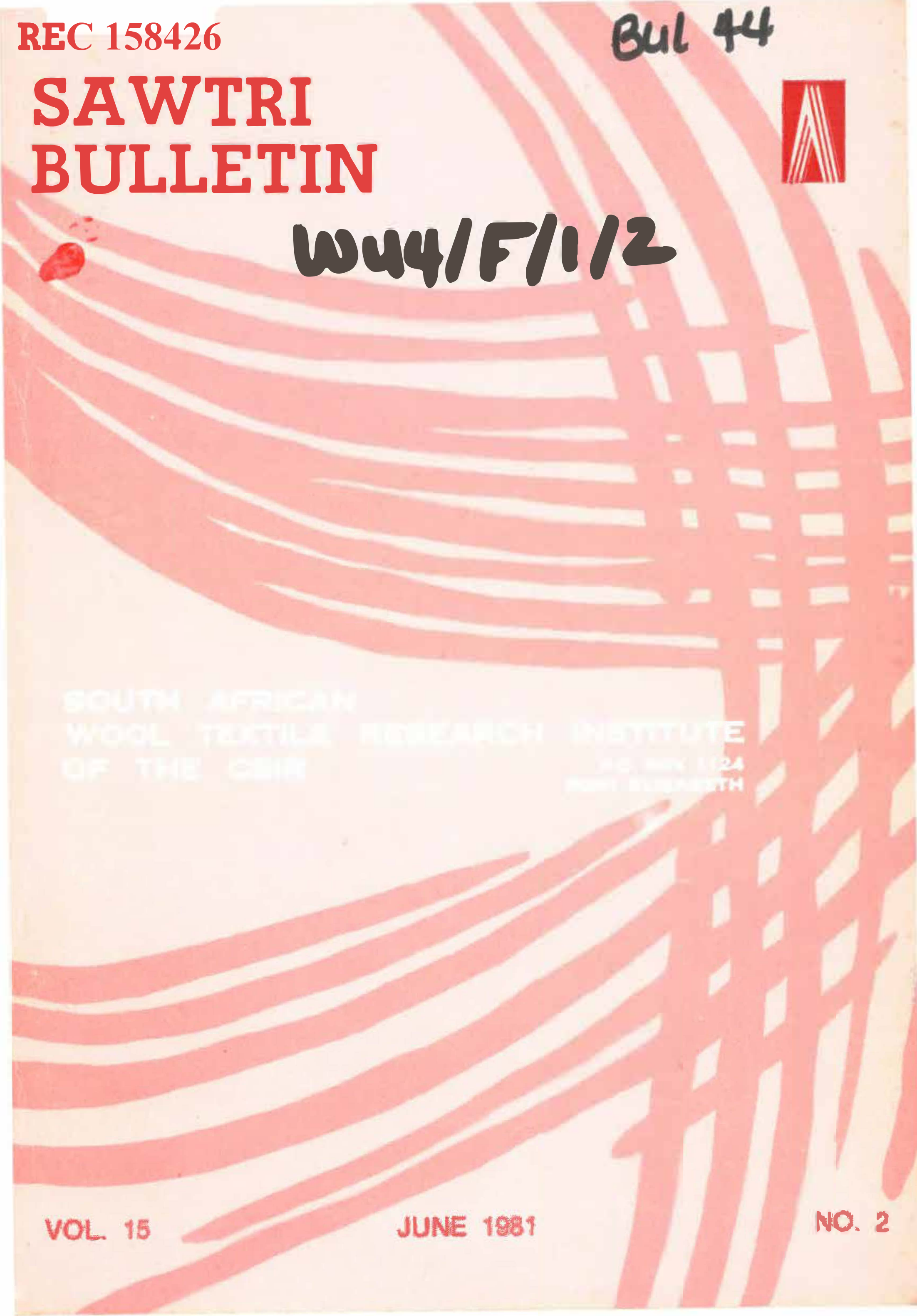
SAWTRI BULLETIN



SOUTH AFRICAN
WOOL TEXTILE RESEARCH INSTITUTE
OF THE CSIR
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SAWTRI BULLETIN

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TECHNICAL PAPERS:

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EDITORIAL COMMITTEE

INSTITUTE NEWS

Meeting of the International Wool Textile Organisation

During April of this year, SAWTRI's Director, Dr D. W. F. Turpie, attended the IWTO meeting in Christchurch, New Zealand. The IWTO provides for membership of the Organisation on a national basis and today 25 national associations, representing all stages of trade and processing in the wool textile industry, are full members of this organisation. The Christchurch meeting was the third in seven years to be held in a grower country, the previous two such meetings having been held in Cape Town (1977) and Melbourne (1974).

Among the aims of the IWTO are the maintenance of permanent connections between the wool textile organisations of member countries and representing the wool textile trade and industry in all branches of economic activity. It promotes the study and solution of economic and commercial questions of the industry and ensures the functioning of the industry's International Arbitration Agreement. It also collects and disseminates statistics and other information of interest to the Industry. These aims are realised by a number of committees and working groups set up on a permanent basis and which meet from time to time throughout the year. The Christchurch meeting was one of such regular meetings and was opened by the New Zealand Minister of Overseas Trade.

SAWTRI and WRONZ

While in New Zealand, Dr Turpie also paid a visit to the Wool Research Organisation of New Zealand (WRONZ) where he had discussions with the Director, Dr S. Simpson and other senior scientists.

SAWTRI and the CSIRO

While in Australia, Dr Turpie visited the research institutes of the CSIRO in Geelong and Sydney, Australia, where he held discussions on wool research matters of mutual interest to South Africa and Australia. The treatment and disposal of effluents from textile mills received particular attention and the results of a joint project between the CSIRO and SAWTRI on the processing of Australian and South African Wools were also discussed.

SAWTRI and The University of New South Wales

Dr Turpie's visit to Australasia also included an important appointment with Prof. S. Nossar and Dr S. de Jong of the University of New South Wales. The discussions with Dr de Jong centered around a joint project between the University and SAWTRI which is aimed at clarifying the interrelationships between wool fibre properties and fabric testing and wrinkling characteristics.

Director visits the U.K.

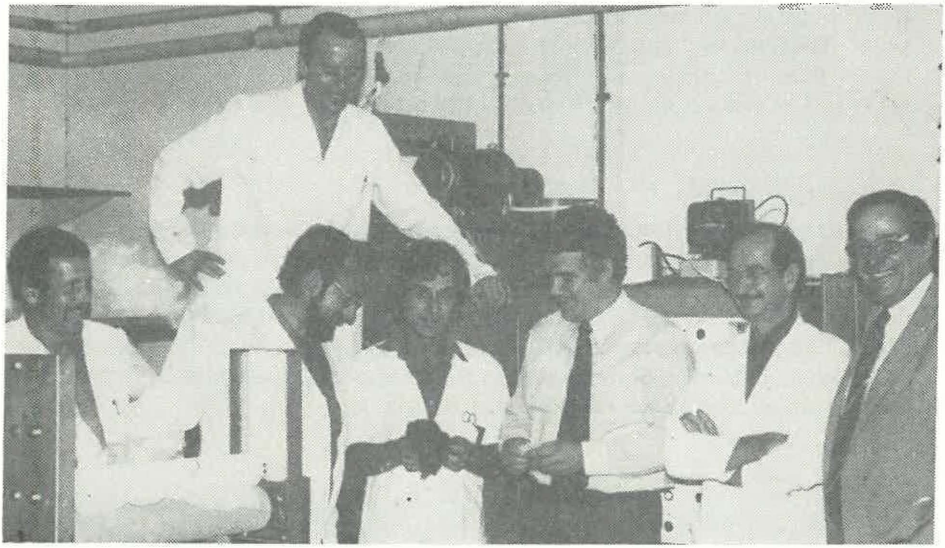
During May of this year, Dr Turpie attended the IWS Research and Development meeting in Ilkley, Yorkshire. This R and D meeting is held annually to review and coordinate global wool research activities. After the meeting, Dr Turpie visited the Scottish College of Textiles in Galashiels where he attended a gathering of senior staff members and visitors for discussions on recent research by SAWTRI on worsted or long staple processing. He also held discussions with Mr Furniss, Principal of the College, Dr Harwood, Head of Textile Technology, Dr Martindale and Mr J. P. van der Merwe, who is engaged in post graduate studies on the processing of South African wools on the *woollen* system. Dr Turpie also paid visits to Dawson International in Selkirk, Scotland, and the office of the South African Scientific Counsellor in London which completed his rather arduous itinerary.

SAWTRI moves ahead in the Quest for Energy Conservation

In a world which is becoming increasingly concerned about dwindling energy reserves and increases in energy costs, more and more industries are seeking ways and means of reducing energy consumption. The textile industry is one such industry in which energy consumption ranks particularly high.

