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The Between Bale and Between Lot Variation of South African Grown Cottons

Part 1:
Micronaire, Maturity Ratio, Fineness, 2,5% Span Length, Uniformity Ratio and Trash Content

by

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MICRONAIRE, MATURITY RATIO, FINENESS, 2,5% SPAN LENGTH, UNIFORMITY RATIO AND TRASH CONTENT

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ABSTRACT

The between-bale (σ_b) and between lot (σ_l) variations in micronaire, maturity ratio, fineness, 2,5 per cent span length, uniformity ratio and trash content have been determined for a wide range of cottons grown in South Africa. Typical average values for these physical properties and for their variations for the season 1974/75 have been derived for each class and grade. An estimate of the between-gin variation has also been made.

The values of these variations can be used to construct sampling plans which will permit a given accuracy to be achieved. They also give an indication of the type of variation present in the different grades etc. of South African grown cotton. The average values arrived at for the various physical properties measured may also be used in practice as a basis of reference.

INTRODUCTION

The cotton lint from the various cotton cultivars grown in South Africa is graded by an official cotton grader according to a fixed schedule (see Table I). Some variations will exist within each grade of cotton, properties will vary within certain limits, from bale to bale, from lot to lot and also, possibly from locality to locality. It therefore becomes important for a manufacturer, who wants to ensure the consistency of his product to know the size of the variations that occur in the cotton lint he uses and which nominally belongs to one grade and class. He also wants to know how much variation in fibre properties may be regarded as normal and acceptable for different bales and lots and how this variation is affected by the locality in which the cotton is grown. Furthermore, it would be useful to know what are typical average values for the more important fibre properties of cotton in the various grades and classes.

An investigation covering these points would have to be statistical in nature thereby enabling meaningful average values, and confidence limits to be derived. Once such values are available it is a reasonably simple matter to determine what differences encountered in practice are

statistically significant and the number of tests and type of sample required for a certain degree of accuracy, to be determined in advance.

It is with the above in mind that SAWTRI embarked on a project to measure the within-grade and between-grade variations for several commonly measured fibre properties and, having done so, to give average values, typical for each grade, for use as a guide in practice.

The main objective of this investigation was therefore to obtain estimates of the typical variations present in some of the more important physical properties of the various cottons marketed in South Africa and also to obtain average values for these physical properties which can be considered typical for each grade and class of cotton.

Fibre tensile properties (i.e.) bundle tenacity and extension) will be dealt with in a later report.

EXPERIMENTAL

Sampling of Cotton:

The cotton samples used in this investigation were drawn at seven South African gins and were sub-lots (150 to 500 g in mass) of the samples drawn for the official South African Grader. Where possible 12 bales per lot were sampled and tested separately. At SAWTRI a random sub-sample of approximately 50 g was taken from each sub-lot and all the tests were carried out on it. The manner in which the sub-sample was obtained precluded the calculation of a true within-bale variation in cotton fibre properties. Table I gives the various classes and grades of cotton marketed in South Africa and which have been covered in this investigation (1975-classification).

For the sake of simplicity the Premium, Basic and Discount categories in the A-class cottons have been labelled and referred to as A_1, A_2 and A_3 throughout this report while the corresponding categories in the B-class cottons have been labelled and referred to as B_1, B_2 and B_3 throughout this report.

Table II shows the number of lots and the average number of bales per lot which were sampled and tested.

Fibre Tests:

All the fibre tests were carried out under standard atmospheric conditions of 20 $\pm$ 2°C and 65 $\pm$ 2% RH.

The fibre length characteristics viz. 2,5 *per cent* span length and uniformity ratio, were determined by means of a digital Fibrograph (model 330). Three tests per sample were carried out.

