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Processing Losses during Topmaking

Part II: The Effect of Certain Fibre Properties and the Degree of Fribbiness of the Raw Wool

by

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ABSTRACT

Actual fibre losses sustained during the pilot scale processing of 57 lots of short wools and outsorts, as well as yields of top and noil, were measured.

The fibre losses, expressed as a percentage of the measured bone dry clean scoured wool, ranged from 5% to 25% and could not be explained adequately in terms of fault content or type of fault only. Inclusion of data on the fribbiness of the wool which were obtained by a test especially devised for this purpose, significantly improved the prediction of fibre losses. Fibre losses could be predicted with far greater accuracy than was possible using the IWTO formula by using regression equations relating the actual fibre losses to fribbiness, staple length, VM clean, percentage burrs, number of burr removal points on the card, card production rate, mean fibre diameter and staple strength.

Equations for predicting top and noil yields of short wools and outsorts are presented which allow a more accurate estimate of yields than has been possible using the existing IWTO conversion formulae.

INTRODUCTION

The traditional function of the wool buyer in the pre-objective measurement era was, *inter alia,* to supply his client with an assessment of how much top and noil he could expect from a given consignment of raw wool. This assessment of yield was based on the buyer's experience of yields of similar wools on his client's equipment, and included an estimate of fibre loss during processing. Such losses occur during scouring (as fibrous wastes), carding (as sweepings and fly, card fettlings and burry wastes) and combing (as comb shoddy).

The basis for commercial transactions involving raw wool has changed considerably since the advent and widespread acceptance of objective measurement of fineness and yield according to IWTO core-test specifications. Three important parameters are currently specified on a certificate, namely wool base (i.e. the percentage of oven-dry, fat-free, vegetable matter free and ash free wool), vegetable matter (VM) base (i.e. the ash free. fat-free percentage of burrs. hard heads, twigs, leaves and seeds) and mean fibre diameter[1]. Wool base is then used to calculate the theoretical top and noil yield, and by using vegetable matter base (VM) to calculate the processing allowance, the estimated commercial top and noil yield can be obtained. Although both the theoretical as well as the estimated commercial top and noil yield appear on the certificate, the latter is not certified, and the IWTO advises strongly against using it as the basis for transactions as it is supplied merely as a guide. The processing allowance was established empirically by WIRA during the early 1960's and is based on a standard 2,5% allowance for card wastes and Schlumberger comb shoddy, plus a variable percentage based upon the actual vegetable matter content, excluding hard heads and twigs.

The IWTO Raw Wool Certification Sub-Committee has, in recent years, collected a large number of core-test/combing result comparisons from participating mills (some 854 for Schlumberger dry-combing alone)[2]. This Committee has also considered alternative formulae for calculating the processing allowance, but from a practical point of view found none better than the existing empirical relationship. This, together with the fact that there were large discrepancies between mills, led the IWTO to decide to retain the present processing allowances. However, it is stated in the Core Test Regulations that the processing allowances are considered to be related to the *average* processing losses of a large number of individual mill batches. This merely implies that core test yield data, although still a useful guide, as yet cannot be used for the accurate prediction of the performance of *individual* combing batches. The reason for these anomalies can be ascribed to two major sources, namely to the different processing conditions and equipment used by different mills, and to the fact that not every variable exerting an influence on yield has, as yet, been quantified. In fact, by definition, the processing allowances used at present only attempt to eliminate variabilities in the estimated top and noil yield caused by the presence of vegetable matter in the wool.

Although the IWTO recognises that other parameters are correlated with processing losses it has been suggested that these add very little to the accuracy of the current allowances[3]. However, at the same time it is also recognised that the existing allowances, in addition to the inherent discrepancies discussed above, also do not appear to be suitable for certain categories of wool, short combing wools in particular being mentioned in the Regulations[4]. This is of particular significance for South African wools, since around 22% of merino fleeces, bellies and lambs are considered short, i.e. 7/9 months (45 mm staple length) or less[5].

In view of the above considerations, it was decided to investigate the actual processing losses sustained during the pilot scale processing of a range of South African wools and to relate these to various fibre properties. Initial work on a limited selection of medium to short grades was carried out by Turpie[6] and subsequent studies have been carried out on a wider selection of wools to study staple length as a variable. In addition, a novel method for determining the degree of "fribbiness" of the raw wool has been devised and its effect on the processing losses has also been investigated.

MATERIALS AND METHODS

Raw Materials

Fifty-seven one-bale batches of merino wools were selected for processing. Thirty-four of these (coded PLS) were processed specifically to study the losses occurring in the processing of short wools. The remaining 23 batches (coded OSP) were studied in terms of their general processing performance.

The selection included fleeces, lambs, bellies, backs and locks and the distribution according to class description is given in Table 1.

TABLE 1

DISTRIBUTION OF RAW WOOL LOTS ACCORDING TO CLASS

CLASS	NO. OF BATCHES
Fleeces	6
Lambs	16
Bellies	15
Backs	6
Locks	14
TOTAL	57

Each batch was divided into small portions by hand and layer blended. Hand samples were then drawn for the determination of mean staple length, crimp frequency and mean staple strength, as well as their grease and suint characteristics. The blend was then re-packed and cored for the determination of wool base, VM greasy (including the distribution of the total vegetable matter into categories for burrs, seed, shive and leaves and hard heads/twigs) and mean fibre diameter. In addition, a 250 g sample of raw wool from each batch was drawn for the determination of the degree of fribbiness of the wool. The definition of fribbiness and its method of testing are discussed in the relevant section for Test Procedures.

Some of the physical properties of the wools in each of the five class descriptions are given in Table 2.

Scouring

Sufficient raw wool to produce between 60 and 70 kg clean, calculated from core test data in accordance with the Japanese Clean Scoured Yield, was scoured in a four-bowl Petrie and McNaught pilot plant using ®Berol Lanco in the first three bowls. Bowl temperatures were set at 55° C, 55° C, 50° C and 40° C, respectively. The pH of the first bowl was set to between 9 and 10 by means of soda ash. After scouring, the wool was sprayed with sufficient water and ®Topsol XLAS/®Lissapol NX emulsion to increase its regain to around 12% and its total fatty matter to around 0,8%.

Carding and Combing

Each batch was allowed to condition for at least 72 hours to reach a regain of about 14 to 15% before carding. Carding was then carried out on an FOR Biella continental worsted card under ambient conditions of 22° C and 65% RH. The card was set at a swift speed of 115 rev/min and the production rates and worker/swift settings were selected broadly in accordance with the staple length of each individual batch. The card was fettled after each batch. The card had two burr removal points, namely one on the Morel (between the breast and the first swift) and one on the breast, the latter being used only in a few isolated cases when batches with a high vegetable fault were processed.

The carded sliver was prepared for combing by gilling three times on a Schlumberger GNP gill box and adding sufficient moisture to increase the regain to between 18 and 20%.

Comb tests were carried out on a Schlumberger PB 26 fitted with Nitto Unicomb segments and set in accordance with the length of the individual batches. Generally, gauge settings were between 24 and 28 mm and the comb run at 150 nips/min. Each batch of top sliver was autolevelled twice to a finished top linear density of 24 ktex.

Test Procedures

To relate fibre properties to processing losses, a precise measurement of the amount as well as composition of the various wastes generated by processing was required. For this purpose, a "waste package" comprising the fibrous waste from scouring, card fettlings, sweepings, woolly burr and comb shoddy was carefully collected for each batch processed. The package was subsampled by coring in a manner similar to that used by Bownass *et al* [7]. The total reject was packed into a suitable container (normally a polythene bag), compressed by an hydraulic jack and cored. Three core samples of 160 g each were then tested for wool base in accordance with the IWTO core-test specifications[1]. This allowed calculation of the total amount of bone-dry fat free, ash free and vegetable matter free wool fibre which did not contribute to the top and noil yield of each batch.

In an attempt to identify the raw wool properties which could contribute to fibre losses, it was decided to measure the amount of fribs. Per definition, fribs are second- or double cuts which occur during shearing and which cause a short portion to be either partly or completely detached from the staple. In the context of this investigation, however, the term fribbiness also includes the proportion of very short staples or any other "woolly" component which could possibly be detached physically from the bulk of the wool during carding, for example, and which would thus not contribute to the final top and noil yield.

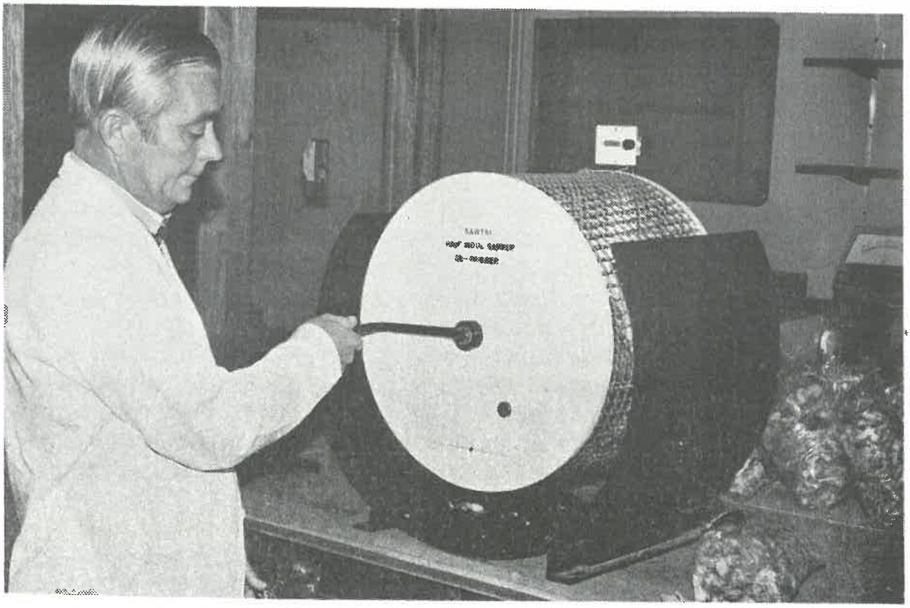

Fig. 1 – The raw wool defribbing apparatus showing the shield plate, wire mesh circumference, trap door and counter.

