RAPID ESTIMATION OF FIBRE LENGTH DISTRIBUTIONS IN WOOL STAPLES BY MEANS OF INFORMATION PROVIDED BY THE SAWTRI LENGTH/STRENGTH TESTER*

by D.W.F. TURPIE and J. CIZEK

ABSTRACT

One of the unique features of the SAWTRI Length/Strength Tester for Raw Wool Staples is that it provides automatic measurement of the staple profile in addition to data on staple length and strength. This lends itself to a number of interesting applications including the rapid estimation of the mean fibre length and distribution of Fibre length in raw wool lots which can be carried out with the aid of best-fit trapeziums to the profiles of the individual staples.

INTRODUCTION

One of the unique features of the SAWTRI length/strength tester for raw wool staples is that it provides automatic measurement of the staple profile (cross-section) in addition to data on staple length and strength.[1] This lends itself to a number of interesting applications. For example, it can provide information on the overall staple shape, or variation in cross-sectional area and also pinpoint the exact positions of weakness. Such information is of obvious interest and of commercial importance to the grower or breeder and to the merchant and topmaker.

Several examples of staple profiles obtained on the SAWTRI instrument were presented at the 54th IWTO Conference, and have been published subsequently as a SAWTRI Technical Report.[2] These profiles were derived from merino-type wools and illustrated the shapes of high, medium and low-tenacity staples as well as staples exhibiting a reduction in cross-section (weak place) near their middle and tips.

Further examples of staples, the profiles of which revealed possible weaknesses, have been presented at the 2nd World Merino Conference and are shown in Figs 1(a), (b), (c) and (d).[3] Fig 1(a) shows the profile of a South African Mutton Merino wool which exhibits a gradual thinning towards the root end. Fig. 1(b) shows a similar trend, but with a further marked reduction occurring at a position about 25% of the staple length from the root. Fig. 1(c) shows the profile of a Kent Longwool having a sharp reduction in cross-section at about 20% of its length from the root. Fig. 1(d) shows the profile of a Basuto wool

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showing a slight reduction in cross-section over a prolonged period of growth from about 20% to 40% of its length from the root. Such information as the above is clearly of interest to a number of sectors of the industry.

Another interesting application of the measurement of staple profile relates to the rapid estimation of the mean fibre length and distribution of fibre length in staples, and this paper addresses this specific issue.

USE OF STAPLE PROFILES FOR RAPID ESTIMATION OF FIBRE LENGTH DISTRIBUTION:

Previous attempts have been described in which the use of collective information on wool staple profiles and also mohair staple profiles have been used to estimate the mean fibre length and distribution of fibre length in wool or mohair staples respectively.[2,4,5] The methods used initially involved a summation of the estimated scoured profiles of all test staples representing a lot, after first normalising the staple thickness values so that all staples carried the same weight in the analysis. This produced curves such as those shown in Figs 2(a) and 2(b) for a specific wool lot and a specific mohair lot, respectively. These curves were then smoothed, the characteristic distortion at the root-end eliminated and the curves reconstructed in such a manner that the positions of the points derived from the root ends were each moved to coincide with the vertical axis. The "standardised staple profile" curve, so obtained, could be likened to a fibre length distribution diagram, and in certain cases showed a striking similarity to the Hauteur diagrams obtained from the same material after combing, as shown in Fig 3 for a lot of mohair. However, the summation of certain staple shapes produced curves with double humps and other irregularities such as already seen in Fig 2(a) which were some cause for concern when trying to interpret the fibre length distribution. This led to the idea of reducing the staple shape to that of a trapezium, with a view to determining the fibre length and its distribution from this simple geometric shape or "taper diagram".

Fig 4 illustrates the profiles of single staples obtained from a variety of long wools, lustre wools and various merino-related crosses.[3] (To obviate having to introduce corrections for contaminants, which could vary widely for different breeds, all the staples were hand-scoured and the profiles therefore represent the actual *scoured* profiles. Furthermore, to facilitate comparisons of the different staple shapes, the length of each staple was normalised to 100%). To obtain a measure of the staple taper towards the tip-end of the staple, a best-fit estimate of the staple shape in terms of a trapezium of equal area was obtained by computer. The point at which the taper of the staple commences can be expressed as a percentage of the staple length, and is defined as the x-co-ordinate of the point where the non-parallel side of the trapezium commences.