SAWTRI has been playing its part in this important field together with other research organisations worldwide. Manufacturers of textile machinery also play a major role in this respect by developing new technologies and machinery which enable the textile industry to reduce their energy consumption. Two such technologies which recently appeared on the scene, involve the dyeing of textiles by radio frequency and the application of foam in textile finishing. As announced in the March, 1981 Bulletin, SAWTRI considered these techniques to have considerable potential and therefore purchased the necessary equipment for research in this field. Great interest has been shown in these developments by a number of local textile firms, certain of which have visited SAWTRI to become better acquainted with the machines and also to carry out some trials of their own.

In wet processing a great deal of heat energy is required to ensure adequate fixation of any chemical applied during the process. A rapid and efficient way of providing such heat is by applying *radio frequency* energy to the textiles being treated. The Smith Fastran Electronic Dye Fixation machine now in use at SAWTRI has been developed for the continuous dyeing of natural and synthetic fibres in sliver form and it is claimed that this ensures rapid dye fixation of textile materials and considerable savings in energy. The process basically involves padding the fibre, which is in sliver form with a solution containing the dyestuff and various dyeing auxiliaries. The sliver is then fed continuously into a polypropylene tube or fixation chamber which is positioned between electrodes where radio frequency energy (RF) is used to heat the fibres to a temperature slightly higher than 100°C. A further washing off stage



Dr F. A. Barkhuysen (centre) surrounded by a number of industrial technicians with Drs van Rensburg and Turpie of SAWTRI on the extreme right during trial runs on the Fastran R.F. Machine

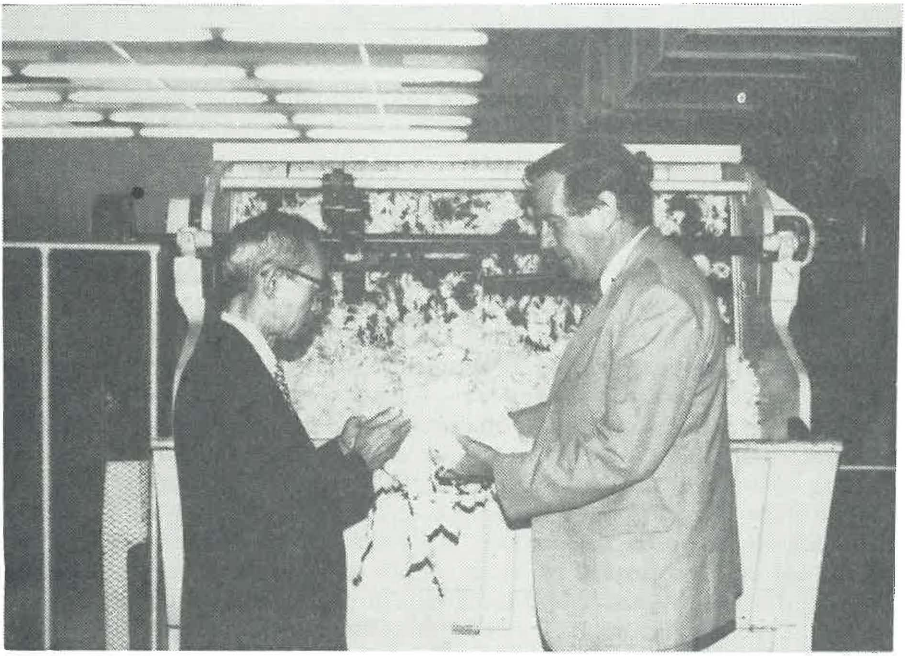
completes the process. The machine SAWTRI has acquired, has a production rate of 15 kg/h . With large scale machines it can be as high as 450 kg/h or in some cases, even higher.

Traditionally, textile finishing involves the application of various chemicals to textiles from aqueous media. After having served its purpose during the various finishing processes, the water has to be removed from the textile materials in some way or other, this process normally requiring a great deal of energy. One way of conserving energy is to reduce the wet pick-up during dyeing and finishing, thereby reducing the energy required to dry the fabric at the same time reducing water consumption. Various ways of reducing wet pick-up have been proposed but one which appears to hold much promise is the use of *foam* instead of water for the application of textile chemicals. What little water is used, is diluted by the use of *air* and certain *foaming agents*. Typically, the wet pick-up of fabrics can be reduced from 80% to 20%. *Pressurised foam* is applied directly to the fabric in specific quantities through a nozzle in an applicator. Upon contact with the fabric surface the foam bubbles burst and the chemicals carried in the bubble walls are released onto the textile fibres.

Foam Finishing appears to hold considerable potential, lending itself to the application of most textile chemicals, such as dyes, durable press resins, water repellents and softeners to both natural and synthetic fibre fabrics. For the purpose of investigating the potential and possibilities of *foam finishing,* SAWTRI is using a Gaston County Laboratory FFT machine.

Visitors to SAWTRI

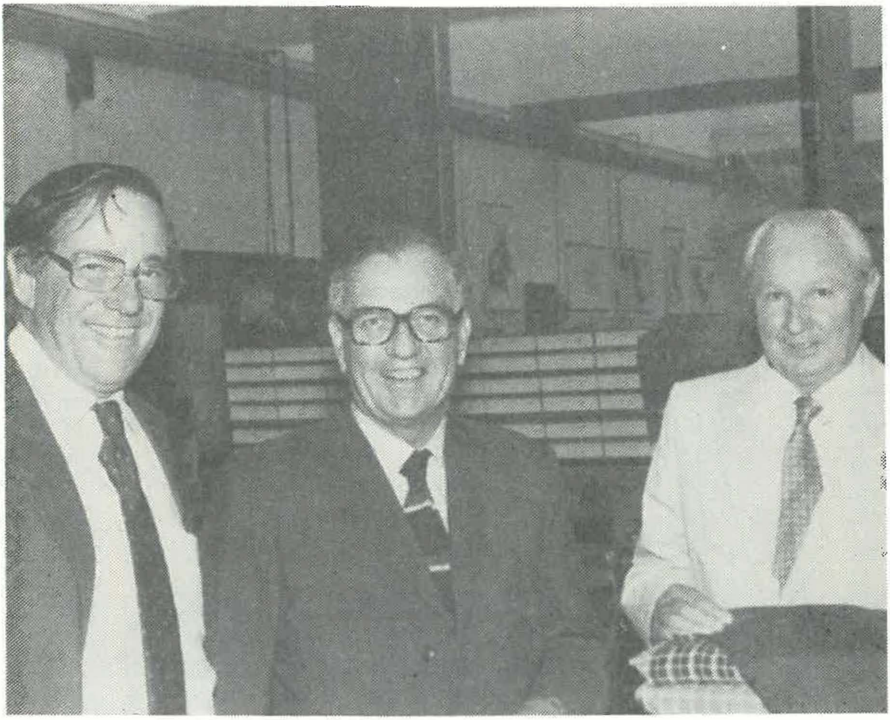
The Chairman of the Organising Committee for the seventh Quinquennial International Wool Textile Research Conference which is to be held in 1985 in Japan, Dr F. Bekku, paid a visit to SAWTRI on March 24th. Dr Bekku who is the Coordinator of the Asian Area of the International Wool Secretariat in Tokyo had discussions with SAWTRI's Director, Dr D. W. F. Turpie and Mr N. J. Vogt, both of whom served on the Organising Committee of the sixth Quinquennial conference for 1980 in Pretoria.



Dr Bekku examining scoured wool at the Card with Dr Turpie

Miss Lorna Cripps of the CSIR's London office in High Holborn, has been on a visit to South Africa calling on all the CSIR Institutes and on March 26th, she visited SAWTRI spending the day with the Regional Office and in the SAWTRI library.

On April 3rd, Mr Alan Clough, who is the president of the Textile Institute of Manchester, England had talks with Dr Turpie and was later hosted by Mr Alan Robinson, Chairman of the Eastern Cape Section of the Textile Institute.



Left to right: Dr D. W. F. Turpie, SAWTRI's Director, Mr J. A. Clough and Mr N. J. Vogt

A Farmers' Study Group from Australia spent the day of April 7th at SAWTRI where they were shown around the laboratories and processing departments and on April 9th, a delegation from the Hoëveld Agricultural High School in Morgenzon, Transvaal, were taken on a tour of the Institute.

TABLE I

DESCRIPTION OF PROCESSING SEQUENCE

Route	Description
Control	No steaming, moisture application via atomiser spray — comb from cans
A	Steam on third preparer only, comb from cans.
B	Steam on third preparer, comb from cans and steam on second finisher.
C	Steam on third preparer only, comb from balls.
D	Steam on third preparer, comb from balls and steam on second finisher.
E	Steam on first and second preparers only, comb from balls.
F	Steam on first and second preparers, comb from balls and steam on second finisher.

RESULTS AND DISCUSSION

Preliminary Trials

Preliminary experiments involving running the preparer gill-box at various speeds (30 to 50 m/min delivery speed) and steambox gauge settings (20 to 25 kPa) indicated that depending on the input regain, an increase of at best 3 to 5% (absolute) in regain could be achieved by steaming. It was also found, however, that the maximum practical gauge settings which could be employed depended to a large extent on the state of entanglement of the input sliver. For example, during the first preparatory gilling the maximum practical gauge setting was found to be 20 kPa . Higher settings caused sliver breakage in the steam chamber. During the second preparatory gilling this problem only arose at settings higher than 30 kPa . Steaming on the third preparer could be carried out at 50 kPa without any problem. It would therefore appear that if the intention is to increase the regain prior to combing from a relatively dry state of about 12% to 20 to 22%[10,11], a spray applicator would be required. There also appeared to be indications of a slight decrease in output regain with increasing sliver delivery rates, although this effect appeared to be neither large nor consistent.