To obtain an estimate of the fribbiness of the wool, a method involving a hand-operated laboratory defribbing apparatus was devised. The apparatus comprises a cylindrical wire cage of 460 mm diameter, closed at both ends, and fixed to a central shaft. The cage is mounted in a semi-circular metal shield plate in such a manner that there is a clearance of about 85 mm between the cage and the plate. The shaft is connected to a handle which allows the cage to be revolved by hand and a pin-activated counter records the number of revolutions of the cage. The cage is constructed of square mesh wire of 10 gauge (3,25 mm) 16 mm square. A trap door in one of the closed ends of the cage allows introduction and retrieval of the sample before and after testing. A general view of the apparatus is given in Fig. 1.

The test method using the de-fribbing apparatus was as follows: A 250 g sample from each batch of raw wool was placed in the cage and the cage revolved in a smooth and regular motion for 50 cycles. The circular velocity of the cage was maintained at such a level that at no time the wool was lifted higher than a point on the circumference approximately 30° from the horizontal plane. The material ejected from the cage onto the shield plate was collected, hand-washed in hot water and detergent, oven dried and its bone dry clean mass determined. This was then expressed as a percentage of the wool base contained in the original 250 g sample and is referred to as the percentage fribbiness of the raw wool.

RESULTS AND DISCUSSION

Table 2 gives the average values of the various raw wool properties tested. The individual values are given in Table 3 which shows that the majority of the batches were short (35 to 55 mm) except for the backs which were on average about 59 mm long. Mean fibre diameter values varied from 18 to 24 μm. The bellies were the most and the fleeces the least faulty and the VM greasy values for the other classes were within a fairly restricted range.

Processing data describing the behaviour of the various batches are also given in Table 3. It can be seen from Table 3 that the actual fibre loss ranged from 5% to as high as 25%. These losses were relatively high when one considers the relatively low vegetable fault range (compared with wools from some other countries) and the processing allowances normally associated with this fault range for combing types.

Some of the main processing data shown in Table 3 have been grouped into class descriptions and are shown in Table 4. The bellies were clearly the most faulty (on a clean basis) followed by the locks, the lambs and the backs, with the fleeces being nearly free of fault. None of the class descriptions, except perhaps the locks, had more than a marginal amount of hard heads. The bellies and lambs had more burrs than seeds, whereas the other class descriptions had

TABLE 2

RAW WOOL DATA*

Class	Staple Length (mm)	Mean Fibre Diameter (μm)	Wool Base (%)	VM Greasy (%)	Grease Content (%)	Suint (%)	Crimpiness
Fleeces	40,1 ± 6,3	21,4 ± 3,2	50,4 ± 14,5	0,32 ± 0,4	12,7 ± 3,4	6,7 ± 5,9	0,96 ± 0,32
Lambs	40,2 ± 5,8	20,3 ± 2,2	49,2 ± 9,2	1,35 ± 2,9	13,4 ± 4,8	7,2 ± 3,4	0,81 ± 0,19
Bellies	43,6 ± 5,7	20,8 ± 2,6	48,1 ± 5,4	2,12 ± 4,5	12,8 ± 4,2	9,2 ± 3,3	0,87 ± 0,22
Backs	58,6 ± 8,12	22,0 ± 2,2	46,6 ± 12,1	0,99 ± 0,84	14,0 ± 4,9	6,0 ± 2,1	0,90 ± 0,20
Locks	45,0 ± 19,2	20,6 ± 1,1	43,3 ± 6,4	1,30 ± 0,59	11,3 ± 1,2	11,1 ± 3,4	0,79 ± 0,10

*The values in this table represents the mean ± 2 σ of each of the raw wool properties and indicates the range over which these properties varied.

TABLE 3

PROCESSING DATA

Sample	Class Description	Wool Base (%)	Staple Length (mm)	VM Clean* (%)	Seed Clean (%)	Burrs Clean (%)	Hard Heaos Clean (%)	% Fribbiness	Mean Fibre Diameter (μm)	Staple Strength (N/ktex)	Card Production Rate (kg/hr)	No. of Burr Beaters	Bowl Waste (%)	Card Rejects (%)	Comb Shoddy (%)	Waste Base (%)	Clean Fibre Loss (%)
PLS 10	Fleeces	51,79	37,9	0,37	0,37	0,00	0.00	1,40	20,4	38,3	15,5	1	2,06	4,3	0,7	67,3	5,55
11	Bellies	47,73	44,4	7,50	1,52	5,98	0,00	0,70	19,5	25,8	15,8	2	0,85	11,6	1,5	56,6	9,97
12		48,77	40,0	2,48	1,71	0,71	0,00	0,90	21,1	39,8	15,7	1	0,70	6,0	1,0	63,1	5,81
13		45,61	40,2	2,28	1,56	0,48	0,24	3,00	20,4	38,9	15,7	1	0,81	6,7	0,9	66,0	6,62
14		50,22	47,4	3,72	3,37	0.00	0,35	1,10	18,4	32,4	15,3	1	1,27	9,5	1,1	53,0	7,62
15	Lambs	53,44	41,6	1.40	1,17	0,23	0.00	2,30	19.1	31,0	15,7	1	0,47	6,2	0,9	68,4	6,12
16		51,48	42,3	2,02	1,07	0,95	0,00	1,30	19,8	27,0	16,2	1	0,56	6,9	1,1	67,4	6,87
17	Bellies	49,42	42,8	2,71	2,12	0,59	0,00	12,50	21,7	27,3	15,7	1	0,57	10,2	0,9	61,9	8,65
18		50,77	45,1	1,14	1,03	0,11	0,00	0,90	20,9	36,6	16,3	1	0,78	5,6	0,6	67,8	5,58
19	Lambs	52,69	35,9	4,21	1,18	2,68	0,00	1,90	20,9	27,2	15,1	1	0,70	9,0	1,9	62,6	8,82
20		53,64	36,2	0,60	0,36	0,24	0,00	2,00	21,3	26,6	15,7	1	0,73	10,4	1,4	80,3	11,80
21		52,39	44,4	0,84	0,24	0,60	0,00	1,40	19,9	42,7	16,1	1	0,46	4,7	0,9	70,1	5,00
22		44,79	43,2	0,74	0,62	0,12	0,00	1,60	18,8	31,0	15,8	1	0,43	6,4	0,8	58,0	5,20
23		41,33	39,8	0,56	0,34	0,22	0,00	1,50	19,6	30,9	16,1	1	0,52	6,3	0,8	56,1	5,00
24		41,44	39,4	2,29	2,29	0,00	0,00	2,70	21,6	33,5	16,1	1	0,71	8,3	1,4	69,0	8,57
25		47,88	34,5	1,04	1,04	0,00	0,00	2,80	22,7	55,1	15,8	1	0,99	9,4	1,3	68,4	9,42
26	Bellies	48,28	40,7	1,35	1,11	0,24	0,00	2,40	21,0	36,8	16,4	1	0,81	5,7	1,0	67,8	6,01
27		49,57	44,7	2,54	1,27	1,27	0,00	1,60	20,1	36,3	15,7	1	0,61	6,5	1,0	61,5	5,90
28		42,03	46,5	19,72	2,00	17,72	0,00	0,60	21,2	38,6	14,5	2	0,42	21,0	1,5	36,9	11,90
29		49,96	40,6	2,00	0,59	1,41	0,00	1,50	18,7	36,8	15,6	1	0,80	9,3	1,0	71,1	9,40
30	Lambs	53,89	38,5	2,60	0,47	2,13	0,00	1,70	18,9	34,6	15,5	1	0,87	7,8	1,0	61,2	7,10
31		48,77	38,9	5,04	0,47	4,10	0,47	2,80	20,2	36,3	16,0	1	0,99	8,2	1,1	60,6	7,60
32	Fleeces	53,54	38,0	0,47	0,47	0,00	0,00	1,60	24,1	54,4	15,9	1	0,60	6,1	0,9	76,9	6,80
33	Lambs	45,03	41,4	2,24	1,54	0,70	0,00	1,90	21,0	27.0	16.0	1	0,97	5,6	0,8	68,4	6,00
34		56,61	40,6	0,97	0,85	0,00	0,12	1,80	19,5	46,1	16,0	1	1.24	5,4	0,5	72,1	6,10
35	Fleeces	57,98	42,5	0,52	0,52	0,00	0,00	1,00	21,7	51,7	15,9	1	0,80	5,2	0,7	72,8	5,70
36		36,58	40,8	0,63	0,63	0,00	0,00	2,10	19,4	36,6	13,9	1	0,90	6,0	0,6	67,7	6,00
37		50,99	44,9	1,41	1,18	0,23	0,00	2,00	22,1	33,2	15.9	1	0,77	6,6	0.8	64,9	6,30
38		51,36	36,7	0,41	0,36	0,05	0,00	3,70	20,9	36,0	15,9	1	1,27	7,7	0,9	74,2	8,60
39	Bellies	52,84	41,1	1,36	0,62	0,37	0,37	3,70	22,1	40,9	15,9	1	0,80	8,4	1,1	70,3	8,60
40		45,39	42,8	4,01	0,88	2,76	0,37	7,00	21,8	39,5	15,9	1	0,61	9,2	0,9	52,5	6,80
41	Lambs	47,26	42,1	1,78	0,89	0,89	0,00	5,70	21,1	27,9	16,1	1	0,99	7,1	1,0	63,7	6,90
42		46,53	44,1	12,83	1,23	11,60	0,00	3,00	19,6	30,9	13,8	2	0,95	18,4	1,4	45,1	12,00
43		50,47	40,7	5,03	0,98	4,05	0,00	4,60	20,9	32,0	15,9	1	0,95	9,4	1,5	57,1	8,20
OSP 13	Backs	52,27	54,8	1,15	0,92	0,12	0,12	0,40	23,0	38,3	19,8	1	0,70	5,9	0,9	64,1	5,70
14		47,03	54,8	1,04	1,04	0,00	0,00	0,00	20,4	42,0	16,1	1	1,14	6,1	0,8	61,0	5,80
15		39,22	62,7	3,47	0,36	3,11	0,00	0,30	20,6	38,9	16,1	1	0,73	13,9	1,1	43,7	8,20
22	Bellies	45,40	47,8	2,27	1,14	0,91	0,22	2,30	20,7	34,4	15,8	1	0,73	12,7	1,3	74,2	13,00
23		49,49	48,0	3,05	2,14	0,91	0,00	1,50	21,8	41,2	15,9	1	0,54	7,7	1,2	57,9	6,50
24		46,36	42,6	12,64	1,27	11,37	0,00	2,60	23,2	46,0	16,1	2	0,41	16,4	1,4	57,6	13,50
28	Backs	54,28	56,4	2,03	1,83	0,00	0,20	0,00	22,7	43,9	17,9	1	0,85	6,1	0,8	59,6	5,50
29		46,06	64,4	1,24	1,11	0,00	0,13	0,00	22,6	39,4	18,2	1	0,58	6,1	0,8	60,4	5,30
30		40,59	58,6	3,60	2,88	0,00	0,72	0,20	22,7	35,2	18,1	1	0,90	8,0	0,7	34,9	4,00
31	Lox	41,52	57,0	3,88	3,88	0,00	0,00	8,50	20,3	35,6	19,9	1	0,50	10,4	1,1	54,5	7,90
31A		41,15	58,7	3,52	3,12	0,00	0,40	1,20	20,3	37,6	20,2	1	0,40	10,4	1,1	54,8	7,80
31B		36,33	51,0	2,26	1,70	0,28	0,28	12,80	20,3	32,4	16,1	1	1,70	14,3	1,5	50,6	10,50
32		43,81	41,0	3,77	1,88	0,95	0,95	12,30	20,6	35,7	18,1	1	0,70	13,4	1,3	63,9	11,80
32A		48,42	42,6	3,59	1,99	0,80	0,80	1,20	20,8	34,3	17,9	1	0,50	11,6	1,3	57,3	9,25
32B		41,92	38,5	3,20	1,91	0,32	0,96	20,50	20,4	35,6	16,0	1	1,70	11,7	1,8	65,9	12,05
33		44,57	32,4	3,52	2,46	0,71	0,35	33,90	19,8	38,2	15,9	1	1,00	16,9	2,8	71,8	17,90
33A		46,04	31,4	2,39	1,33	0,53	0,53	11,70	19,8	37,7	16,1	1	1,10	13,2	2,0	69,0	13,40
34		43,82	52,3	2,37	1,42	0,48	0,48	2,40	21,0	46,4	20,2	1	1,50	9,2	1,0	55,9	7,80
35		42,70	49,0	3,30	0,66	1,32	1,32	4,90	21,0	47,2	17,9	1	1,10	10,4	1,1	57,8	8,60
36		46,42	30,9	2,11	1,88	0,23	0,00	27,00	21,1	39,9	13,7	1	1,90	23,3	2,0	78,8	25,40
37		42,57	56,9	2,84	2,27	0,29	0,29	2,20	21,3	45,4	19,8	1	0,60	8,8	1,0	52,6	6,50
38		47,38	46,4	3,06	2,38	0,34	0,34	4,00	21,6	38,8	18,1	1	0,80	9,1	0,9	48,3	6,20
39		39,95	41,7	2,28	1,78	0,25	0,25	20,20	20,3	37,2	15,3	1	2,40	15,0	1,7	71,5	16,10