TABLE I
CLASSIFICATION OF COTTONS (1975)*
A-CLASS COTTONS

TYPE	STAPLE LENGTH (inch)	MICRONAIRE	STRENGTH IN 1000 lb/sq. ins.	VARIOUS GRADES
Discount (A_3) (Deltapine types)	$\geqslant 1^1/_{16}$ (27 mm)	3,8/4,8	75/81 (36/39 cN/tex)	Deal Dirk Doly Duns LFY
Basic (A_2) (CS_2, Albar, Albacala)	$\geqslant 1^1/_{16}$ (27 mm)	3,8/4,8	82/88 (40/43 cN/tex)	Deal Dirk Doly Duns LFY
Premium (A_1) (Alcala types)	$\geqslant 1^1/_8$ (28,6 mm)	3,3/4,2	90 (44 cN/tex)	Deal Dirk Doly Duns LFY

B-CLASS COTTONS

Discount (B_3)	$1\ ^1/_{16}$ (27 mm)			Dirk
Basic (B_2)	for 1975 but $1\ ^1/_{32}$—$1\ ^1/_{16}$	Same as for	Same as for	Doly
Premium (B_1)	for 1976* (26 — 27 mm)	A-Class	A-Class	Duns LFY

* All cotton not falling in A or B is to be graded as BSG

Trash content (visible only) was determined on a Shirley Analyser, the number of tests being determined by the sample size, with a maximum of 2 tests per sample being carried out.

Maturity ratio, fibre fineness and micronaire were all determined by means of an 'IIC-Shirley' Fineness/Maturity Tester. Two tests were carried out per sample after the samples had been passed through a Shirley Analyser.

Statistical Analysis:

The main object of the analysis was to obtain estimates of the following typical variation:

1. sample and test variation, σ_t and CV_t
2. between bales, within a lot σ_b and CV_b
3. between lots, within one class, σ_ℓ and CV_ℓ

The estimate of the variation between lots contained variations associated with different gins. Later in the analysis an attempt was made to separate these. These estimates were obtained from a Hierarchical Analysis of Variance procedure. By this procedure, the variations in the measured values of a given property for a given grade and type were separated into various groups. The following illustrates the procedure and represents the *micronaire data* for the Deal grade of the A1 cottons.

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Quantity Estimated by Mean Square
Between lots (bL)	1	4,0018	4,0018	$\sigma_t^2 + t\,\sigma_b^2 + t.b\,\sigma_\ell^2$
Between bales within lots (bBwL)	21	0,1522	0,0072	$\sigma_t^2 + t\,\sigma_b^2$
Total within bales and lots (w.B.L.)	22	4,1541		
Between tests, w.B.L.	34	0,0295	0,0009	σ_t^2
TOTAL w.T.B.L.	56	4,1836		

where $\bar{t}$ = average number of tests per bale = 2,47
$\bar{b}$ = average number of bales per lot = 11,538

From the last two columns, by simple subtraction, division and square root the following estimates were obtained:

$\sigma_t = 0{,}030$

$\sigma_b = 0{,}0505$

$\sigma_\ell = 0{,}3744$

When divided by the mean value of the observations the corresponding CV values were obtained.

TABLE II
NUMBER OF BALES AND LOTS SAMPLED FOR THE DIFFERENT COTTONS

VARIOUS GRADES	NUMBER OF LOTS			AVERAGE NUMBER OF BALES PER LOT TESTED		
	A_1	A_2	A_3	A_1	A_2	A_3
Deal	2	3	3	11,5	12	12
Dirk	38	4	4	11,4	12	11
Doly	12	5	3	9,4	12	12
Duns	4	4	5	11,8	5,3	12
LFY	4	—	1	12,0	—	12
	B_2		B_3	B_2		B_3
Dirk (BS/1)	2		7	12		11,9
Doly (BS/2)	5		4	12		9,8
Duns (BS/3)	3		6	9		12,0
LFY (BS/4)	—		2	—		12,0
	BSG			BSG		
Albacala	27			9,9		
Deltapine	5			4,8		
Acala	37			8,2		

RESULTS AND DISCUSSION

The mean values for each quality of cotton and for each property are given in Tables III while Table IV is a condensed version of this table in that the values have been averaged over the various grades. The values given in Tables III can be regarded as typical for the various fibre properties of the different grades and classes of cottons marketed in South Africa during the 1974/75 season.