During finisher gilling it was found that gauge settings of higher than 20 kPa caused the sliver to emerge from the gills in too damp a state, this, in turn, giving rise to excessive roller lapping. However, at this gauge setting the top slivers emerged at regains of the order of 17,5% without any problem.

The Effect of Steaming on Combing Performance

The combing results for the different routes are given in Table II.

Table II shows that steaming on the first and second preparer and combing from balls appeared to give marginally better results. The trends possibly would have been accentuated further if the regains before combing had been equal to that of the control lot. The improvements in tear when combing from balls as opposed to cans was not large from a practical point of view, but at least indicated that to some small extent an additional smoothing (i.e. further crimp reduction) and setting could possibly have taken place. The decrease in noil with a decrease in crimp is in agreement with Turpie's findings[2,3] and could possibly have been greater if the regains before combing had been constant.

The Effect of Steaming on the Properties of the Top

The physical characteristics of the tops which were produced via the different routes are given in Table III.

Table III shows that routes, B, D and F (i.e. those routes which involved steaming on the second finisher) produced tops which were very similar in mean fibre length to the control sample. A reason for this observation could possibly be found if one considers the differences in the manner in which steam was applied on the finisher gill as opposed to the preparer gill. On the preparer gill, the hot damp fibres emerged from the steam chamber and had to travel approximately 350 mm to the nip of the back roller while under tension. On the finisher gill, the fibres had to travel more than twice this distance (approximately 850 mm) and as a result possibly under less tension, as the steam chamber had to be mounted in front of the autoleveller measuring head. It is possible therefore that the slivers actually entered the finisher gill in a slightly more relaxed state, allowing some crimp development. This could possibly have caused the slightly lower mean fibre length values obtained on the Almeter. Such a crimp effect on Almeter measurements was previously also observed by Turpie[12,13].

As far as a comparison between ball and can feed to the comb is concerned, no distinct differences were apparent, with possibly route E (i.e. steaming on the first and second preparers, ball feed to comb and standard finishing routine) producing the best top in terms of conversion ratio and short fibre content.

SUMMARY AND CONCLUSIONS

An attempt was made to determine differences in the combing performance and top properties of an overcrimped wool when employing a steaming operation during preparatory and finisher gillings, as opposed to water application by conventional means (spray applicator). For this purpose a 10/12 month 60's quality (22 μm) wool which was 28% overcrimped relative to wool conforming to the average Duerden crimp/fineness relationship was converted into top along seven different routes. The first route was considered the standard route (i.e. moisture application via spray applicator on first and second prepaper gilling) while the remaining 6 routes differed in terms of whether the slivers were steamed on the first and second preparers or on the third preparer only, whether the comb feed was from balls or cans or whether the combed sliver was steamed on the second finisher or not.

Initial trials showed that the maximum practical gauge pressure depended upon the state of entanglement of the input sliver. A maximum setting of 50 kPa was possible on the third preparer. Under these conditions, it was found that the maximum regain which can be obtained by steaming was lower than that which can be obtained by spray application. However, during subsequent combing trials small improvements in tear were found, especially when combing from balls. This indicated that a small crimp reduction effect could have taken place. From a practical point of view, however, these differences were very small. As far as the top mean fibre lengths were concerned, it appeared that steaming during finishing had an apparent detrimental effect on length, possibly as a result of the restoration of some crimp during steaming on the finisher gill. Combing from balls as opposed to combing from cans did not appear to affect top properties consistently, although the best overall results were obtained when the wool was steamed on the first and second preparer, combed from balls and not steamed on the finisher.

It should be stressed that these results are tentative and further work, in particular with wools of varying levels of crimp will have to be carried out to confirm the trends observed.

ACKNOWLEDGEMENTS

The authors wish to thank Mr H. W. Labuschagne and Mrs L. L. Meiring for technical assistance, as well as Dr D. W. F. Turpie for valuable suggestions during the planning of the experiments.

THE USE OF PROPRIETARY NAMES

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SOME TYPICAL BUNDLE AND SINGLE FIBRE TENSILE PROPERTIES OF MOHAIR

by L. HUNTER and S. SMUTS

ABSTRACT

The bundle and single fibre tensile properties of a large number of mohair lots, ranging in diameter from 21 µm to 44 µm, have been determined. Leather linings were found to be more suitable than cardboard linings for the Stelometer bundle tensile tests. Both bundle- and single fibre tenacity were independent of the mohair fibre linear density (or fineness) and values considered typical for mohair have been arrived at. The initial modulus was found to decrease slightly as the mohair became coarser.

INTRODUCTION

It is widely recognised that the tensile characteristics of a textile fibre play an important rôle in determining its processing efficiency and subsequent end-use performance or durability. It is not surprising therefore that the tensile properties of fibres feature prominently in quality control as well as in research and development work. Nevertheless, single fibre tensile tests can be very time consuming and tedious and for this reason bundle tensile tests, in which the tensile properties of a bundle of fibres are measured, and which provide a simpler and a more rapid test, are increasingly being adopted. Such tests have been carried out for a long time on cotton and were also adopted a few years ago for wool. Using this method, "average" or "typical" values have been compiled for the bundle tensile properties of wool tops[1]. Such values may be used as a basis of reference when assessing the tensile properties of wool tops in practice.

No work appears to have been carried out on the bundle tensile properties of mohair fibres although work has been done on its single-fibre tensile properties[2-8]. It was therefore decided to carry out bundle tensile tests on a wide range of mohair samples and to use the information to prepare "average" or "typical" values for mohair. To make the study more complete it was also decided to measure the single fibre tensile properties and to establish the effect of fibre diameter on the bundle and single fibre tensile properties.

EXPERIMENTAL

Samples from 54 mohair lots (scoured, tops and rovings) were studied (see Table I). The mohair varied in mean fibre diameter from about 21 µm to 44 µm which just about spans the complete range for mohair produced in South Africa. All tests were carried out at 65% RH and 20°C.

Bundle Tests

The bundle tensile tests were carried out on a Stelometer, in accordance with the test method developed for wool (IWTO-5-73E) using both cardboard and leather jaw linings, six tests being carried out per sample. A control wool top used in an earlier study[1], was used to obtain a correction factor which was then applied to the mohair results. This correction factor was generally about 1,16, i.e. the values given in Table I are approximately 16% higher than those actually obtained, this being based upon the correction factor obtained by means of a standard wool top[1].

Single Fibre Tests

Single fibre tensile tests were carried out on 29 of the mohair lots. Approximately 15 fibres were tested for each lot on an Instron tensile tester under the following conditions:

Gauge length	:	20 mm
Rate of extension	:	20 mm/min
Pre-tension	:	0,5 cN/tex.

Prior to each test, the fibre fineness was determined[9] on a Zweigle Vibroskop S 151/2 vibroscope, the same segment afterwards being subjected to the tensile test.

Fibre Diameter

The fibre diameter results given in Table I, were obtained on a projection microscope and represent the overall sample mean and not the mean for the 15 fibres actually tested, the latter being the case for the linear density determinations on the vibroscope.

RESULTS AND DISCUSSION

Bundle Tensile Properties

From Table I and Fig 1 it can be seen that the cardboard jaw linings generally gave much lower tenacity values than the leather linings, indicating that fibre slippage occurred when cardboard linings were used.

The cardboard linings also gave slightly lower extension values (see Table I and Fig 2). These specific cardboard linings therefore appear to be unsuitable for mohair.

Regression analyses of either bundle tenacity or bundle extension against mean fibre diameter showed that fibre diameter had no effect on the bundle tensile properties, and it can be concluded therefore that the average of all the bundle tenacity values obtained with the leather linings, namely 14 cN/tex (CV = 3,7%) may be regarded as typical for mohair. This is very similar to the values previously[1] obtained for wool tops of the same mean fibre diameter. A bundle extension of 14,6% (CV = 6,4%) may be taken as typical, although the extension values obtained in a bundle test of this nature are not considered reliable. There were no differences between the results obtained on the scoured fibres, tops and rovings.