$$*\text{VM clean} = \frac{\text{VM greasy}}{\text{wool base}}$$

TABLE 4

PROCESSING DATA BY CLASS DESCRIPTION*

Class Description	Staple Strength (N/ktex)	VM Clean (%)	Seed Clean (%)	Burrs Clean (%)	Hard Heads Clean (%)	Frib-biness (%)	Bowl Waste (%)	Card Rejects (%)	Comb Shoddy (%)	Card Prod. Rate (kg/hr)	No. of Burr Beaters	Clean Fibre Loss (%)
Fleeces	41,4 ± 18,0	0,64 ± 0,8	0,59 ± 0,61	0,05 ± 0,18		2,0 ± 1,8	1,1 ± 1,1	6,0 ± 2,3	0,8 ± 0,2	15,5 ± 1,6	1 ± 0	6,5 ± 2,2
Lambs	33,9 ± 16,4	2,76 ± 6,1	0,92 ± 1,05	1,78 ± 5,9	0,04 ± 0,2	2,4 ± 2,4	0,8 ± 0,4	8,1 ± 6,4	1,1 ± 0,7	15,7 ± 1,2	1,1 ± 0,5	7,5 ± 4,3
Bellies	36,7 ± 8,0	4,58 ± 10,2	1,49 ± 1,4	2,99 ± 10,1	0,10 ±0,3	2,8 ± 6,2	0,7 ± 0,4	9,8 ± 8,6	1,1 ± 0,6	15,7 ± 0,8	1,2 ± 0,8	8,4 ± 5,3
Backs	39,6 ± 6,0	2,08 ± 2,3	1,36 ± 1,8	0,54 ± 2,5	0,20 ± 0,5	0,2 ± 0,3	0,8 ± 0,4	7,7 ± 6,2	0,9 ± 0,3	17,7 ± 2,8	1 ± 0	5,8 ± 2,7
Locks	38,4 ± 9,2	3,01 ± 1,2	2,05 ± 1,6	0,46 ± 0,7	0,50 ± 0,8	11,6 ± 20,7	1,1 ± 1,2	12,7 ± 7,7	1,5 ± 1,1	17,5 ± 4,1	1 ± 0	11,5 ± 10,6

*The values in this table represents the mean $\pm 2\sigma$ of each of the raw wool properties and indicates the range over which these properties varied.

more seeds than burrs. Staple strength results showed that the lambs were significantly weaker than the other class descriptions, possibly due to the tapered nature of lambs wool staples.

A preliminary statistical analyses of the data showed that the fibre loss results could not be adequately explained in terms of the parameters usually associated with fibre loss such as fault content and type of fault, nor with parameters such as length, diameter, number of burr beaters and throughput rate during carding. However, it could be observed that during carding, discrete bunches of short fibrous material were detached from the surrounding fibrous bulk and ejected as waste. It was therefore decided to test the degree of fribbiness of the raw wool and the method described earlier was devised. Fribbiness (see Table 3) ranged from zero to 34% and was particularly high in the case of most of the locks with the exception of lots 31A and 32A, which had already been de-fribbed by a commercial de-fribbing operation.

Table 5 gives the various correlation coefficients in the case of all the parameters shown in Table 4. It is not surprising that the fibre loss correlated very highly with card rejects and comb shoddy (even though these had not been adjusted to clean fibre), but the most interesting observation was that it correlated so highly with fribbs, the percentage fit in the latter case being 93%.

TABLE 5

CORRELATIONS BETWEEN AVERAGE FIBRE LOSS FOR DIFFERENT CLASS DESCRIPTIONS AND VARIOUS PARAMETERS (n = 5)

PARAMETER	r	% Fit ($r^2 \times 100$)
Fribbiness	0,96	93
VM clean	0,49	24
Burrs clean	0,11	—
Seeds clean	0,34	12
Staple length	-0,30	9
Staple strength	-0,19	—
Card production rate	0,25	6
Number of burr beaters	0,06	—
Card rejects	0,93	87
Bowl waste	0,35	13
Comb shoddy	0,96	92

A series of regressions was subsequently carried out to determine on which parameters fibre loss depended. These are summarised in Table 6 which shows the percentage contribution of the significant terms obtained in each regression and the total fit obtained. The table also signifies by means of the letters "ns" which other variables were included in the analysis but which were not found to make a significant contribution. The significant equations derived from the data are given in Table 7.