General observations are that all the A-class cotton and in the B-class the B_2 cotton had similar property values, except that those grouped under A_1 had a higher 2,5 *per cent* span length and those in B_2 had a higher trash content. The cotton grouped under B_3 generally had inferior properties.

The values obtained for the BSG cotton were lower than those obtained for the others except in the case of the trash content which was higher.

Although the values for the different grades have been pooled and averaged (see Table IV) this does not imply that differences between the grades do not exist, in some cases they certainly do, for instance, micronaire values decrease systematically for the fine grades of A_1 from 4,08 to 3,27. Nevertheless, in most of the other cases no consistent trends were evident. There was a tendency for the various fibre properties of the A_1 cotton to deteriorate with the grade although the differences between the various grades were often neither great nor consistent. No such trends were obvious for the other cotton although the trash content was generally higher for the lower grades. The trash content also tended to increase when going from the A-Class to the B-Class and finally to the BSG cotton, although once again, the differences were not always consistent and were sometimes small.

Within the B-class, the B_2 cotton tended to have higher property values than the Discount (B_3) cotton. The difference, however, were generally small (see Tables III and IV).

Within the BSG cottons the Albacala and Deltapine varieties generally had similar properties and were grouped together in calculating the values shown in Table IV. No study of statistical differences, existing between the various grades and types, has been made. This can be done by using the data given in the later tables, if so desired.

Table V shows the values obtained for σ_t and CV_t, Table VI shows the σ_b and CV_b values and Table VII gives the σ_ℓ and CV_ℓ values. The values given in Tables V and VI would be much more useful in practice if they could be condensed into typical values for each property which is representative of all the cotton grades and classes. For instance, the

TABLE III

MEAN VALUES FOR THE MICRONAIRE, MATURITY AND FINENESS, 2,5 PER CENT SPAN LENGTH, UNIFORMITY RATIO AND TRASH CONTENT

VARIOUS GRADES	MICRONAIRE			MATURITY RATIO			FINENESS (mtex)			2,5% SPAN LENGTH (mm)			UNIFORMITY RATIO			TRASH CONTENT		
A-CLASS COTTONS	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3
Deal	4,08	3,68	3,86	0,94	0,85	0,83	178	156	169	29,8	26,1	26,2	46,3	45,9	45,2	1,4	1,6	1,3
Dirk	3,74	4,08	3,88	0,87	0,89	0,87	156	170	164	29,5	26,3	26,0	45,5	46,1	45,9	1,6	1,3	1,5
Doly	3,79	3,88	4,00	0,89	0,85	0,89	158	167	168	29,1	26,5	26,8	45,0	46,4	47,7	1,8	1,9	2,6
Duns	3,64	3,60	3,81	0,83	0,80	0,85	158	160	163	29,0	26,9	26,9	45,1	46,1	44,6	1,9	2,4	2,1
LFY	3,27	—	3,88	0,81	—	0,82	141	—	173	28,4	—	26,9	43,6	—	43,1	2,2	—	1,8
B-CLASS COTTON	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3
Dirk (BS/1)	3,90		3,70	0,91		0,86	158		156	26,1		25,4	46,8		45,8	2,0		1,6
Doly (BS/2)	3,83		3,67	0,85		0,82	164		160	26,7		26,0	46,4		45,2	2,3		2,7
Duns (BS/3)	4,05		3,56	0,86		0,82	175		155	26,9		25,9	45,8		45,5	2,2		2,8
LFY (BS/4)	—		4,07	—		0,89	—		169	—		26,8	—		46,7	—		2,9
BSG COTTON																		
Albacala		3,48			0,80			155			26,1			45,2			3,2	
Deltapine		3,53			0,82			154			25,5			45,0			3,0	
Acala		3,07			0,79			132			28,4			44,6			2,1	

variation (σ_b) for micronaire between bales of A_1 Class, Deal grade was 0,05 while for the Dirk grade it was 0,15 (see Table VI). If a value of 0,12 say, can be reasonably used then the picture would be greatly simplified.