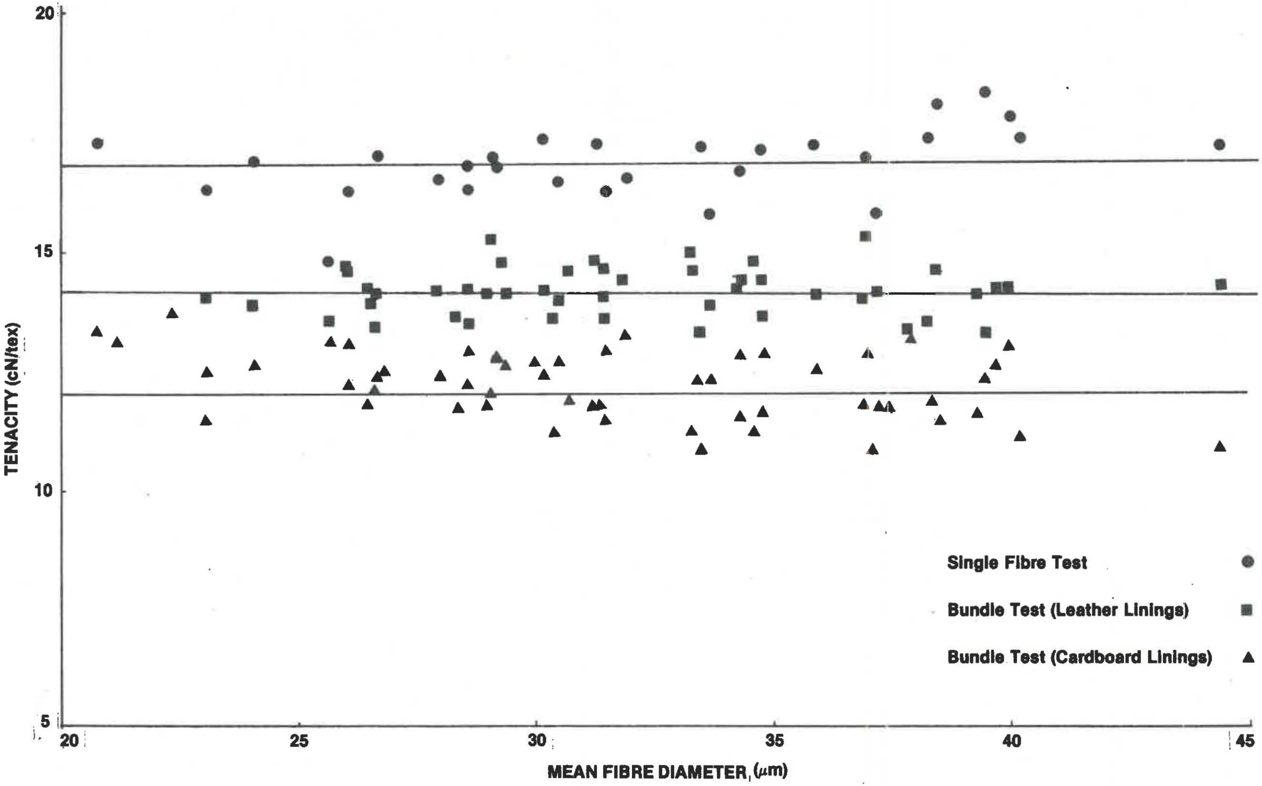

FIGURE 1
Mohair Fibre Tenacity vs Mean Fibre Diameter

TABLE I
MOHAIR FIBRE DETAILS

Lot No.	Fibre* Diameter		Linear** Density		Single Fibre Tests***								Bundle Tests**** (3,2 cm gauge)			
					Initial Modulus		Breaking Strength		Extension at Break		Tenacity		Cardboard Linings		Leather Linings	
	Mean (µm)	CV (%)	Mean (dtex)	CV (%)	Mean (cN/tex)	CV (%)	Mean (cN)	CV (%)	Mean (%)	CV (%)	Mean (cN/tex)	CV (%)	Tenacity (cN/tex)	Extension (%)	Tenacity (cN/tex)	Extension (%)
1	20,7	30,2	5,8	25,7	428	7,8	10,0	29,4	43,7	10,7	17,1	11,5	13,2	12,3	—	—
2	21,1	32,0	—	—	—	—	—	—	—	—	—	—	12,9	11,9	—	—
3	22,3	32,1	—	—	—	—	—	—	—	—	—	—	13,5	14,2	—	—
4	23,0	31,8	—	—	—	—	—	—	—	—	—	—	12,3	13,0	—	—
5	25,6	33,6	11,5	35,4	389	6,0	16,7	36,0	38,0	8,2	14,6	10,4	12,9	13,9	13,3	14,8
6	28,5	33,4	12,2	30,8	396	10,6	20,0	37,5	39,3	12,3	16,1	9,2	12,7	14,6	13,3	14,3
7	31,4	31,0	13,9	30,9	400	9,7	23,4	36,5	39,9	9,5	16,1	11,0	11,3	12,8	13,4	14,7
8	33,3	22,4	—	—	—	—	—	—	—	—	—	—	12,1	12,9	14,4	14,4
9	34,7	22,4	—	—	—	—	—	—	—	—	—	—	11,4	12,7	13,4	14,7
10	38,4	26,2	15,0	20,2	399	6,2	25,9	29,6	43,6	6,8	17,9	17,7	11,2	11,5	14,4	16,1
11	40,1	21,8	14,5	26,8	395	5,7	25,2	30,9	45,4	8,0	17,2	11,3	10,9	11,5	—	—
12	44,3	23,4	20,1	21,9	384	8,7	34,4	26,8	40,4	9,8	17,0	8,4	10,7	13,0	14,1	12,1
13	24,0	33,0	8,0	34,0	429	5,1	13,5	36,4	45,8	6,7	16,7	9,2	12,4	11,9	13,7	13,3
14	26,4	29,9	—	—	—	—	—	—	—	—	—	—	11,6	11,1	14,0	13,8
15	26,6	28,6	9,4	19,4	423	6,1	15,8	21,3	44,7	5,6	16,8	8,3	12,2	12,4	14,0	14,6
16	26,5	28,0	—	—	—	—	—	—	—	—	—	—	11,9	12,1	13,8	13,4
17	27,9	25,6	10,8	23,0	422	7,3	17,5	23,7	41,8	7,4	16,3	7,2	12,2	11,0	14,1	13,5
18	28,3	32,7	—	—	—	—	—	—	—	—	—	—	11,6	12,2	13,3	14,5
19	29,0	23,2	9,2	26,3	411	11,9	15,5	27,0	45,5	5,7	16,8	8,0	11,8	11,4	15,1	14,9
20	29,3	29,2	—	—	—	—	—	—	—	—	—	—	12,4	12,1	13,9	15,0
21	30,1	25,3	9,9	28,9	423	7,8	16,5	27,9	44,8	8,8	17,2	8,9	12,2	12,2	14,0	14,8
22	30,6	23,0	—	—	—	—	—	—	—	—	—	—	11,7	10,7	14,4	15,3
23	31,2	25,6	10,7	35,5	421	9,8	18,6	42,7	44,3	11,1	17,1	11,4	11,5	12,0	14,7	14,3
24	31,3	24,2	—	—	—	—	—	—	—	—	—	—	11,5	11,2	14,7	15,8
25	31,4	23,0	—	—	—	—	—	—	—	—	—	—	12,7	11,4	13,8	14,2
26	31,8	26,4	11,1	36,1	407	12,2	18,3	37,3	43,5	14,6	16,4	13,1	13,0	12,0	14,2	14,3
27	33,4	25,0	13,0	28,2	418	7,8	22,2	30,2	42,7	7,4	17,0	6,1	10,6	10,6	13,1	13,5
28	34,2	23,2	—	—	—	—	—	—	—	—	—	—	11,3	11,7	14,1	15,2
29	34,2	27,3	12,0	35,7	408	5,1	20,4	48,3	41,4	11,5	16,5	12,1	12,6	12,9	14,1	15,2
30	35,8	27,8	15,0	31,8	409	7,4	25,9	38,2	41,5	8,5	17,0	7,7	12,3	13,0	13,9	15,1
31	37,8	26,1	—	—	—	—	—	—	—	—	—	—	12,9	12,6	13,1	13,6
32	38,2	26,5	15,8	26,8	399	5,7	26,8	38,0	41,7	8,9	17,2	11,9	11,6	12,1	13,3	13,2

(Continued on next page)

TABLE I
MOHAIR FIBRE DETAILS (Continued)