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SUMMARY OF STATISTICAL ANALYSIS : CONTRIBU
VARIOUS REGRESSION

Regression No.	Significant Level	Data Set	No. of Points	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_1^2	X_3^2	X_4^2	X_5^2	X_6^2	X_9^2	X_{10}^2	$X_1.X_2$	$X_1.X_3$	$X_1.X_4$	$X_1.X$
39	95	PLS	34	12	44	ns	ns	ns	ns	ns				ns	ns	ns					ns	ns	ns	
43	95	PLS	34	12	44	ns	ns	ns	ns	ns											ns	ns	ns	
44	95	PLS	34	11	ns	ns	ns	ns	ns	38				10	ns	ns						ns	ns	
45	95	PLS	34	20		11	11	ns	ns					19	ns	ns						ns	ns	
46	95	PLS	34	20		11	11	ns						19	ns	ns	ns					ns	ns	ns
40	95	OSP	23	6	ns	ns	ns	ns	ns	ns				ns	ns	ns					ns	23	ns	
41	95	PLS + OSP	57	ns	27	ns	ns	ns	ns	ns				ns	ns	ns					ns	ns	8	
47	95	PLS + OSP	57	ns	ns	ns	ns	ns	ns	ns											ns	ns	6	
48	95	PLS + OSP	57	ns		ns	ns	ns	ns	ns				ns	ns	7						ns	17	
49	95	PLS + OSP	54	ns		ns	ns	ns	ns	ns				ns	ns	ns						ns	17	
50	93	PLS + OSP	54	ns		ns	ns	ns	ns	ns				ns	ns	ns						ns	10	
51	95	PLS + OSP	53	ns		ns	ns	ns	ns					ns	ns	ns						ns	17	
52	95	PLS + OSP	53	ns		ns	ns	ns	ns					ns	ns	ns	ns	ns				ns	ns	ns
53	95	PLS + OSP	53	ns		ns	48	ns	ns		ns											ns	ns	ns
54	95	PLS + OSP	41	ns		ns	43	ns	ns					ns	ns	15						ns	24	
55	95	PLS + OSP	53	ns		ns	40	ns	ns					ns	ns	10						ns	24	
56	95	PLS + OSP	53	ns		ns	ns	ns				ns		ns	ns	ns	ns		ns			ns	ns	ns
57	94	PLS + OSP	53	ns		ns	ns	ns				6		ns	ns	6	ns		ns			ns	14	ns
58	93	PLS + OSP	53	ns			40	ns				ns		ns	ns	10	ns		ns			ns	24	ns
59	95	PLS + OSP	53	ns		ns	ns	ns					ns	ns	ns	ns	ns			ns		ns	17	ns
60	95	PLS + OSP	53	ns		ns	ns	ns					ns	ns	ns	ns	ns			ns		ns	12	ns
61	95	PLS + OSP	57	ns	ns	ns	ns	ns	ns			ns										ns	ns	

* Where X_1 = Staple length; X_2 = VM Clean; X_3 = Burrs, clean; X_4 = Fribbiness; X_5 = Diameter; X_6 = Card production rate;
X_7 = No. of burr beaters; X_8 = Wool base; X_9 = Staple strength; X_{10} = Staple strength clean.
ns = not significant

BLE 6

TION OF SIGNIFICANT TERMS TO TOTAL FIT OF THE EQUATIONS OBTAINED

PARAMETER*																												% Fit
$X_1.X_6$	$X_1.X_7$	$X_1.X_8$	$X_1.X_9$	$X_1.X_{10}$	$X_2.X_3$	$X_2.X_4$	$X_2.X_5$	$X_2.X_9$	$X_3.X_4$	$X_3.X_5$	$X_3.X_6$	$X_3.X_7$	$X_3.X_8$	$X_3.X_9$	$X_3.X_{10}$	$X_4.X_5$	$X_4.X_6$	$X_4.X_7$	$X_4.X_8$	$X_4.X_9$	$X_4.X_{10}$	$X_5.X_6$	$X_5.X_8$	$X_5.X_9$	$X_5.X_{10}$	$X_6.X_7$	$X_6.X_8$	
					ns	ns	ns		ns	ns	ns					ns						ns						56
	ns				ns	ns	ns		ns	ns	ns					ns		ns				ns				ns		56
	ns								ns	ns	ns					ns						ns				ns		69
									ns	9	ns					ns						ns						70
									ns	9						ns												70
					ns	19	x		ns	ns	ns					42						ns						90
					ns	7	ns		ns	ns	ns					35						ns						78
	ns				ns	13	ns		ns	ns	23					ns		38				ns				ns		78
	ns								10	ns	10					ns		28				ns				ns		80
	ns								ns	ns	ns					55		ns				ns				ns		72
	ns								14	ns	15					40		ns				ns				ns		80
									ns	ns	ns					56						ns						74
ns									ns	ns	ns					50	26					ns						76
ns		ns							ns	ns	ns		ns			ns	28		ns			ns	ns				ns	76
									ns	ns	ns											ns						82
									ns	ns	ns											ns						74
			ns						ns	ns				ns		ns				71				ns				71
			ns						13	9				ns		ns				35				ns				83
			ns						ns					ns										ns				74
				ns					ns	ns					ns	56									ns			74
				ns					ns	ns					ns						60				ns			72
			ns			10		17	ns	ns	ns	ns		ns			11	42			ns			ns				80

TABLE 7

EQUATIONS DERIVED IN THE VARIOUS REGRESSIONS

Regression No.	EQUATION	n	% Fit
39	$Y = 0{,}414X_2 - 0{,}276X_1 + 17{,}6$	34	56
40	$Y = 0{,}042X_4X_5 + 0{,}019X_1X_3 - 0{,}173X_2X_4 - 0{,}133X_1 + 13{,}1$	23	90
41	$Y = 0{,}064X_4X_5 - 0{,}015X_1X_4 - 0{,}114X_2X_4 + 0{,}553X_2 + 5{,}1$	57	78
43	$Y = 0{,}414X_2 - 0{,}276X_1 + 17{,}6$	34	56
44	$Y = -4{,}86X_1 + 0{,}056X_1^2 + 0{,}269X_4X_7 + 4{,}70X_7 + 105{,}7$	34	69
45	$Y = 3{,}445X_3 - 5{,}306X_1 + 0{,}062X_1^2 + 0{,}242X_4 - 0{,}149X_3X_5 + 118{,}6$	34	70
46	$Y = 3{,}445X_3 - 5{,}306X_1 + 0{,}062X_1^2 + 0{,}242X_4 - 0{,}149X_3X_5 + 118{,}6$	34	70
47	$Y = 1{,}384X_4X_7 + 0{,}033X_3X_6 - 0{,}164X_2X_4 - 0{,}013X_1X_4 + 5{,}8$	57	78
48	$Y = 1{,}845X_4X_7 + 0{,}033X_3X_6 - 0{,}027X_1X_4 - 0{,}192X_3X_4 - 0{,}013X^2_4 + 5{,}7$	57	80
49	$Y = 0{,}048X_4X_5 - 0{,}015X_1X_4 + 6{,}5$	54	72
50	$Y = 0{,}057X_4X_5 - 0{,}02X_1X_4 + 0{,}07X_3X_6 - 0{,}31X_3X_4 + 5{,}8$	54	80
51	$Y = 0{,}048X_4X_5 - 0{,}015X_1X_4 + 6{,}4$	53	74
52	$Y = 0{,}077X_4X_5 - 0{,}073X_4X_6 + 6{,}2$	53	76
53	$Y = -0{,}095X_4X_6 + 1{,}90X_4 + 6{,}4$	53	76
54	$Y = 1{,}77X_4 - 0{,}025X_1X_4 - 0{,}016X^2_4 + 5{,}6$	53	82
55	$Y = 1{,}6X_4 - 0{,}024X_1X_4 - 0{,}012X^2_4 + 5{,}9$	53	74
56	$Y = 0{,}012X_4X_9 + 6{,}1$	53	71
57	$Y = 0{,}039X_4X_9 - 0{,}016X_1X_4 - 0{,}012X^2_4 - 0{,}094X_9 - 0{,}318X_3X_4 + 0{,}053X_3X_5 + 8{,}9$	53	83
58	$Y = 1{,}60X_4 - 0{,}024X_1X_4 - 0{,}012X^2_4 + 5{,}9$	53	74
59	$Y = 0{,}048X_4X_5 - 0{,}015X_1X_4 + 6{,}4$	53	74
60	$Y = 0{,}924X_4X_{10} - 0{,}010X_1X_4 + 6{,}5$	53	72
61	$Y = 1{,}708X_4X_7 - 0{,}059X_4X_6 - 0{,}126X_2X_4 + 0{,}010X_2X_9 + 5{,}4$	57	80

The first five regressions shown in the Table 7 i.e. regressions 39 and 43 to 46, were carried out on the PLS data set containing 34 points. Both the first and second gave a 56% fit to the data with VM clean and staple length the only significant variables. When VM clean was omitted from the regression as in the next three regressions, the fit improved to 70%, the significant variables being staple length, fribbiness and burrs, or burr beaters.

A regression of the OSP data set of 23 points (regression 40) gave a 90% fit to the data with staple length, burrs, fribbiness and diameter being the significant variables. No further regressions were carried out on this data set.

The remainder of the regressions shown in Table 6 were carried out on the combined data set, sometimes omitting 3 or 4 points (considered as being possibly "extreme" points as a result of experimental error) to try and improve the fit.

Regressions 41, 47 and 48 were carried out on all 57 points with slight variations in selection of parameters. All three of these gave roughly 80% fit to the data. Staple length and fribbiness featured in all three cases and other parameters which made significant contributions were VM clean, burrs, burr beaters, production rate and diameter.

A number of further regressions were carried out (regressions 49 to 61) some of which involved a reduction in the number of data points considered, some of which involved newly acquired additional data and some of which involved the lowering of the level of significance slightly. In most cases these manoeuvres were hardly justified and at best only resulted in a marginal improvement in fit.