In Table VIII the weighed means of the CV's are given for the A, B and BSG classes. Using these in conjunction with the statistical F-test showed that most of the corresponding values in Tables V to VII were not different. A few grades gave significantly lower CV values while two gave significantly higher values.

There appeared to be no consistent trend for the testing variations to vary according to the Grade of Cotton (i.e. Deal, Dirk, Doly, Duns and LFY — Table V) and these values could therefore justifiably be averaged over the various grades as shown in Table VIII. The same could perhaps be said for the between-bale variations although there may have been a tendency for the better grades (i.e. Deal and Dirk) to have slightly lower variation than the poorer grades (see Table VI). The between-lots variation was more variable although, once again, it was difficult to detect a definite trend with grade which was consistent for all the classes and properties. For instance, the σ_l values associated with micronaire and 2,5 *per cent* span length appeared to decrease with a deterioration in Grade in the case of the A_1 cottons (see Table VII) but similar trends were not observed for the other properties and cotton. Nevertheless, very little accuracy would be lost by applying these average values instead of the individual values given in Tables V to VII, whereas the practical application of the information would be greatly simplified.

TABLE IV

AVERAGE VALUES FOR THE VARIOUS PHYSICAL PROPERTIES (AVERAGED OVER THE VARIOUS GRADES)

	A_1	A_2	A_3	B_2	B_3	BSG*	BSG Acala
Micronaire	4,01	4,01	4,09	3,93	3,64	3,51	3,07
Maturity Ratio	0,88	0,85	0,86	0,87	0,89	0,81	0,79
Fineness (mtex)	163	163	166	166	157	155	132
2,5% Span Length (mm)	29,4	26,5	26,6	26,5	25,8	25,8	28,4
Uniformity Ratio (%)	45,5	46,1	45,9	46,3	45,5	45,1	44,6
Trash Content (%)	1,7	1,8	1,9	2,2	2,4	3,1	2,1
	Means of four grades			Means of three grades			

* Deltapine, Albacala } together

TABLE V
VARIATION BETWEEN TESTS (σ_t AND CV_t)*

Various Grades	MICRONAIRE			MATURITY RATIO			FINENESS			2,5% SPAN LENGTH			UNIFORMITY RATIO			TRASH CONTENT		
A-Class Cotton	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3
Deal	0,03(0,7)	0,03(0,8)	0,03(0,8)	0,022(2,3)	0,014(1,6)	0,017(2,0)	4,0(2,2)	3,0(1,9)	3,3(2,0)	0,44(1,5)	0,37(1,4)	0,36(1,4)	—	—	—	0,078(5,6)	—	—
Dirk	0,04(1,1)	0,03(0,7)	0,04(1,0)	0,025(2,9)	0,022(2,5)	0,017(2,0)	4,5(2,9)	4,1(2,4)	3,5(2,1)	0,48(1,6)	0,32(1,2)	0,37(1,4)	—	—	—	0,145(9,1)	—	—
Doly	0,05(1,3)	0,03(0,8)	0,04(1,0)	0,020(2,2)	0,014(1,6)	0,017(1,9)	3,6(2,3)	3,1(1,9)	3,6(2,1)	0,44(1,5)	0,44(1,7)	0,47(1,8)	—	—	—	0,218(12,1)	—	—
Duns	0,05(1,4)	0,04(1,1)	0,03(0,8)	0,020(2,4)	0,014(1,8)	0,017(2,0)	3,9(2,5)	3,0(1,9)	2,9(1,8)	0,50(1,7)	0,43(1,6)	0,39(1,4)	—	—	—	0,108(5,7)	—	—
LFY	0,04(1,2)	—	0,03(0,8)	0,017(2,1)	—	0,014(1,7)	3,1(2,2)	—	3,3(1,9)	0,46(1,6)	—	0,47(1,7)	—	—	—	—	—	0,193 (10,7)
B-Class Cotton	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3
Dirk (BS/1)	0,03(0,8)		0,04(1,1)	0,010(1,1)		0,014(1,6)	2,2(1,4)		2,7(1,7)	0,49(1,9)		0,37(1,5)	—		—	0,191(9,6)		—
Doly (BS/2)	0,03(0,8)		0,05(1,4)	0,017(2,0)		0,014(1,7)	3,1(1,9)		3,6(2,2)	0,38(1,4)		0,51(2,0)	—		—	—		—
Duns (BS/3)	0,04(1,0)		0,03(0,8)	0,017(2,0)		0,014(1,7)	3,2(1,8)		3,2(2,1)	0,43(1,6)		0,42(1,6)	—		—	—		—
LFY(BS/4)	—		0,03(0,7)	—		0,017(1,9)	—		3,2(1,9)	—		0,45(1,7)	—		—	—		—
BSG Cotton																		
Albacala	0,03(0,9)			0,041(5,1)			3,2(2,1)			0,40(1,5)			—			—		
Deltapine	0,04(1,1)			0,010(1,2)			2,7(1,8)			0,37(1,5)			—			0,366(12,2)		
Acala	0,04(1,3)			0,017(2,2)			2,7(2,0)			0,50(1,8)			—			0,174(8,3)		