It can be seen from Fig 4, that tapering of staples commences at different points. For example, this occurred at 0% for the specific Devon Longwool staple

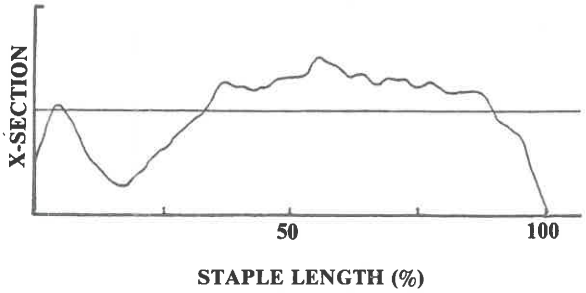


Fig. 1(c) Kent Long Wool showing a sharp reduction in cross-section at about 20%.

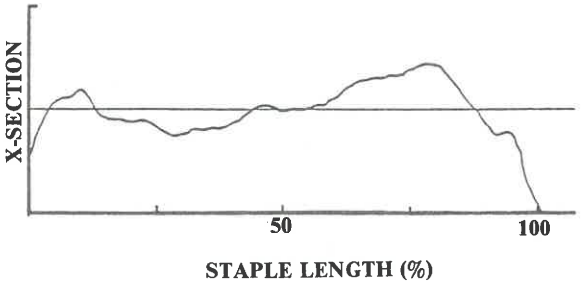


Fig. 1(d) Basuto showing a slight reduction in cross-section, about 20 to 40%.

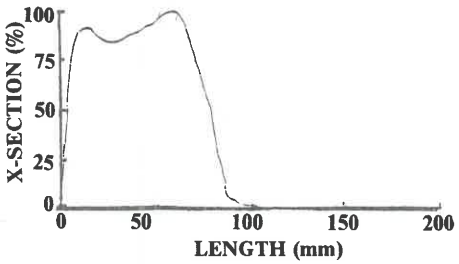


Fig. 2(a) Summation of estimated scoured profiles of all staples representing one wool lot.

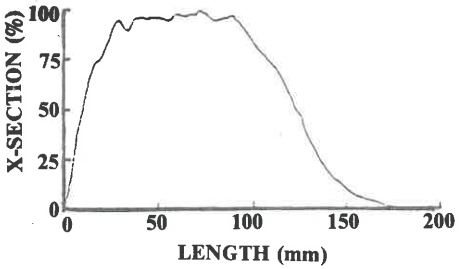


Fig. 2(b) Summation of estimated scoured profiles of all staples representing one mohair lot.

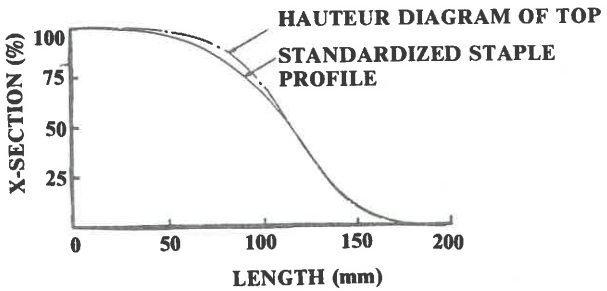
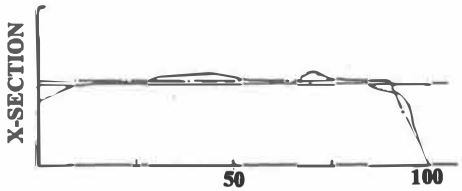
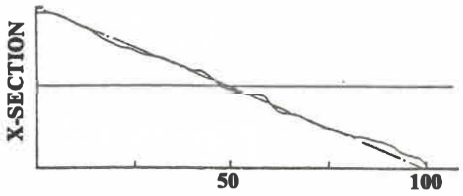


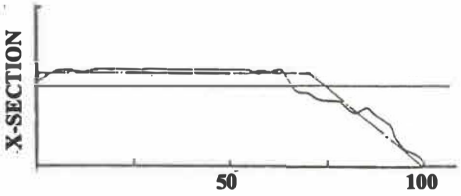
Fig. 3 Standardised staple profile for the mohair lot shown in Fig 2(b).