Taking an overall view of the results shown in Table 6 it would seem important to measure most, but not necessarily all, of the following 8 parameters to arrive at a reasonable explanation of fibre losses which occur during worsted topmaking of short wools:

1. Fribbiness
2. Staple length
3. VM clean
4. Burrs
5. Number of burr beaters
6. Card throughput rate
7. Diameter
8. Staple strength

It can be seen from the correlation matrix (Table 8) that, apart from the correlation between burrs and VM clean (which is understandable), the above variables are independent of each other.

Regressions 41, 47, 48 and 61 seem to offer the best overall relationship involving all the points, and give about an 80% fit. The respective regression equations involve knowledge of 4, 6, 5 and 6 different parameters from the above selection, respectively. None of these regressions can predict losses very accurately, but at least they are considerably better than has been possible until now. This can be illustrated by Table 9 which shows the *measured loss* expressed as a percentage of the measured bone dry clean scoured wool produced, together with the losses predicted on the same basis by regression formulae numbers 41, 47, 48 and 61. The mean measured loss for all 57 samples was 8,4%. The standard deviation of the *difference* between the measured and

TABLE 8

CORRELATION MATRIX ILLUSTRATING THE INTERDEPENDANCE OF VARIOUS PARAMETERS WHICH INFLUENCE FIBRE LOSSES ("r")

	1	2	3	4	5	6	7	8
1. Fribbiness	1,0	-0,38	-0,01	-0,11	-0,11	-0,16	-0,11	-0,05
2. Staple length		1,0	0,07	-0,01	-0,01	0,63	0,20	0,11
3. VM clean			1,0	0,96	0,86	-0,16	0,02	-0,08
4. Burrs				1,0	0,88	-0,29	0,02	-0,06
5. No. of burr beaters					1,0	-0,25	0,01	-0,08
6. Card throughput						1,0	0,28	0,22
7. Diameter							1,0	0,45
8. Staple strength								1,0

predicted values was 1,74 1,63 1,65 and 1,61 for the four different regressions, respectively, indicating that all four are about equally accurate. These results should be compared with the losses predicted using the IWTO formulae (and expressed on a clean basis) which show a mean loss for all 57 samples of 5,72% and a standard deviation of the *difference* between the measured and predicted values of 3,47%. The standard deviation of the difference in the case of the four

TABLE 9

MEASURED AND PREDICTED FIBRE LOSSES

Sample No.		Measured Loss	Predicted Losses				IWTO Allowance*
			Reg. 41	Reg. 47	Reg. 48	Reg. 61	
PLS	10	5,6	6,3	7,0	6,8	6,6	4,2
	11	10,0	9,1	9,6	9,8	8,4	7,2
	12	5,8	6,9	6,6	6,6	6,8	5,4
	13	6,6	7,7	7,5	7,8	7,8	5,6
	14	7,6	7,2	6,0	6,3	7,0	5,7
	15	6,1	6,9	7,3	7,3	7,2	4,6
	16	6,9	6,8	7,0	6,9	6,6	5,0
	17	8,7	12,1	10,9	11,2	11,6	5,5
	18	5,6	6,2	6,4	6,3	6,4	4,7
	19	8,8	8,1	7,6	7,7	7,1	5,7
	20	11,8	7,8	7,6	7,4	7,0	4,2
	21	5,0	6,3	7,1	6,7	6,7	4,4
	22	5,2	6,3	7,0	6,8	6,7	5,0
	23	5,0	6,3	7,1	6,9	6,6	5,3
	24	8,6	7,8	7,1	7,7	7,4	6,1
	25	9,4	8,0	7,9	8,2	7,8	4,9
	26	6,0	7,3	7,5	7,4	7,3	5,0
	27	5,9	7,1	7,1	7,0	7,1	5,4
	28	11,9	15,1	13,6	13,6	13,1	10,2
	29	9,4	6,8	7,3	7,1	6,9	5,1
	30	7,1	7,1	7,7	7,4	7,1	5,1
	31	7,6	8,3	8,1	7,8	7,6	6,2
	32	6,8	6,9	7,1	7,0	6,8	4,1
	33	6,0	7,3	7,1	7,1	6,9	5,7
	34	6,1	6,6	7,1	7,0	7,0	4,1
	35	5,7	6,1	6,5	6,4	6,4	3,8
	36	6,0	6,7	7,4	7,2	7,3	6,0
	37	6,3	7,1	7,1	6,9	7,1	4,8
	38	8,6	8,1	8,9	8,7	8,2	4,2
	39	8,6	8,3	8,3	8,2	8,2	4,5
	40	6,8	9,4	8,4	7,6	8,8	6,2
	41	6,9	9,1	9,4	8,8	8,9	5,3
	42	12,0	9,6	11,4	11,7	12,3	8,5
	43	8,2	8,6	8,1	7,4	7,6	6,2
OSP	13	5,7	6,0	6,1	5,9	6,0	4,5
	14	5,8	5,7	5,8	5,7	5,8	4,9
	15	8,2	7,1	7,5	7,2	6,8	6,9
	22	13,0	7,2	7,2	7,0	7,3	5,6
	23	6,5	7,3	6,7	6,7	7,2	5,6
	24	13,5	10,6	12,2	12,6	13,5	8,4
	28	5,5	6,3	5,8	5,7	6,3	4,7
	29	5,3	5,8	5,8	5,7	5,9	5,1
	30	4,0	7,2	5,8	5,8	6,7	6,5
	31	7,9	7,3	5,9	7,4	7,2	6,8
	31A	7,8	7,1	5,9	6,0	6,8	6,5
	31B	10,5	9,9	10,4	9,0	12,2	6,7
	32	11,8	10,6	9,2	11,1	8,8	6,1
	32A	9,3	7,5	6,6	6,8	6,9	5,6
	32B	12,1	14,4	13,3	15,7	13,9	6,1
	33	17,9	20,0	19,2	19,4	17,8	6,1
	33A	13,4	12,6	12,9	14,7	11,6	5,4
	34	7,8	7,1	6,9	6,8	7,0	5,7
	35	8,6	8,1	7,6	7,5	8,1	5,9
	36	25,4	23,8	23,1	22,4	23,4	5,5
	37	6,5	7,1	6,4	6,4	7,1	6,1
	38	6,2	8,2	7,1	7,8	7,6	5,7
	39	16,1	14,8	15,4	14,1	16,7	6,2
MEAN		8,44	8,49	8,42	8,45	8,47	5,62
Standard deviation of difference		—	1,74	1,63	1,67	1,67	3,47

*Adjusted to a clean basis

TABLE 10

MEASURED AND PREDICTED TOP AND NOIL YIELDS

Sample No.		Measured Yield	Predicted Yield (%)				IWTO (%)
			Reg. 41(a)	Reg. 47(a)	Reg. 48(a)	Reg. 61(a)	
PLS	10	58,1	59,9	59,7	59,1	59,7	59,9
	11	52,6	53,6	53,5	52,8	54,0	53,5
	12	55,9	56,0	56,4	55,8	56,1	55,7
	13	51,7	52,0	52,2	51,5	51,9	52,0
	14	54,9	57,5	58,4	57,6	57,7	57,2
	15	60,5	61,4	61,3	60,7	61,2	61,6
	16	54,8	59,3	59,3	58,7	59,3	59,0
	17	55,1	53,7	54,6	53,8	54,0	56,4
	18	58,1	58,8	58,8	58,3	58,7	58,4
	19	58,0	59,8	60,3	59,6	60,4	59,9
	20	58,7	61,6	61,4	60,8	61,6	62,0
	21	61,4	60,6	60,3	59,9	60,3	60,5
	22	52,0	51,8	51,6	51,2	51,6	51,4
	23	47,6	47,8	47,6	47,2	47,6	47,2
	24	46,8	47,2	47,6	46,9	47,3	47,0
	25	54,4	54,4	54,6	53,9	54,5	55,0
	26	55,4	55,3	55,3	54,8	55,3	55,4
	27	58,1	56,9	57,0	56,5	56,9	56,6
	28	49,4	44,2	45,0	44,5	45,2	45,6
	29	56,5	57,5	57,3	56,9	57,4	57,2
	30	60,9	61,8	61,6	61,1	61,8	61,8
	31	55,4	55,2	55,5	55,1	55,6	55,2
	32	60,0	61,6	61,6	61,0	61,6	62,0
	33	61,1	51,6	51,8	51,2	51,7	51,3
	34	63,2	65,3	65,1	64,5	65,0	65,5
	35	65,9	67,2	67,1	66,5	67,0	67,3
	36	42,3	42,2	42,0	41,6	41,8	41,5
	37	57,1	58,5	58,7	58,1	58,5	58,6
	38	56,7	58,3	57,9	57,5	58,2	59,4
	39	59,9	59,9	60,0	59,5	59,9	60,9
	40	52,0	50,8	51,5	51,4	51,1	51,4
	41	55,2	53,1	53,1	52,8	53,1	54,0
	42	52,5	52,0	51,1	50,4	50,4	51,4
	43	57,1	57,0	57,5	57,3	57,5	57,1
OSP	13	60,6	60,7	60,8	60,2	60,6	60,3
	14	54,8	54,7	54,8	54,3	54,6	54,0
	15	47,4	45,0	44,9	44,6	45,1	44,1
	22	49,1	52,0	52,2	51,7	51,9	51,7
	23	55,6	56,6	57,2	56,6	56,7	56,4
	24	53,2	51,2	50,5	49,7	49,6	51,2
	28	63,2	62,8	63,3	62,7	62,8	62,4
	29	54,1	53,5	53,7	53,2	53,5	52,8
	30	47,5	46,5	47,3	46,9	46,7	45,8
	31	46,9	47,5	48,4	47,1	47,6	46,7
	31A	48,8	47,2	48,0	47,4	47,3	46,4
	31B	40,2	40,4	40,3	40,5	39,4	40,9
	32	47,6	48,4	49,3	47,7	49,3	49,7
	32A	52,6	55,3	56,0	55,3	55,7	55,2
	32B	46,0	44,4	45,1	43,4	44,6	47,5
	33	43,7	44,2	44,7	44,1	45,3	50,5
	33A	49,2	49,8	49,7	48,2	50,3	52,6
	34	49,8	50,2	50,5	50,1	50,3	49,9
	35	49,1	48,5	48,9	48,4	48,4	48,5
	36	42,8	43,9	44,4	44,2	44,1	53,0
	37	50,4	48,8	49,3	48,8	48,8	48,2
	38	54,7	53,7	54,5	53,5	54,0	53,9
	39	42,8	42,1	42,0	42,1	41,2	45,2
MEAN		53,5	53,5	53,7	53,1	53,5	54,0
Standard deviation of difference		—	2,02	2,01	2,00	2,06	2,66

