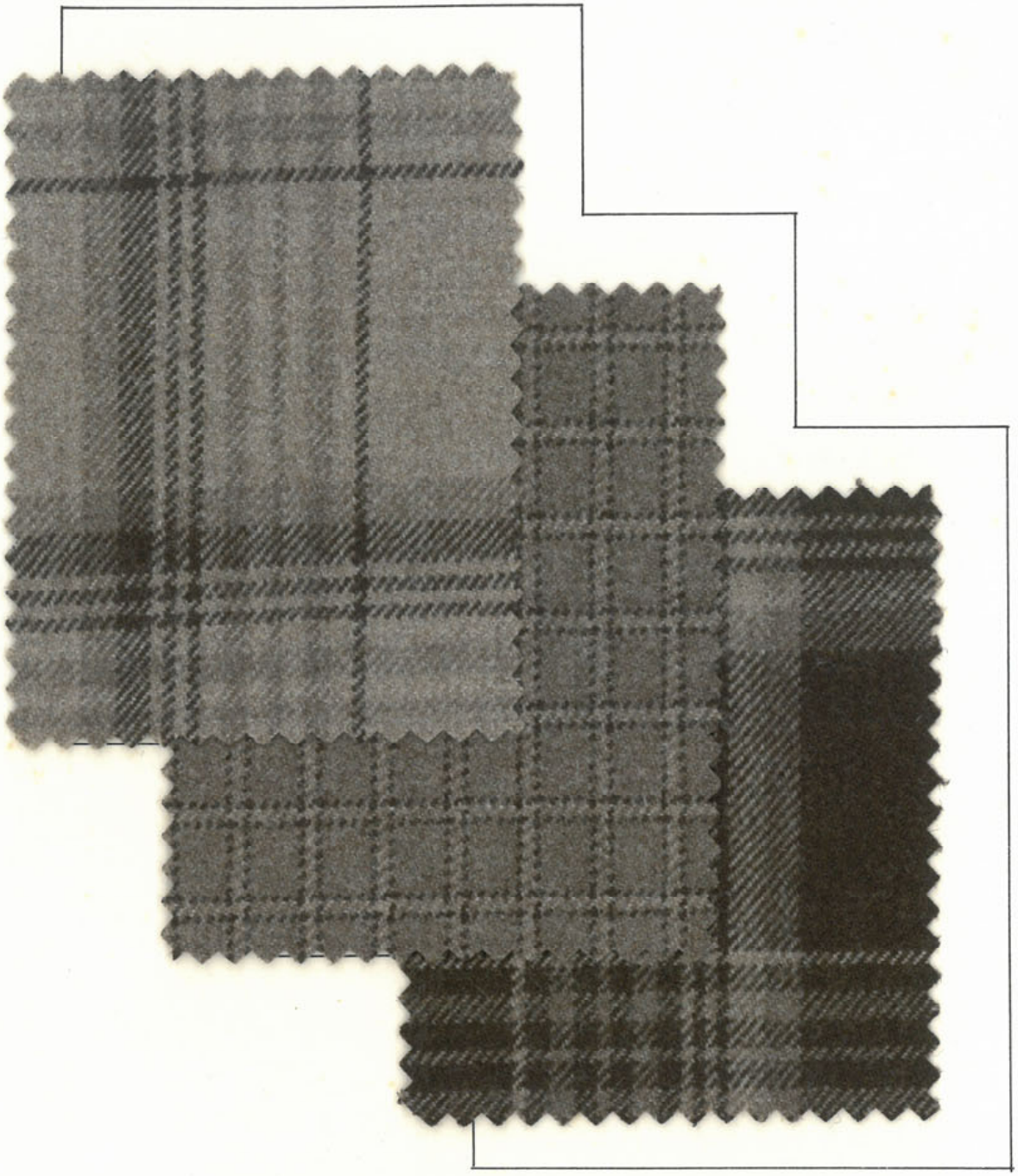
About 10% of the total shorn production of the South African wool clip (80 000 bales) comprises pigmented fibres. About three-quarters of this pertains to *karakul* while the remainder comprises four main class descriptions of pigmented *wool*, namely types 213 to 216 inclusive. In view of an apparent revival of interest, particularly by hand-spinners and weavers, in the naturally coloured wools, it was decided initially, to investigate the best grade of the South African pigmented wools, namely the one referred to sometimes as "merino black" and which is produced largely from T213. It was decided to process a small quantity through to worsted fabric.

Performance of the "merino black" through topmaking was quite satisfactory, a fine top of good spinning potential being produced. From this top a relatively soft fabric of fairly good wrinkling performance and abrasion resistance was produced. While the light fastness results were considered as below-standard, it was observed that the wet fastness results were excellent. No bleeding of the pigment from the raw wool, the tops or the fabric was observed. This was in contrast to previous experience on *karakul* which bled significantly. In addition, further tests established that chlorination could be carried out with little or no detrimental effect on the fastness characteristics of the fabric.

In view of obvious advantages with respect to the *savings on dyestuffs* and the excellent wet fastness results, it was considered that the above work could be usefully extended. Accordingly, a further quantity of "merino black" was selected, but on this occasion the wool was re-sorted into three distinctly different shades, namely black, dark brown and light brown. These shades were processed separately into R52 tex yarns, woven into a selection of 2/2 twill check patterns, commercially finished into a milled flannel and compared with an identical fabric produced from conventional top-dyed merino wool of 64's quality.

It was concluded that good quality fabrics of interesting and aesthetic appeal (limited in range of shades to the natural colours available), and having

APPENDIX



Samples of fabrics produced from sorted S.A. Pigmented Wools

physical properties equal in most respects to similar fabrics made from merino wool of the same quality, can be produced from the best grade of pigmented wool, with certain obvious economic advantages derived from the saving in dyestuffs.

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