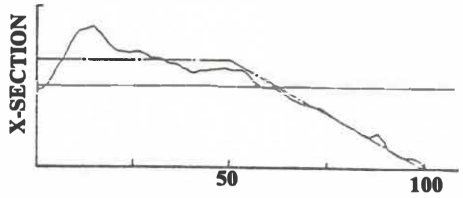
STAPLE LENGTH (%)
MERINO



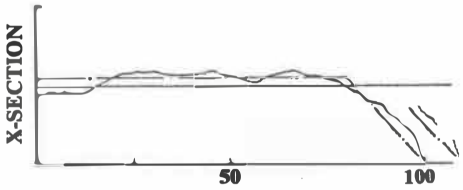
STAPLE LENGTH (%)
DEVON LONGWOOL



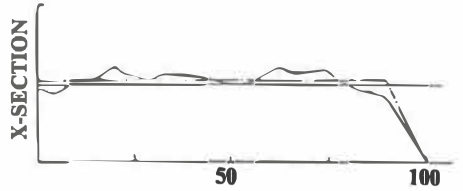
STAPLE LENGTH (%)
MASHAM WETHER LUSTRE WOOL



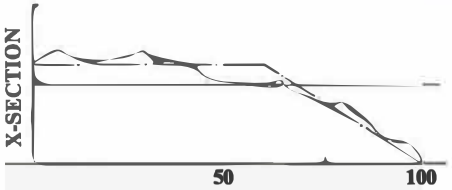
STAPLE LENGTH (%)
WELSH MOUNTAIN WOOL



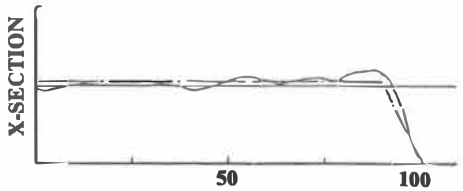
STAPLE LENGTH (%)
BORDER LEICESTER x MERINO



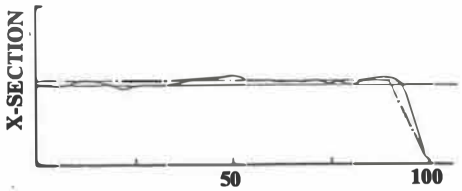
STAPLE LENGTH (%)
CORRIEDALE



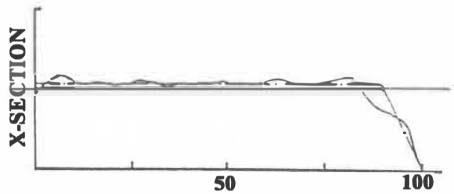
STAPLE LENGTH (%)
LINCOLN



STAPLE LENGTH (%)
MUTTON MERINO



STAPLE LENGTH (%)
TEXEL x MERINO



STAPLE LENGTH (%)

illustrated, at 60% for the Lincoln, at 80% for the Border Leicester/merino cross and at 90% for the Corriedale and also for a number of other merino crosses as well as for the merino itself. It should be noted that these values are *not* necessarily representative of the various breeds, but are simply those of randomly selected single staples from these breeds.

The usefulness of the concept of taper diagrams to obtaine an estimate of fibre length distribution in a single staple was subsequently investigated in a limited experiment involving five staples varying from tapered to almost square in shape.[3] These staples were tested for length by the Wira Single Fibre Length (SFL) method after they had been measured on the SAWTRI length/strength tester, and cumulative distribution curves constructed from the results for comparison with the taper diagrams which had been constructed from the profiles. The two sets of curves are compared in Fig 5. The mean lengths calculated from the taper diagrams and the single fibre length measurements were highly correlated ($r = 0,98$), whereas there was no correlation between staple length and mean fibre length. The CV of length calculated from the taper diagram was also significantly correlated with the CV calculated from the single fibre length results ($r = 0,85$).