	Lot No.	Fibre* Diameter		Linear** Density		Single Fibre Tests***								Bundle Tests**** (3,2 cm gauge)			
						Initial Modulus		Breaking Strength		Extension at Break		Tenacity		Cardboard Linings		Leather Linings	
		Mean (μm)	CV (%)	Mean (dtex)	CV (%)	Mean (cN/tex)	CV (%)	Mean (cN)	CV (%)	Mean (%)	CV (%)	Mean (cN/tex)	CV (%)	Tenacity (cN/tex)	Extension (%)	Tenacity (cN/tex)	Extension (%)
	33	39,6	25,4	15,3	29,6	403	7,3	27,0	32,6	43,5	10,1	17,6	9,9	12,4	13,3	14,0	16,1
	34	39,9	29,3	—	—	—	—	—	—	—	—	—	—	12,8	12,8	14,0	15,2
	35	23,0	34,9	8,7	44,8	413	9,7	14,2	53,3	41,3	22,7	16,1	12,8	11,3	11,1	13,8	16,0
	36	26,0	31,6	—	—	—	—	—	—	—	—	—	—	12,0	12,8	14,5	15,4
	37	26,0	30,6	7,9	29,2	411	4,6	12,8	34,3	45,5	9,1	16,1	8,2	12,9	12,6	14,5	15,3
	38	26,6	24,5	—	—	—	—	—	—	—	—	—	—	12,2	13,1	13,2	13,7
	39	28,5	21,2	6,7	27,3	393	11,5	11,3	32,3	45,4	9,6	16,6	12,4	12,0	13,1	14,0	15,2
	40	28,9	22,5	—	—	—	—	—	—	—	—	—	—	11,6	12,7	13,9	15,3
	41	29,1	22,5	9,5	20,6	430	9,5	15,7	18,4	43,5	9,0	16,6	9,4	12,6	12,7	14,6	14,3
	42	30,3	27,2	—	—	—	—	—	—	—	—	—	—	11,0	12,5	13,4	14,2
	43	30,4	23,1	10,0	30,8	389	11,5	16,3	33,7	42,8	7,6	16,3	11,4	12,5	13,8	13,8	13,2
	44	33,2	23,9	—	—	—	—	—	—	—	—	—	—	11,0	11,8	14,8	17,1
	45	33,6	23,6	10,7	15,5	409	13,5	16,9	18,2	39,3	12,2	15,6	8,1	12,1	13,8	13,7	15,6
	46	34,5	21,7	—	—	—	—	—	—	—	—	—	—	11,0	11,5	14,6	15,1
	47	34,7	22,5	12,8	31,3	404	6,1	22,1	24,7	41,7	5,5	16,9	6,1	11,4	12,8	14,2	14,7
	48	36,8	27,4	—	—	—	—	—	—	—	—	—	—	11,6	13,8	13,8	15,1
	49	36,9	26,8	14,6	26,1	404	9,3	24,6	30,4	43,1	8,1	16,8	9,5	12,6	13,7	15,1	15,1
	50	37,0	27,3	—	—	—	—	—	—	—	—	—	—	10,6	10,5	—	—
	51	37,1	25,9	14,5	28,3	386	8,0	22,3	26,8	40,5	7,5	15,6	12,4	11,5	11,6	13,9	13,7
	52	37,3	27,1	—	—	—	—	—	—	—	—	—	—	11,5	12,7	—	—
	53	39,2	25,7	—	—	—	—	—	—	—	—	—	—	11,4	12,6	13,9	15,2
	54	39,4	24,3	17,5	22,3	407	9,9	31,8	25,5	42,8	6,8	18,1	8,0	12,1	12,7	13,0	14,1
No. of Lots	54	54		29		29				29		29		54	54	47	47
Average		31,7	26,7	11,9		407				42,7		16,7		11,9	12,4	14,0	14,6
Standard Deviation		5,55	3,66	3,3		13,2				2,1		0,72		0,71	0,93	0,52	0,94
CV (%)		17,5	13,7	27,9		3,2				5,0		4,3		5,9	7,5	3,7	6,4

*Projection microscope average for the parent lot

**Vibroscope value obtained on actual fibres tested

***20 mm test length; 20 mm/min rate of extension and 0,5 cN/tex pre-tension

****The tenacity values are about 16% higher than those actually obtained since a correction factor of 1,16 was applied.

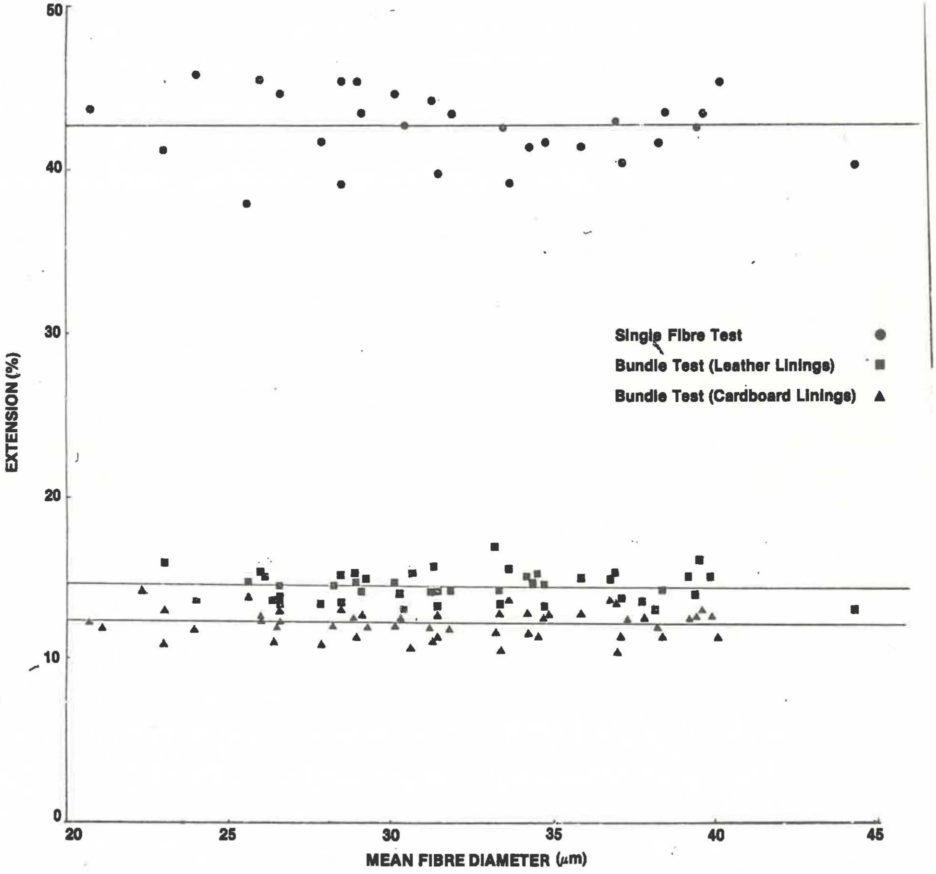

FIGURE 2
Mohair Fibre Extension at Break vs Mean Fibre Diameter

Single Fibre Tensile Properties

The following regression analyses were carried out on the log of the results given in Table I. Breaking strength (cN), tenacity (cN/tex), extension (%) and initial modulus (cN/tex) were each taken as dependent variables and the vibroscope fibre linear density (dtex) as independent variable.

The following significant regression equations were obtained:

Breaking Strength (cN) = 1,54 (Linear density in dtex)^{1,03} .... (1)

Number of results (n) = 29; correlation coefficient (r) = 0,99

Initial Modulus (cN/tex) = 469 (Linear density in dtex)$^{-0,058}$ .... (2)

n = 29; r = 0,52

The decrease in initial modulus with increasing fibre linear density could be an artefact of the test method.

Extension (%) = 50,9 (Linear density in dtex)$^{-0,073}$.................... (3)

n = 29; r = 0,42

From the results of the statistical analyses the following conclusions may be drawn:

The between-sample single fibre breaking strength was a linear function of the fibre linear density and the single fibre tenacity was therefore independent of the fibre linear density (i.e. diameter). A single fibre tenacity value of 16,7 cN/tex can therefore be regarded as typical for mohair. The initial modulus tended to decrease with an increase in fibre linear density (i.e. diameter), decreasing from about 420 cN/tex for a 6 dtex ($\approxeq$ 24 μm) fibre to about 400 cN/tex for a 17 dtex ($\simeq$ 44 μm) fibre. This could be an artefact of the test method, however. There was also a trend for the fibre extension at break to decrease slightly with an increase in fibre linear density (or diameter). The large discrepancy between the single fibre and bundle extension values clearly demonstrate that the bundle extension values are not a reliable guide to the fibre extension characteristics.

The single fibre tenacity and extension results have been plotted against mean fibre diameter in Figs 1 and 2, respectively.

As in the case of the bundle tests, there were no differences between the values obtained on the scoured fibre, tops and rovings, respectively.

SUMMARY AND CONCLUSIONS

The bundle tensile properties of 54 mohair lots, varying in diameter from 21 μm to 44 μm, were determined on a Stelometer at a gauge length of 3,2 mm (1/8″) using cardboard and leather jaw linings, respectively. It was found that the particular cardboard linings used in this study gave significantly lower tenacity and extension values than the leather linings and they are therefore considered unsuitable for testing mohair. It was found that neither bundle tenacity nor bundle extension was significantly affected by the mean fibre diameter. The overall average of all the results (see Table II) can therefore be

regarded as "typical" for mohair and can serve as a basis of reference whenever the bundle tenacity of mohair is determined in practice. Comparable bundle tenacity values were previously obtained for wool tops of similar mean fibre diameters.

TABLE II

TYPICAL TENSILE PROPERTIES OF MOHAIR

Property	**Bundle Test***	**Single Fibre Test**
Tenacity (cN/tex)	14,0	16,7
Extension (%)	14,6**	43,0
Initial Modulus (cN/tex)	—	407

*Leather linings were used and the tenacity values obtained were multiplied by a correction factor of 1,16

**The bundle test is not considered to give reliable extension values.

Single fibre tensile tests were also carried out on 29 of the lots and it was found that the between-sample fibre breaking strength was a linear function of fibre linear density, with the result that the fibre tenacity was independent of the fibre linear density (or diameter). Once again, therefore, the overall average of the tenacity values (see Table II) can be regarded as "typical" of mohair and can be used in practice as a basis of reference.