regression formulae were all highly *significantly lower,* (at the 99,9% level) than the standard deviation of the difference in the case of the IWTO predictions. It can therefore be concluded that losses of fibre incurred during processing into tops could be predicted with significantly better accuracy by any of the above four regressions than was possible using the IWTO formula. This is further illustrated by Figs 2 and 3 which show the measured loss of fibre plotted against the loss of fibre predicted by regression 41 and the IWTO formula, respectively.

While the above reported work has increased our knowledge of what brings about losses of fibre during processing, it is of more practical importance to be able to use such information in the prediction of *yields* of *top* and *noil* with greater accuracy than has been possible hitherto. The actual *measured yield* of top and noil (corrected to standard allowances) is the all-important parameter and an attempt must be made to estimate this by the most suitable formula. The *measured yields* of top and noil are shown in Table 10. It can be seen that the mean of all 57 samples was 53,5%. The yields in the next four columns have been calculated by first deducting fibre losses from the wool base and then multiplying the answer by 1,207 (i.e. assuming standard allowances and a tear of 8:1). The regression formulae 41, 47, 48 and 61 have again been used for this exercise but the value of the constant in each case has been adjusted slightly so as to produce a mean value for all 57 samples which agrees with the mean measured yield, namely 53,5%. The formulae to predict mill yields of top and noil are given in Table 11 and the regressions upon which these have been based have been identified using the same reference numbers as previously but with (a) added to indicate that an adjustment to the constant has been made. In the final column of Table 10 the drycombed top and noil yields predicted using the IWTO formulae are given. The mean of these yields is 53,96%. Some serious discrepancies can be seen between these yields and the actual measured yields, one example being OSP 33 where the prediction is some 5% too high. The standard deviation of the *difference* between the measured and predicted yields is between 1,96 and 1,97 in those cases using the four regression formulae, but is 2,66 in the case using the IWTO formula. The former values are significantly better at the 95% level of confidence, giving an F-test value of 1,84. Thus any of the above formulae can predict the yield with significantly better accuracy than is possible using the IWTO formula. This is further illustrated by Figs. 4 and 5 which show the measured top and noil yield versus the yield of top and noil predicted by regression 41(a) and the IWTO formula, respectively.

The regression formulae given in Table 11 for the prediction of mill yields are a little cumbersome for practical implementation since not all the parameters involved are measured routinely. If, however, an objective measurement of fribbiness is implemented to supplement information about the vegetable matter content of the wool (either VM clean, or burrs) these two parameters are

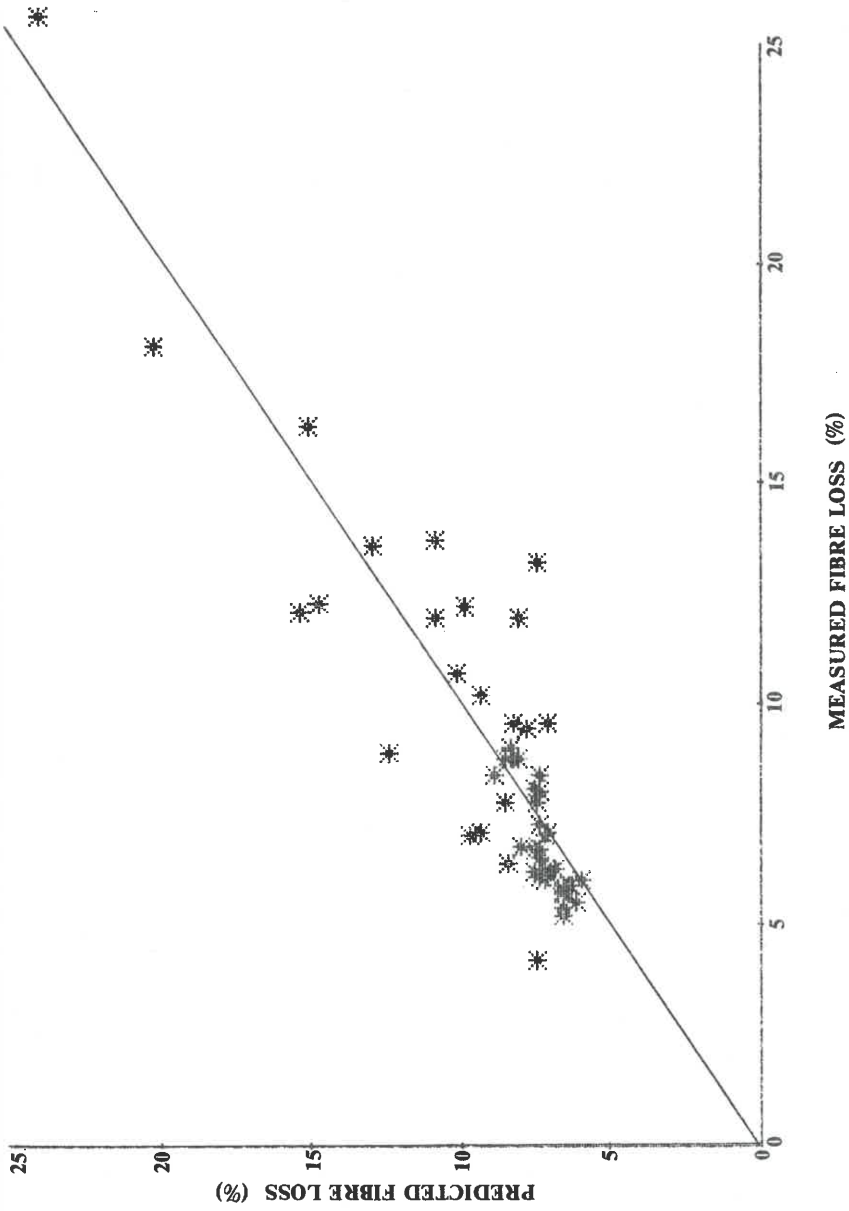

Fig. 2 – Measured loss of fibre versus loss predicted by regression 41
(The superimposed curve represents the 1:1 relationship)

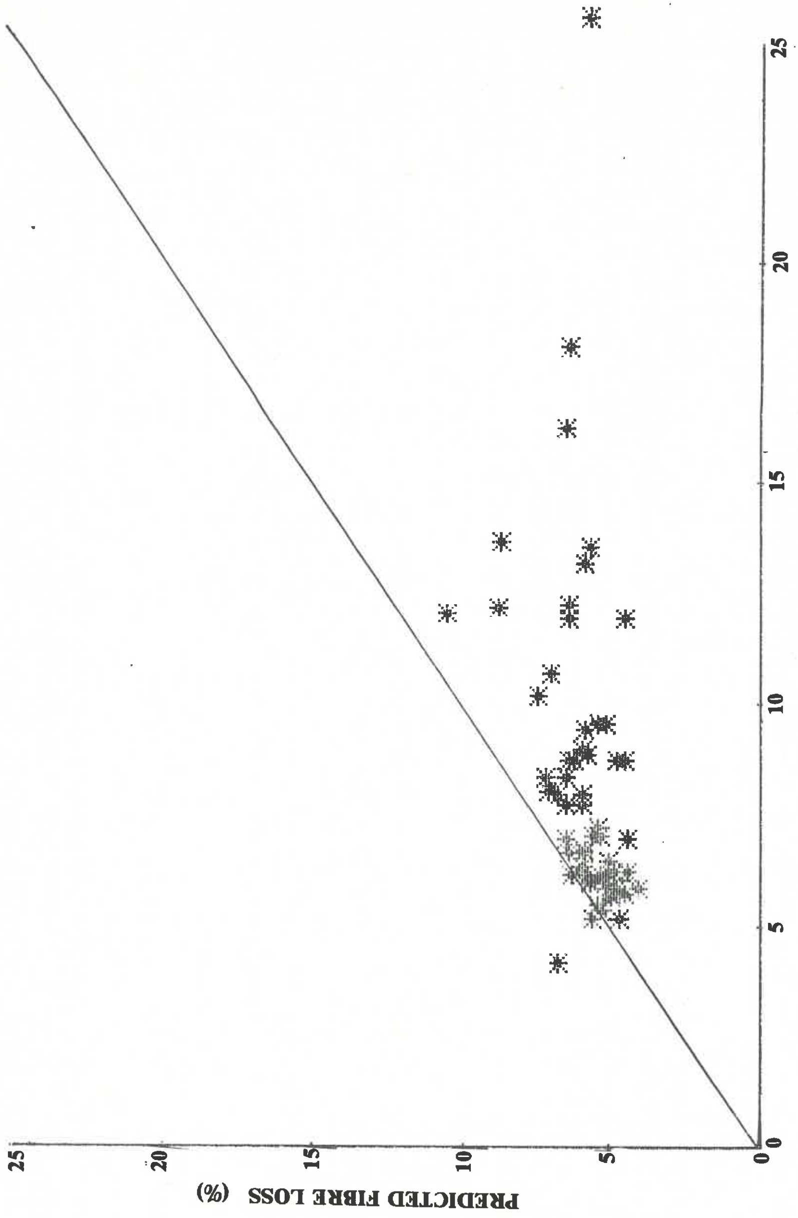

Fig. 3 – Measured loss of fibre versus loss predicted by the IWTO formula
(The superimposed curve represents the 1:1 relationship)