* The values given in parentheses represent the coefficients of variation (in %)

TABLE VI
VARIATION BETWEEN BALES (σ_b AND CV_b)*

VARIOUS GRADES	MICRONAIRE			MATURITY RATIO			FINENESS			2,5% SPAN LENGTH			UNIFORMITY RATIO			TRASH CONTENT		
A-Class Cotton	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3
Deal	0,05(1,2)	0,09(2,4)	0,12(3,1)	0 (0)	0,019(2,2)	0,020(2,4)	0 (0)	3,3(2,1)	4,2(2,5)	0,15(0,5)	0,23(0,9)	0,16(0,6)	0,66(1,4)	0,92(2,0)	0,63(1,4)	0,064(4,6)	0,712(44,5)	0,140(10,8)
Dirk	0,15(4,0)	0,03(0,7)	0,09(2,3)	0,019(2,0)	0,010(1,1)	0,012(1,4)	4,2(2,7)	1,8(1,1)	3,6(2,2)	0,35(1,2)	0,21(0,8)	0,21(0,8)	1,00(2,2)	0,81(1,8)	0,89(1,9)	0,056(3,5)	0,076(5,9)	0,129 (8,6)
Doly	0,16(4,2)	0,16(4,1)	0,18(4,5)	0,024(2,8)	0,025(2,9)	0,037(4,2)	3,8(2,4)	4,8(2,9)	3,8(2,3)	0,47(1,6)	0,33(1,2)	0,64(2,4)	1,14(2,5)	0,90(1,9)	1,32(2,8)	0 (0)	0,145 (7,6)	0,244 (9,4)
Duns	0,10(2,8)	0,27(7,5)	0,06(1,6)	0,014(1,6)	— (4,4)	0,010(1,2)	4,3(2,7)	8,7(5,4)	2,3(1,4)	0,32(1,1)	0 (0)	0,22(0,8)	1,10(2,5)	1,11(2,4)	0,91(2,0)	0,135(7,1)	0,252(10,5)	0,175 (8,3)
LFY	0,10(3,1)	—	0,09(2,3)	0,019(2,4)	—	0,010(1,2)	3,2(2,3)	—	2,8(1,6)	0,25(0,9)	—	0,30(1,1)	0,90(2,1)	—	0,67(1,6)	0,152(8,0)	—	0
B-Class Cotton	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3
Dirk (BS/1)	0,06(1,5)		0,07(1,9)	0,014(1,5)		0,012(1,4)	4,2(2,7)		3,2(2,1)	0,27(1,0)		0, 17(0,7)	0,73(1,6)		0,93(2,0)	0,125 (6,2)		0,073 (4,6)
Doly (BS/2)	0,09(2,4)		0,06(1,6)	0,027(3,2)		0,010(1,2)	4,2(2,6)		1,7(1,1)	0,35(1,3)		0,20(0,8)	1,40(3,0)		0,77(1,7)	0,317(13,8)		0,506 (18,7)
Duns (BS/3)	0,06(1,5)		0,14(3,9)	0,014(1,6)		0,020(2,4)	4,5(2,6)		5,3(3,4)	0,20(0,7)		0,27(1,0)	1,43(3,1)		0,93(2,0)	0,172 (7,8)		0,270 (9,6)
LFY (BS/4)	—		0,08(2,0)	—		0,016(1,8)	—		1,1(0,7)	—		0,30(1,1)	—		0,98(2,1)	—		0,126 (4,3)
BSG Cotton																		
Albacala	0,19(5,5)			0,029(3,6)			7,1(4,6)			0,29(1,1)			0,93(2,1)			0,330(10,3)		
Deltapine	0,16(4,5)			0,025(3,0)			5,7(3,7)			0,37(1,4)			0,59(1,3)			0,524(17,5)		
Acala	0,12(3,9)			0,021(2,7)			4,1(3,1)			0,30(1,1)			0,95(2,1)			0,135 (6,4)		