There was a trend for both the single fibre initial modulus and extension to decrease with an increase in mean fibre diameter although the effect was not very large. The changes in the initial modulus however, could have been an artefact of the test method.

ACKNOWLEDGEMENTS

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THE RELATIONSHIP BETWEEN WOOL MEAN FIBRE LENGTH IN THE TOP AND THAT IN THE YARN

by L. HUNTER, E. GEE and A. BRAUN

ABSTRACT

Some 50 wool tops, covering a range of fibre diameter, length and crimp were processed into 35 and 50 tex yarns on the continental system followed by ring-spinning (double apron drafting). The mean fibre lengths in the tops and the yarns were compared and it was found that the mean fibre length in the yarn was lower than that in the top, the difference being a function of fibre length and crimp. Generally the CV's of fibre length were similar in the tops and yarns, with more highly crimped wools being associated with higher CV's in the yarn.

INTRODUCTION

The importance of wool fibre length in determining yarn physical properties is undisputed[1] but there is little information available concerning the changes which occur in the fibre length characteristics from the top to yarn, particularly with respect to processing on the continental (French) system, followed by spinning on a double-apron ring spinning frame.

Most of the work done to date[2-7] has been on the Bradford system of drawing followed by either cap or Ambler superdraft spinning. These studies have shown that a significant decrease in mean fibre length could occur during both drawing and spinning as a result of fibre breakage. The actual decrease in mean fibre length, amongst other things, was found to depend upon fibre diameter[3,5,7] and strength[4,5], as well as on roving twist[3], the spinning system[6] and yarn linear density[7].

With respect to processing on the continental system, Bratt[7] mentioned that unpublished work had shown fibre breakage to be quite low. Grignet[8] produced some results, obtained on the continental system when processing a 21 μm wool, which showed fibre length to decrease from 63,5 mm in the top to 52 mm in the yarn, the main reduction in length occurring during spinning. Results by Dusenbury and Dansizer[9], who processed wools differing in length and diameter on the continental system, indicated that mean fibre length hardly changed from top to roving. Menkart and Detenbeck[10] also observed some fibre breakage during both French drawing and ring-spinning of two merino wools differing in crimp.

Godard *et al*[11] have stated that, for fine fibres, the mean fibre length in the roving at most is only about 4% lower than that in the top, whereas it could be reduced by as much as 10% from the roving to the yarn stage. For wools coarser than about 23 μm, there apparently is good agreement between the fibre length distribution in the top and in the yarn. Hunter[12] also found that the mean fibre length in yarns, processed on the continental system and spun on a double-apron ring-spinning frame, generally was lower than that in the top.

The above studies, in particular those on the continental system, have been limited in that very few wool lots generally have been covered and little therefore is known about how the decrease in mean fibre length from the top to the yarn is affected by factors such as fibre length, diameter and crimp. It was decided therefore to measure the fibre length characteristics of about 100 yarns spun from some 50 wool lots differing widely in their fibre characteristics. Such information should prove valuable for assessing models being developed[13] for predicting the fibre length in yarns from the top and grease wool values.

EXPERIMENTAL

Details of the wool tops are given in Table I. Fibre diameter was determined by projection microscope, and fibre length by both the Almeter and Wira single fibre length methods. The staple crimp was determined on the greasy wool while the resistance to compression (or bulk) was determined on the tops using a SAWTRI Compressibility tester[14,15] after steam-relaxation. The values given are directly proportional to the bulk (volume) of a 2,5 g randomised wool sample compressed for one minute in a cylinder 50,5 mm in diameter by a load of 1 kg (9,8 N). Various studies have shown that such a simplified test correlates very well with other more sophisticated measures of bulk resistance to compression.

Each 24 ktex top was treated with 0,3% (o.m.f.) of antistatic/lubricant prior to reducing to 12 ktex on a Schlumberger GNP gill box (three doublings, draft = 6,0). Two further gillings (on a Schlumberger GN4 gillbox) reduced the sliver linear density to 3 ktex, each gilling involving three doublings and a draft of 6,0. From each batch of gilled top sliver, two sets of rovings were prepared on a Schlumberger FM-1 roving frame, namely 500 tex (two doublings at a draft of 14,3) and 620 tex (two doublings at a draft of 9,7). Both sets of rovings were spun on a Rieter H6 worsted ringframe (double-apron) fitted with crowned spindles (collapsed balloon).

The 500 tex rovings were spun into 35 tex Z475 yarns (draft = 14,3) and the 620 tex rovings into 50 tex S380 yarns (draft = 12,4). Both these yarns were spun at a spindle speed of 7 000 rev/min and were to be used in various projects aimed at relating wool fibre properties to yarn and fabric properties.

Fibre length tests were carried out on the various yarns according to the IWTO-5-60 test method (at least 2 000 measurements per yarn) and the results are given in Table I.

TABLE I
FIBRE DETAILS

Lot	Grease wool	Tops						Yarns*		
	Staple Crimp (per cm)	Single Fibre Length Test		Almeter Test		Resistance to Compression (mm)	Mean Fibre Diameter (μm)	Fibre Length (mm)		
		Mean (mm)	CV (%)	Mean (mm)	CV (%)			35 tex	50 tex	Average
BR1	4,4	80	45	77	43	18,1	20,2	65,7 (46)	73,8 (44)	69,8 (44,8)
BR2	5,8	70	45	67	40	22,9	20,7	64,9 (43)	72,9 (40)	68,9 (41,5)
BR3	3,5	84	37	80	42	16,9	22,4	74,7 (44)	74,5 (43)	74,6 (43,5)
BR4	4,8	79	46	73	50	19,5	21,3	59,9 (50)	62,4 (49)	61,2 (49,2)
BR5	3,0	83	44	74	57	15,5	24,9	68,5 (44)	68,3 (44)	68,4 (44,2)
BR6	4,5	76	42	74	44	18,1	20,8	67,3 (45)	71,2 (44)	69,3 (44,6)
BR7	4,6	80	39	72	44	18,6	20,9	70,5 (42)	68,6 (42)	69,6 (41,8)
BR8	4,1	76	44	71	52	18,8	24,3	63,8 (46)	64,8 (44)	64,3 (45,0)
BR9	5,3	78	41	76	43	18,5	19,0	68,5 (44)	69,8 (41)	69,2 (42,7)
BR10	4,0	87	41	89	36	16,7	20,7	77,8 (42)	83,7 (41)	80,8 (41,9)
BR11	5,3	78	43	75	44	18,4	19,5	64,9 (48)	71,4 (42)	68,2 (44,9)
BR12	5,2	75	41	71	45	20,0	20,2	66,9 (43)	65,2 (45)	66,1 (44,2)
BR13	4,8	82	46	75	53	20,8	23,8	69,1 (48)	74,7 (41)	71,9 (44,5)
BR14	3,7	84	45	73	58	16,5	23,1	61,4 (50)	69,8 (42)	65,6 (46,0)
BR15	6,2	70	42	66	45	20,7	19,2	63,8 (43)	65,0 (42)	64,4 (42,4)
BR16	2,5	83	34	85	33	14,7	25,4	78,9 (38)	80,0 (36)	79,5 (36,6)
BR17	4,8	75	49	71	51	19,7	21,1	64,5 (47)	64,5 (45)	64,5 (45,9)
BR18	5,2	84	41	78	43	17,5	20,1	71,2 (45)	73,4 (43)	72,3 (44,1)
BR19	3,7	79	38	73	42	15,2	22,3	70,8 (40)	72,0 (39)	71,4 (39,1)
BR20	5,3	81	42	74	44	19,3	22,9	69,0 (45)	73,6 (40)	71,3 (42,6)
BR21	3,8	80	41	80	44	14,6	21,7	77,5 (41)	78,5 (40)	78,0 (40,1)
BR22	2,9	93	44	89	48	17,7	28,5	79,0 (43)	79,8 (46)	79,4 (44,5)
BR23	3,0	70	40	70	41	16,6	24,7	73,8 (32)	70,5 (35)	72,2 (33,3)
BR24	2,6	68	47	73	42	14,0	26,5	72,6 (36)	72,1 (38)	72,4 (36,9)
BR25	3,3	71	41	77	36	14,4	24,6	74,0 (35)	74,2 (35)	74,1 (35,2)
BR28	3,0	76	44	78	36	15,1	24,7	78,5 (34)	77,2 (36)	77,9 (35,1)
BR29	2,9	77	45	76	47	16,0	27,1	72,2 (41)	75,8 (39)	74,0 (40,1)
BR30	2,1	113	47	115	43	16,7	31,7	87,7 (47)	88,7 (45)	88,2 (45,9)
BR33	5,9	65	40	53	47	21,1	24,1	60,1 (43)	59,4 (42)	59,8 (42,7)
BR34	4,0	56	39	51	50	14,4	21,0	60,0 (36)	60,5 (36)	60,3 (35,9)
BR35	5,9	60	48	54	51	22,6	21,1	58,5 (41)	55,5 (43)	57,0 (42,3)
BR36	3,7	68	38	66	44	14,9	22,6	73,7 (33)	75,5 (33)	74,6 (32,8)
BR37	3,3	62	32	62	39	15,3	25,1	69,5 (28)	65,9 (32)	67,7 (30,3)
BR38	5,6	60	36	53	38	14,8	23,2	61,8 (33)	62,3 (34)	62,1 (33,4)
BR39	4,6	58	35	52	40	20,2	18,2	59,9 (34)	60,2 (32)	60,1 (32,9)
BR40	4,2	56	39	49	49	16,0	20,1	60,8 (36)	58,9 (35)	59,9 (35,4)
BR41	4,2	67	32	60	45	17,9	23,1	67,6 (33)	65,3 (36)	66,5 (34,5)
BR42	4,1	71	40	58	57	14,0	19,6	68,5 (40)	66,4 (43)	67,5 (41,9)
BR43	3,6	55	33	49	39	15,1	21,2	58,8 (34)	54,4 (35)	56,6 (34,4)
BR44	3,0	68	34	66	41	14,8	23,2	71,0 (30)	72,7 (39)	71,9 (34,8)
BR45	3,6	55	32	53	33	15,0	21,3	59,0 (31)	58,6 (29)	58,8 (29,9)
BR46	2,6	72	34	68	45	14,6	29,2	72,2 (35)	66,7 (37)	69,5 (36,1)
BR47	3,7	58	37	55	38	15,6	21,1	58,1 (37)	59,4 (36)	58,8 (36,7)
BR48	2,6	74	40	70	52	15,0	29,5	71,5 (42)	71,3 (31)	71,4 (36,7)
BR49	1,9	78	46	72	55	13,6	33,1	70,0 (45)	72,7 (41)	71,4 (43,3)
BR51	3,2	60	31	55	33	15,2	22,9	62,0 (34)	61,7 (32)	61,9 (32,7)
BR52	4,5	69	31	54	47	15,0	19,0	62,8 (40)	59,5 (37)	61,2 (38,3)
BR53	5,1	64	50	56	56	22,6	26,4	55,8 (50)	62,1 (43)	59,0 (46,6)
BR54	6,4	60	42	44	56	24,7	19,2	50,6 (45)	49,8 (41)	50,2 (43,3)
BR55	6,5	48	46	38	56	23,8	19,5	47,2 (42)	47,0 (42)	47,1 (42,3)
BR56	5,1	65	51	62	55	17,5	18,3	62,2 (44)	64,9 (47)	63,6 (45,5)
BR57	6,0	63	43	53	49	20,3	18,5	57,3 (43)	58,3 (42)	57,8 (42,7)