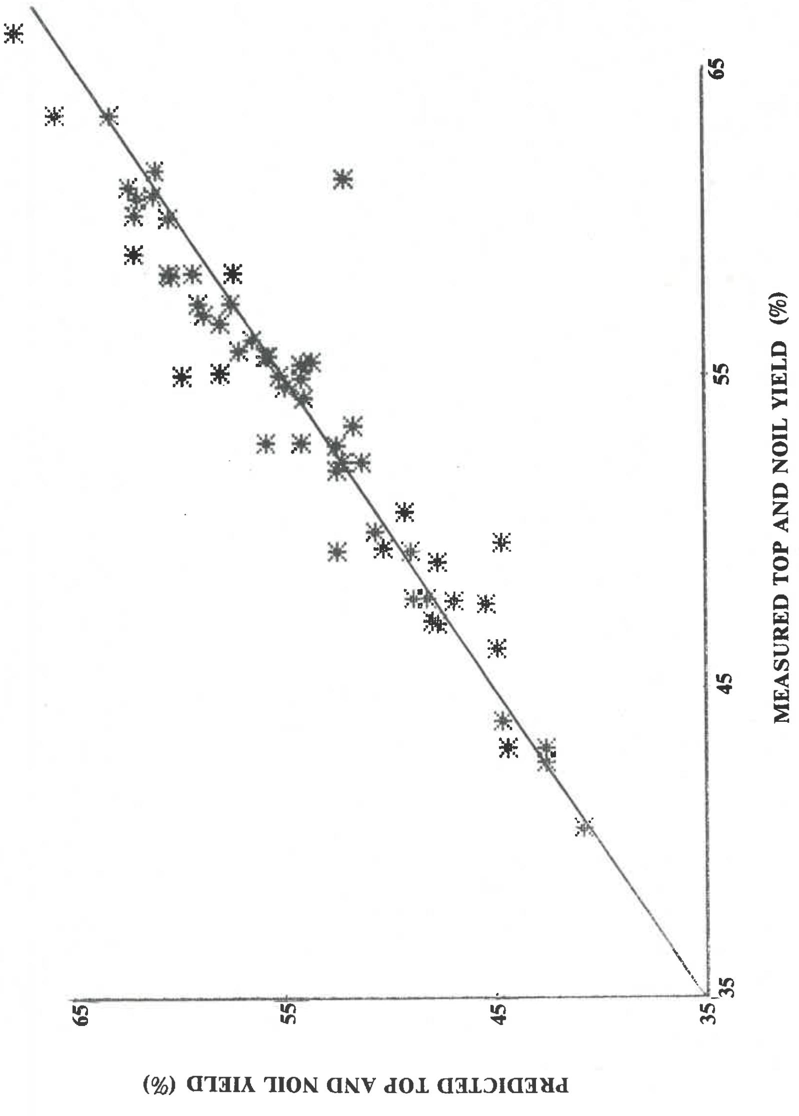

Fig. 4 – Measured top and noil yield versus top and noil yield predicted by regression 41(a) (The superimposed curve represents the 1:1 relationship)

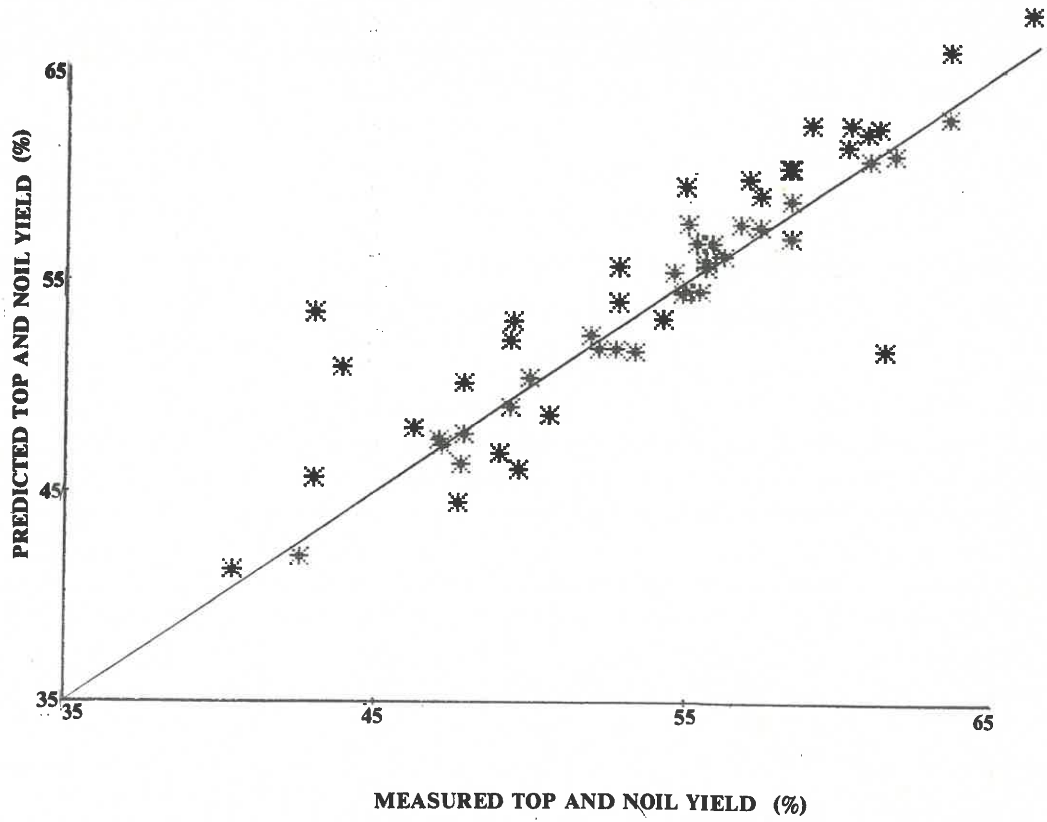

Fig. 5 – Measured top and noil yield versus top and noil yield predicted by the IWTO formula (The superimposed curve represents the 1:1 relationship)

TABLE 11

FORMULAE* TO PREDICT YIELDS OF TOP AND NOIL FOR SHORT WOOLS AND OUTSORTS

Based Upon Regression	DRYCOMBED TOP AND NOIL YIELD (%)	Standard Deviation of Difference between Measured Yield and Predicted Yield
41(a) (78% fit)	Wool base - 1,207 - $\left(1 - \frac{\text{Loss}}{100}\right)$, where Loss = $0{,}064X_4X_5 - 0{,}015X_1X_4 - 0{,}114X_2X_4 + 0{,}553X_2 + 3{,}0$	2,02
47(a) (78% fit)	Wool base . 1,207 . $\left(1 - \frac{\text{Loss}}{100}\right)$, Where Loss = $1{,}384X_4X_7 + 0{,}033X_3X_6 - 0{,}164X_2X_4 - 0{,}013X_1X_4 + 3{,}4$	2,01
48(a) (80% fit)	Wool base • 1,207 • $\left(1 - \frac{\text{Loss}}{100}\right)$, Where Loss = $1{,}845X_4X_7 + 0{,}035X_3X_6 - 0{,}027X_1X_4 - 0{,}192X_3X_4 - 0{,}013X^2_4 + 4{,}3$	2,00
61(a) (80% fit)	Wool base • 1,207 • $\left(1 - \frac{\text{Loss}}{100}\right)$, where Loss = $1{,}708X_4X_7 - -0{,}059X_4X_6 + 0{,}010X_2X_9 - 0{,}126X_2X_4 + 3{,}3$	2,06
IWTO (12% fit)	Wool base • 1,207 - (2,5 + VA)	2,66

*See Table 6 for identification of the variables sufficient to enable one to improve the prediction as is presently done using the IWTO formula. Regression formulae derived using these parameters alone for the prediction of mill yields of top and noil are given in Table 12. In these cases the standard deviation of the *difference* between measured yield and predicted yield was 2,03 and 2,06 respectively, both of which were still significantly better than the value of 2,66 in the case of the IWTO predictions. Thus these simplified formulae could be used to predict the mill yields of top and noil of short wools and outsorts with better accuracy than is at present possible using the IWTO formula. This is further illustrated by Figs 6 and 7. Fig 6 shows the measured loss of fibre plotted against the loss of fibre predicted by the simplified formula derived in regression 66. Fig 7 shows the measured top and noil yield plotted against the top and noil yield predicted using the simplified formula derived regression 66.