* The values given in parentheses represent the coefficient of variation (in %) obtained by expressing σ_b as a percentage of the mean.

TABLE VII
VARIATION BETWEEN LOTS (σ_l AND CV_l)*

Various Grades	MICRONAIRE			MATURITY RATIO			FINENESS			2,5% SPAN LENGTH			UNIFORMITY RATIO			TRASH CONTENT		
A-Class Cotton	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3	A_1	A_2	A_3
Deal	0,37(9,1)	0,24(6,5)	0,28 (7,3)	—	0,023(2,7)	0,083(10,0)	—	8,7(5,8)	8,9 (5,3)	1,25(4,2)	0,32(1,2)	0,60(2,3)	1,76(3,8)	0,49(1,1)	0,59(1,3)	—	0	0,384(29,5)
Dirk	0,31(8,3)	0,25(6,1)	0,35 (9,0)	0,031(3,6)	0,042(4,7)	0,053 (6,1)	14,1(9,0)	7,5(4,4)	12,5 (7,6)	1,79(2,7)	0,37(1,4)	0,21(0,8)	0,90(2,0)	0,34(0,7)	1,56(3,4)	0,175(10,9)	0,091 (7,0)	0,732(48,5)
Doly	0,37(9,8)	0,29(7,5)	0,40(10,0)	0,064(7,2)	0,057(6,7)	0,059 (6,6)	15,6(9,9)	8,8(5,3)	12,3 (7,3)	0,88(3,0)	0,72(2,9)	0,61(2,3)	0,78(1,7)	1,05(2,3)	0,93(1,9)	0,197(10,9)	0,768(40,4)	0,110 (4,2)
Duns	0,26(7,1)	0 (0)	0,26 (6,8)	0,039(4,7)	0,011(1,4)	0,030 (3,5)	10,5(6,6)	0 (0)	14,0(11,6)	0,73(2,5)	0,63(2,3)	1,10(4,1)	1,28(2,8)	0,58(1,3)	1,21(2,7)	0,178 (9,4)	0,397(16,5)	0,621(29,6)
LFY	0,07(2,1)	—	—	0,035(4,3)	—	—	4,9(3,5)	—	—	0,43(1,5)	—	—	1,02(2,3)	—	—	0,219(10,0)	—	—
B-Class Cotton	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3	B_2		B_3
Dirk (BS/1)	0,39(10,0)		0,28 (7,6)	0,018(2,0)		0,039(4,5)	17,0(10,8)		12,0 (7,7)	1,15(4,4)		0,39(1,5)	0 (0)		1,13(2,5)	0,120 (6,0)		0,318(19,9)
Doly (BS/2)	0,17 (4,4)		0,42(11,4)	0,036(4,2)		0,058(7,1)	6,6 (4,0)		16,0(10,0)	0,46(1,7)		0,30(1,2)	1,81(3,9)		1,52(3,4)	0,790(34,4)		0,743(27,5)
Duns (BS/3)	0,39 (9,6)		0,15 (4,2)	0,045(5,2)		0,038(4,6)	13,3 (7,6)		5,2 (3,4)	1,04(3,9)		0,63(2,4)	0,98(2,1)		2,95(6,5)	0,688(31,3)		0,892(31,9)
LFY (BS/4)	—		0,39 (9,6)	—		0,037(4,2)	—		14,2 (8,4)	—		0,96(3,6)	—		0,78(1,7)	—		0,132 (4,6)
BSG Cotton																		
Albacala	0,53(15,2)			0,019(2,4)			2,4(1,5)			0,51(2,0)			0,75(1,7)			0,784(24,5)		
Deltapine	0,76(21,5)			0,037(4,5)			3,4(2,12)			0,03(0,1)			1,16(2,6)			1,034(34,5)		
Acala	1,60(52,1)			0,065(8,2)			10,4(7,9)			1,44(5,1)			1,04(2,3)			0,307(14,6)		