The above experiment was then enlarged by studying a further 15 staples, deliberately selected to span a much wider range of lengths. The mean fibre length results obtained from the single fibre length method have been plotted against the mean fibre length results obtained from the respective taper diagrams (trapeziums) in Fig 6. These results were again found to be highly correlated ($r = 0,972$), the percentage fit being 94,5%. The relation is given by: $y = 0,912x + 6,0$ where y = mean fibre length by SFL method and x = mean fibre length of relevant trapezium.

The mean fibre length results obtained from the single fibre length method have been plotted against the staple length results in Fig 7. Here, however, although there was a correlation obtained between these two parameters ($r = 0,836$), due obviously to the wide range now covered, the percentage fit was only 69,9%. The relation is given by: $y = 0,602x + 17,6$ where y = mean fibre length by SFL method and x = staple length.

In view of the far better correlation obtained between the SAWTRI taper diagram information and the single fibre length values of the staples than between staple length and single fibre length values, it is considered that taper diagrams may possibly have useful application in the estimation of fibre length and its distribution in a raw wool lot. Normally, in such a case, some 50 or 60 staples are randomly selected from a grab sample and are used to characterise the lot for sale in terms of its length and strength characteristics. Such a set of staples will frequently vary widely in length, both within and between staples, and while a meaningful result can be obtained in terms of mean *staple* length, the accurate rapid estimation of mean *fibre* length rapidly from such information has not been feasible. To examine the feasibility of the taper diagram or