*Single fibre length method. CV values are given in parenthesis

RESULTS AND DISCUSSION

Effect of Yarn Linear Density

It was found that there were no statistically significant differences between the mean fibre length and CV of fibre length results for the 35 tex and 50 tex yarns. Only the averages of the two sets of results (see Table I) therefore were considered in the various analyses which are about to be described.

Mean Fibre Length

Statistical analyses were carried out on the log results to determine the relationship between the mean and CV of fibre length in the tops and those in the yarn and the effect of the other fibre characteristics such as diameter, staple crimp and resistance to compression on the relationship.

Multiple regression analyses on the log results were carried out with the mean fibre length in the yarns as dependent variable (Y_1) and the mean fibre length in the tops (single fibre length test X_4), mean fibre diameter (X_1) and either staple crimp (X_2) or resistance to compression (X_3) as independent variables. The analysis was then repeated except that the single length results of the tops were replaced by the Almeter results (X_5). The results of the statistical analyses have been summarised in Table II.

From the statistical analyses it appeared that the mean fibre length in the yarn was a function of that in the top and the fibre crimp. At a constant top mean fibre length, an increase in crimp (or resistance to compression) was associated with a decrease in the mean fibre length in the yarn, which therefore suggests that the more highly crimped wools suffered more breakage during drawing and spinning. According to the regression equation, increasing the staple crimp from 3 to 6 (which represents the extremes) decreased the mean fibre length in the yarn by about 10%, assuming a constant top mean fibre length. Nevertheless, the contribution of crimp to the overall percentage fit was small.

From Table II it can also be seen that the Almeter results (for the tops) generally gave slightly higher correlation coefficients. The effect of crimp on the mean fibre length in the yarn is smaller if the relationship involving the Almeter top mean fibre length results is used, this possibly being due to an effect of crimp on the Almeter results. The trends are illustrated in Figs 1 and 2 from which it can also be seen that the longer tops suffered a larger reduction in mean fibre length than did the shorter tops. Surprisingly, the decrease in mean fibre length did not appear to be a function of mean fibre diameter.

TABLE II

SUMMARY OF STATISTICAL ANALYSES ON MEAN FIBRE LENGTH RESULTS

Dependent Variable	Contribution of each independent variable Overall correlation (%)							Regression Equation	Correlation Coefficient (r)	Percentage Fit (r^2 x 100)
	X_1	X_2	X_3	X_4	X_5	X_6	X_7			
Mean Fibre Length (yarn)	ns	16	*	62	*	*	*	$8{,}7\,X_2^{-0{,}14}\,X_4^{0{,}53}$	0,88	78
	ns	*	15	66	*	*	*	$12{,}2\,X_3^{-0{,}28}\,X_4^{0{,}59}$	0,90	81
	*	*	*	67	*	*	*	$4{,}8\,X_4^{0{,}62}$	0,82	67
	ns	5	*	*	82	*	*	$9{,}9\,X_2^{-0{,}08}\,X_5^{0{,}48}$	0,94	88
	ns	*	7	*	83	*	*	$13{,}6\,X_3^{-0{,}2}\,X_5^{0{,}51}$	0,95	90
	*	*	*	*	84	*	*	$6{,}9\,X_5^{0{,}54}$	0,92	84
CV of Fibre Length (yarn)	ns	4	*	*	*	56	*	$2{,}7\,X_2^{0{,}08}\,X_6^{0{,}69}$	0,78	60
	ns	*	8	*	*	54	*	$2{,}3\,X_3^{0{,}2}\,X_6^{0{,}62}$	0,79	62
	*	*	*	*	*	57	*	$2{,}7\,X_6^{0{,}73}$	0,75	57
	ns	ns	*	*	*	*	38	$5{,}6\,X_7^{0{,}52}$	0,62	38
	ns	*	17	*	*	*	32	$3{,}7\,X_3^{0{,}29}\,X_7^{0{,}41}$	0,70	49

ns = non-significant at 95% level
X_1 = Mean fibre diameter (μm)
X_2 = Staple crimp (per cm)
X_3 = Resistance to compression (mm compressed height)
X_4 = Mean fibre length (mm — single fibre length test)

* = variable not included in the analysis
X_5 = Mean fibre length (mm — Almeter test)
X_6 = CV of fibre length (% — single fibre length test)
X_7 = CV of fibre length (% — Almeter test)

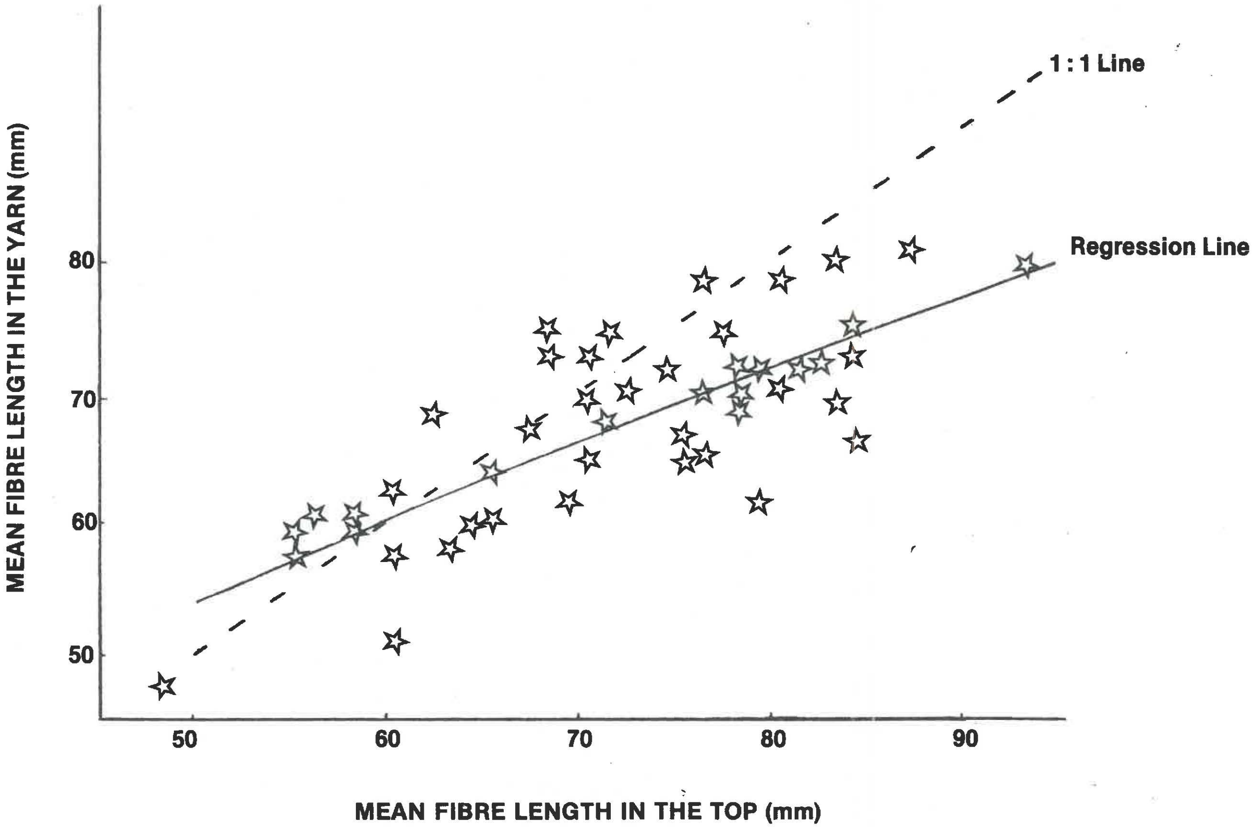

FIGURE 1

The relationship between mean fibre length in the yarn and that in the top (single fibre length test)