* The values in parentheses represent the coefficients of variation (in %) obtained by expressing σ_l as a percentage of the mean.

TABLE VIII
MEANS OF THE CV VALUES FOR THE DIFFERENT COTTONS AND FIBRE PROPERTIES

FIBRE PROPERTIES	A-CLASS			B-CLASS			BSG-CLASS		
	CV_t	CV_b	CV_ℓ	CV_t	CV_b	CV_ℓ	CV_t	CV_b	CV_ℓ
Micronaire	1,0	3,6	7,4	1,0	2,2	8,5	1,1	4,7	33,7
Maturity Ratio	2,1	2,5	5,6	1,7	2,0	4,7	3,3	3,1	5,6
Fineness	2,1	2,6	7,0	1,9	2,4	7,9	2,0	3,8	4,8
2,5% Span Length	1,5	1,1	2,6	1,7	0,8	3,0	1,6	1,2	3,1
Uniformity Ratio	—	2,1	2,2	—	2,3	3,3	—	1,9	2,2
Trash Content	8,6	14,7	23,3	9,6	10,4	25,3	10,4	12,3	25,8

TABLE IX
OVERALL MEAN CV VALUES

	CV_t	CV_b	CV_ℓ
Micronaire	1,0	3,6	8,0*
Maturity Ratio	2,5	2,6	5,3
Fineness	2,0	3,0	6,7
2,5% Span Length	1,6	1,0	2,9
Uniformity Ratio	—	2,1	2,6
Trash Content	9,6	12,6	24,8

* Excluding BSG

By a procedure similar to the one above the values given in Table VIII can be averaged by taking their weighted means to give values averaged over all the cotton classes and grades, for the variations (CV) associated with between tests, between bales and between lots. These values are given in Table IX which shows that the within tests variation is about 2 *per cent*, the between-bales value is about 2 to 3 *per cent* and the between baled lots variation is between 3 and 8 *per cent* for all the properties measured excepting Trash Content. The values in this table can therefore be used in practice as a measure of the variations to be expected in the various physical properties of South African grown cotton. It also enables the calculation of the number of samples and tests required for a certain degree of accuracy, to be made as illustrated by the example given in the section below.

It was possible for some of the sets of data to divide the above variation between lots into two components, that due to variation between gins (σ_g and CV_g) and that due to variation between lots within a gin ($\sigma_{\ell wg}$ and $CV_{\ell wg}$). Table X shows the values obtained. The general conclusion was that the variation between gins was slightly larger than the variation between lots within a gin.

Confidence Limits of the measured mean value for a baled lot:

The percentage confidence limits can be calculated as follows provided the bale is sampled and the sample is combined as was done for this investigation. The 95 *per cent* confidence limits (CL) of a measured mean value of a lot, expressed as a percentage of the mean are given by

$$CL\ (\%) = \pm 2\sqrt{\frac{(N-n)\ CV_b^{\,2}}{N} + \frac{CV_t^{\,2}}{nk}}$$

where N = number of bales in a lot

n = number of bales sampled

k = number of samples per bale

CV_b = % variation between bales (in a lot)

CV_t = % variation between tests.