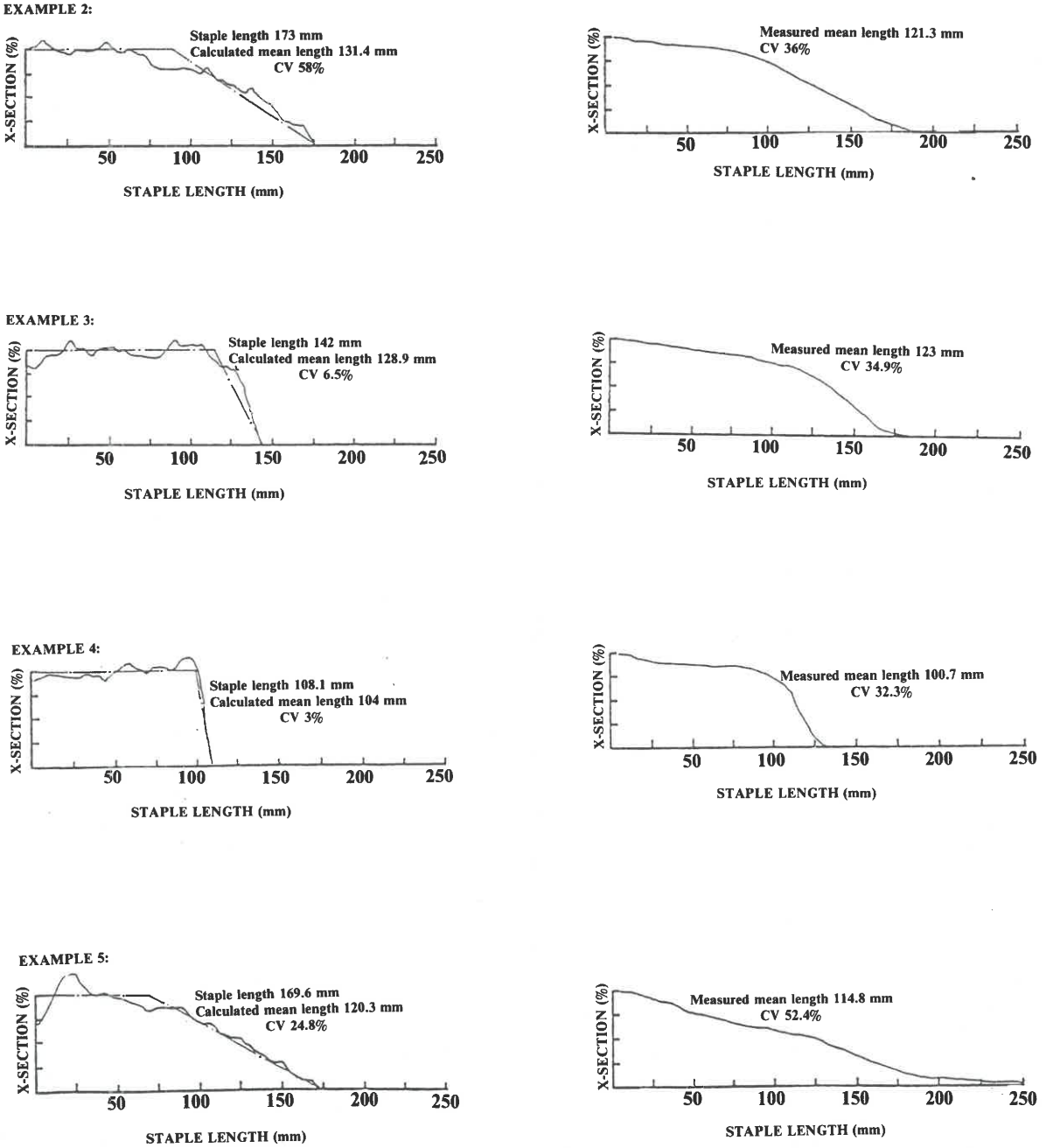


Fig. 5 – Profiles and Best Fit Trapeziums (A) and Single Fibre Length Diagrams (B) of a selection of single staples.

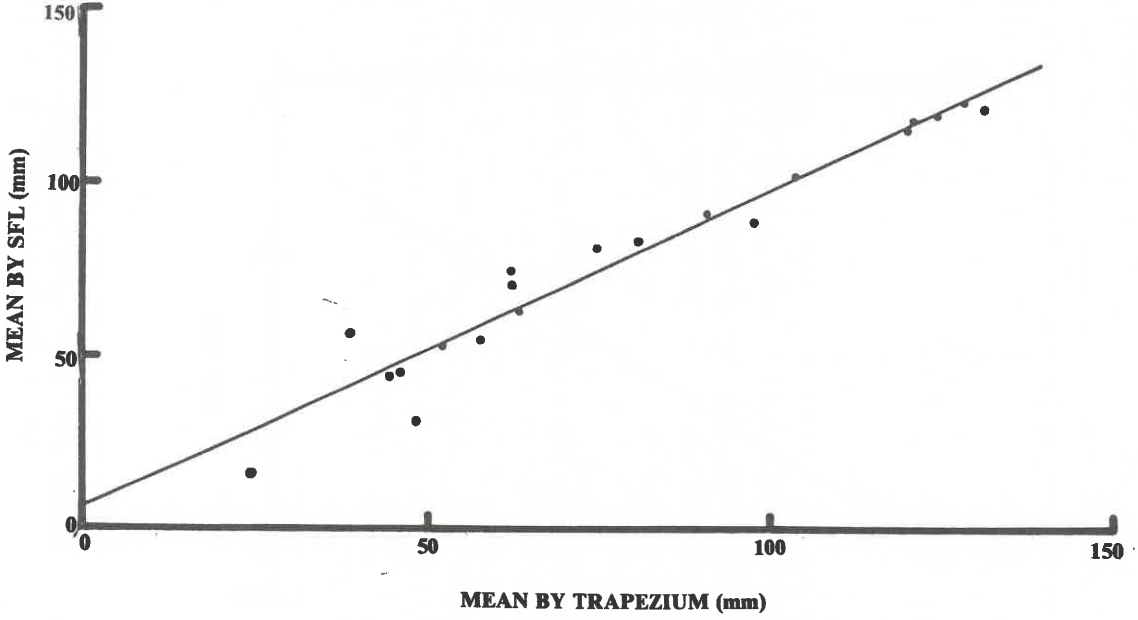


Fig. 6 – Mean Fibre Length Results by SFL versus Trapezium.