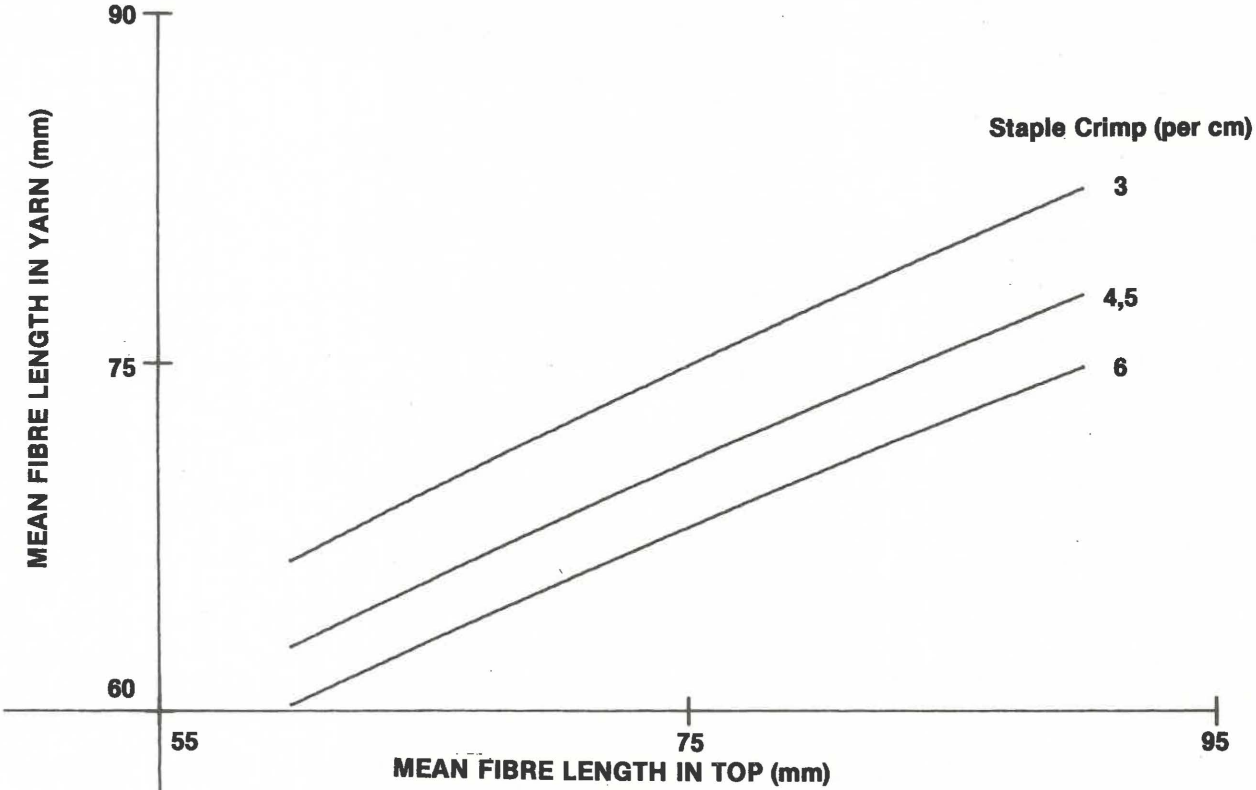

FIGURE 2

Regression curves illustrating the relationship between mean fibre length in the yarn and that in the top and the effect of staple crimp (single fibre length test)

CV of Fibre Length

The results of the statistical analyses on the CV of fibre length results have been summarised in Table II, from which it appears that the CV of fibre length in the yarn was generally a function of both the CV of fibre length in the top and the fibre crimp (or resistance to compression). An increase in fibre crimp generally resulted in an increase in CV of fibre length (see Fig 3). If the CV of fibre length results (single fibre length test) are taken as a whole, it appears that there was little difference between the top and yarn results; what differences there were, probably fell within the experimental error. The Almeter CV results on the tops were not as well correlated with the yarn results as the single fibre length CV results (see Table II).

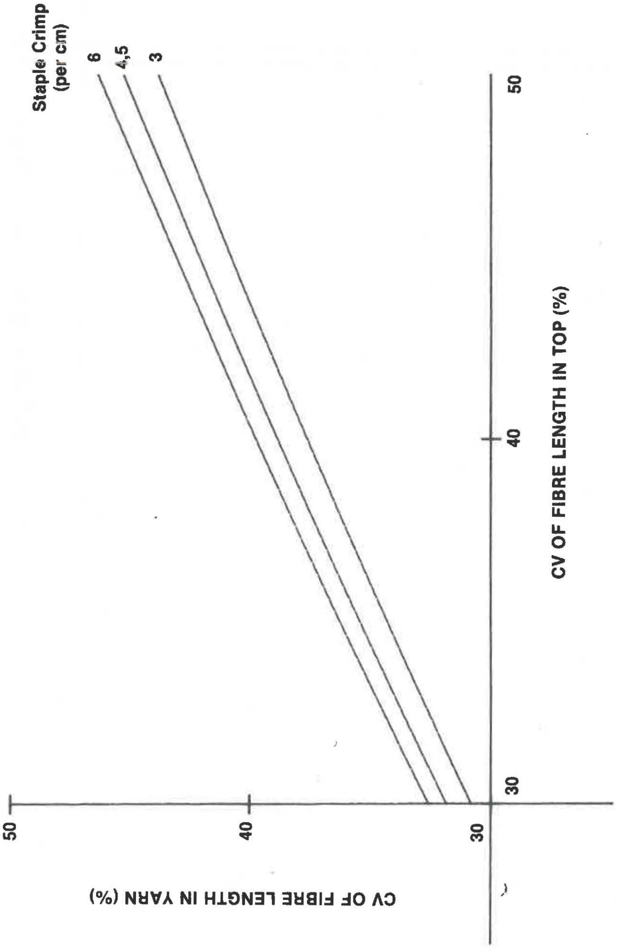

FIGURE 3

Regression curves illustrating the relationship between CV of fibre length in the yarn and that in the top for different levels of staple crimp (single fibre length test)

SUMMARY AND CONCLUSIONS

Because of the limited information available on the change in mean fibre length when wool tops are processed into yarns on the continental system, it was decided to investigate this aspect for a range of wool tops. More than 50 wool tops, differing widely in fibre characteristics, were each spun into 35 and 50 tex yarn, on a ring-frame fitted with a double-apron drafting system. It was found that the mean fibre length results of the two sets of yarns did not differ significantly and their averages were therefore used in the statistical analysis of the data.

Multiple regression analyses, carried out on the log results, showed that the mean fibre length in the yarns generally was a function of both the mean fibre length of the top and the fibre crimp (or bulk resistance to compression). An increase in fibre crimp, at a constant top mean fibre length, resulted in a decrease in the mean fibre length of the yarn, indicating that more highly crimped wools suffered more breakage during drawing and spinning than wools with lower crimp. The shorter wools (below about 60 mm) apparently suffered no reduction in mean fibre length whereas the longer wools decreased in mean fibre length, with the 75 mm wool tops producing yarns with a mean fibre length of approximately 70 mm and the 90 mm tops producing yarns with a mean fibre length of about 78 mm . Surprisingly, mean fibre diameter, which varied from about 18 to 33 μm, had no apparent effect on the decrease in fibre length from top to yarn. Generally there was a better correlation between the mean fibre length of the yarns, measured by the single fibre length method, and the mean fibre length results of the tops measured by the Almeter than between the former and the top results measured by the single fibre length method.

Within the ranges covered by this investigation, the CV's of fibre length of the tops and yarns (single fibre length method) were similar although, at a constant CV of fibre length in the top, more highly crimped wools tended to produce yarns with a higher CV of fibre length than the wools having a lower crimp.

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