By assuming values for CV_b and CV_t of 3 and 1,5 the confidence limits for different numbers of bales in a lot, bales sampled and of samples per bale have been calculated and are shown in the following Table XI.

TABLE X
VARIATION BETWEEN GINS (CV) AND BETWEEN LOTS WITHIN GINS ($CV_{\ell wg}$)

	Micronaire		Maturity Ratio		Fineness		2,5% Span Length		Uniformity Ratio		Trash Content	
Cotton	CV_g	$CV_{\ell wg}$	CV_g	$CV_{\ell wg}$	CV_g	$CV_{\ell wg}$	CV_g	$CV_{\ell wg}$	CV_g	$CV_{\ell wg}$	CV_g	$CV_{\ell wg}$
A_1 Dolly	0	0	0	0	4,4	8,7	3,0	1,3	0	0	7,7	9,2
A_2 Doly	0	0	0	0	0	0	0	0	1,8	1,8	0	0
A_2 Duns	2,6	0	2,7	0	0,9	0	2,2	1,6	0	0	27,4	0
B_2 Doly	3,7	2,5	4,4	0	3,5	2,3	1,9	0	4,3	0	39,3	0
B_3 Duns	0	0	4,0	2,3	0	0	1,8	1,8	5,9	3,7	40,7	7,4
BSG (Alcala)	4,6	4,6	2,1	3,5	6,0	3,5	5,3	2,8	1,2	2,0	10,3	15,6
Mean	2,6	2,1	2,8	1,7	3,4	3,9	2,9	1,6	3,1	1,9	26,2	8,0

TABLE XI
THE PERCENTAGE CONFIDENCE LIMITS (95 PER CENT) OF THE MEAN FOR $CV_b = 3$ AND $CV_t = 1,5$

NUMBER OF BALES IN LOT	NUMBER OF BALES SAMPLED	NUMBER OF SAMPLES PER BALE		
		1	2	3
50	10	1,94	1,82	1,76
	25	1,04	0,94	0,90
	50	0,42	0,30	0,21
200	10	1,32	0,94	0,94
	50	0,56	0,48	0,42
	100	0,24	0,22	0,22
	200	0,21	0,15	0,11

SUMMARY AND CONCLUSIONS

Samples were obtained of ginned cotton (lint) from seven of the largest gins in South Africa. These samples were considered to be representative of the various classes and grades of cotton ginned in South Africa during the 1975 season and were sub-samples of those drawn for and submitted to, the official Cotton Grader in Pretoria. Although samples were drawn from different positions within the bale these were combined

to form one representative sample from which a random sub-sample was drawn for the various tests. It was, therefore, not possible to obtain a measure of the within-bale variation.

The micronaire, maturity ratio, fineness, 2,5 *per cent* span length, uniformity ratio and trash content of the various samples were measured and typical values for each class and grade of cotton were calculated. The results were also subjected to a hierarchical analysis of variance from which estimates could be obtained of the variation associated with:

(i) between tests (σ_t)

(ii) between bales (σ_b) and

(iii) between lots (σ_l).

These values therefore quantified the variations typical for each of the fibre properties tested for each of the cottons. Although some variations occurred in these σ-values for the different types of cotton it was concluded that they could be averaged to facilitate their use in practice. By means of these average values the number of tests required for a desired accuracy could be calculated. This has been illustrated by a typical example.

The various σ-values were expressed as percentages of the mean (i.e. as CV's) to facilitate their use and interpretation and, except for trash content, typical values for these were approximately as follows:

CV_t = 2 *per cent*

CV_b = 2 to 3 *per cent*

CV_l = 3 to 8 *per cent*

A similar study on the *tensile properties* (bundle tenacity and extension) is at present in progress.

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