SUMMARY AND CONCLUSIONS

Actual losses of fibre sustained during the pilot scale processing of 57 lots of short wools and outsorts were measured. This was achieved by collecting all the waste and coring it and determining the 'waste base' in the case of each wool lot. At the same time the yield of top and noil at standard conditions was also established.

Fibre losses, expressed as a percentage of the measured bone dry clean scoured wool, varied from about 5% to as much as 25% and could not be explained adequately in terms of fault content or type of fault, nor of the more common parameters of length, diameter, burr beaters and card production rate. Significant improvements in the correlation between raw wool properties processing data and processing losses were obtained after devising a method to measure the degree of fribbiness of the raw wool.

It was found that fribbiness, staple length, VM clean, burrs, number of burr beaters, card throughput rate, diameter and staple strength contributed some 80% to the correlation between fibre losses, raw wool characteristics and processing variables.

The mean measured loss of fibre for the 57 data points was 8,4%. The standard deviation between the measured loss and the loss predicted by any of the four selected regression equations was about 1,6. This contrasted with the loss calculated using the IWTO formula (but converted to a clean basis) which was 5,6% and with the standard deviation between the measured and predicted loss which was 3,5%. It can therefore be concluded that by using the derived regression equations, loss of fibre incurred during processing into tops could be predicted with significantly better accuracy (significant at 99,9% level) than was possible using the IWTO formulae.

TABLE 12

SIMPLIFIED FORMULAE* TO PREDICT TOP AND NOIL YIELDS OF SHORT WOOLS AND OUTSORTS

Based upon Regression No.	Drycombed Top and Noil Yield (%)	Standard Deviation of Difference Between Measured Yield and Predicted Yield
65 (74% fit)	Wool base $\cdot$ 1,207 $\cdot \left(1 - \frac{\text{Loss}}{100}\right)$, where Loss = $0,83X_4 + 0,585X_2 - 0,14X_2X_4 + 2,7$	2,03
66 (70% fit)	Wool base $\cdot$ 1,207 $\cdot \left(1 - \frac{\text{Loss}}{100}\right)$, where Loss = $0,44X_4 + 0,48X_3 + 3,8$	2,06
IWTO (12% fit)	Wool base $\cdot$ 1,207 - (2,5 + VA)	2,66

* X_2 = VM clean; X_3 = Burrs, clean; X_4 = Fribbiness

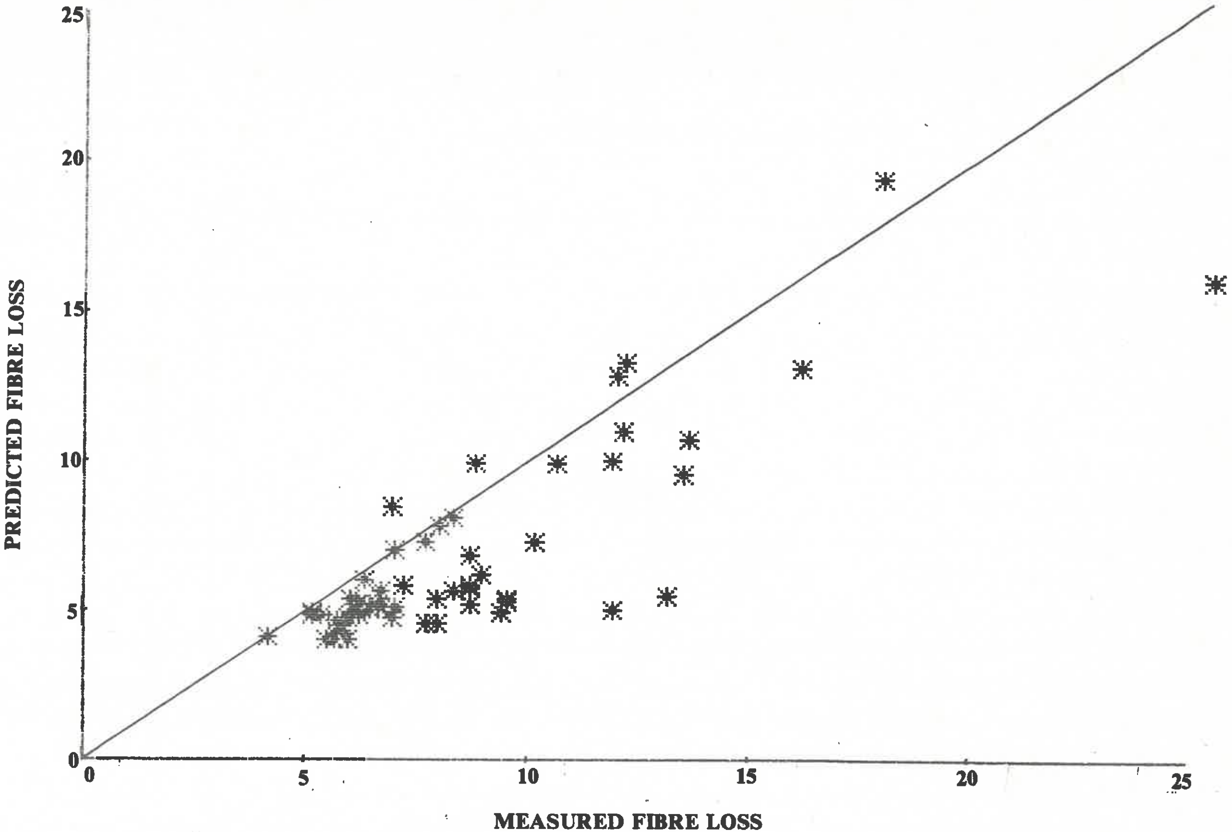

Fig. 6 – Measured loss of fibre versus loss predicted by one of the simplified formulae shown in Table 12 (Regression 66. The superimposed curve represents the 1:1 relationship)

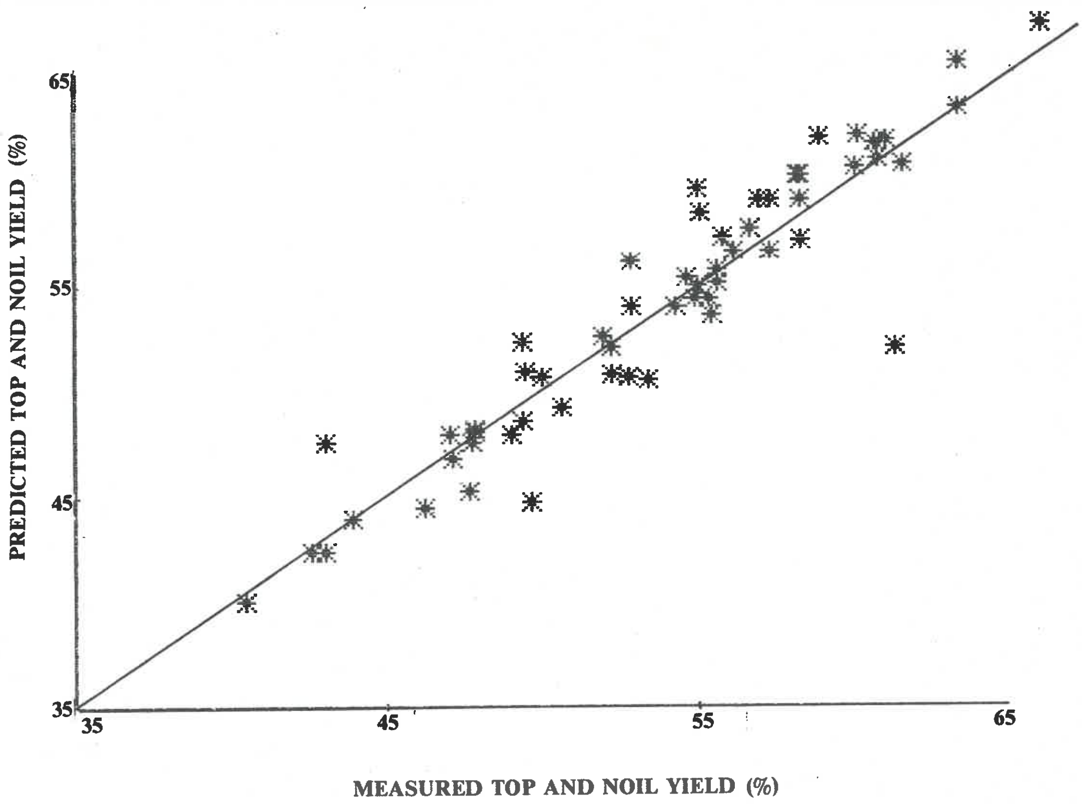

Fig. 7 – Measured top and noil yield versus top and noil yield predicted by one of the simplified formulae shown in Table 12. (Regression 66. The superimposed curve represents the 1:1 relationship)

Using the above information, four expressions for the prediction of yields of top and noil for short wools and outsorts were formulated. The actual *measured* top and noil yields were compared with these predictions and with the top and noil yields predicted using the standard IWTO formula for commercial yields. The standard deviation between the measured top and noil yield and predicted yield was about 2,0 in each of the four regressions while it was about 2,7 in the case of the IWTO formula. Simplified formulae were also derived in which the standard deviation of the difference was under 2,1 and these involved measurement of fribbiness together with either VM clean or burrs. In the case of both the full formulae and the simplified formulae, the prediction of top and noil yield was significantly better than that using the IWTO formula (significant at the 95% level).

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