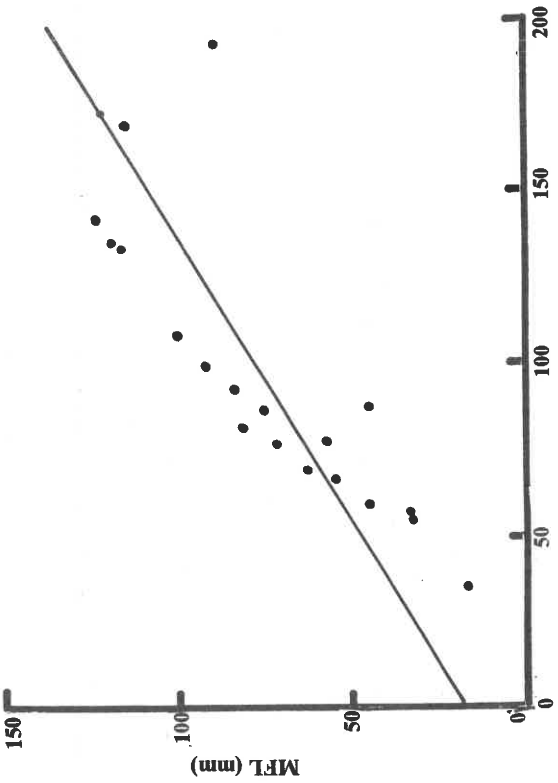


Fig. 7 Mean Fibre Length (SFL Method) versus Staple Length.

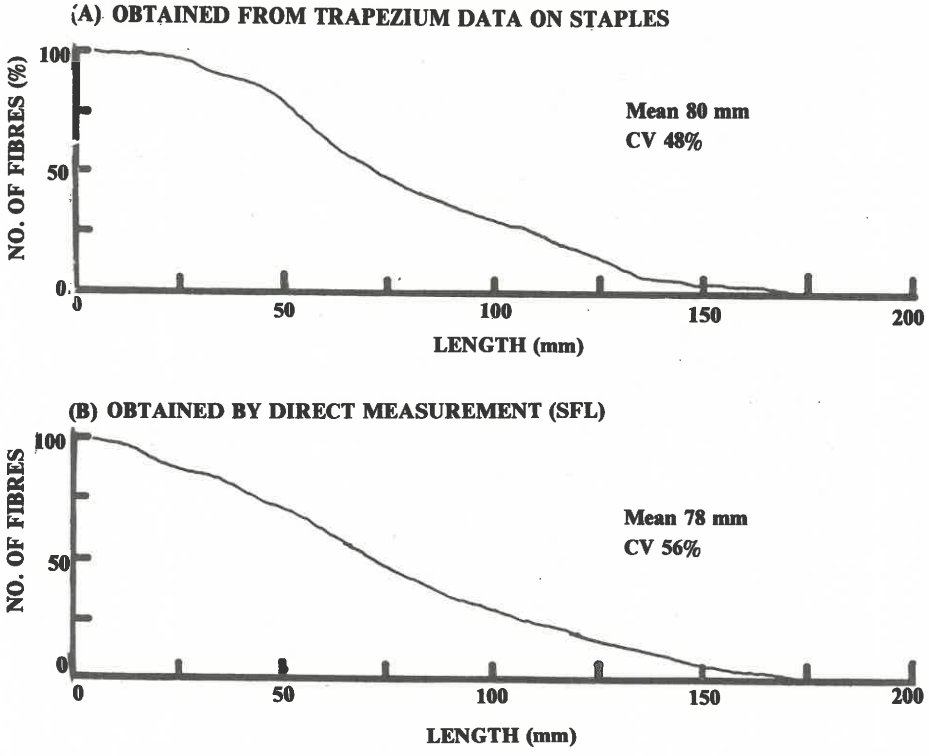


Fig. 8 – Cumulative Fibre Diagrams obtained from Trapezium data and by direct measurement.

trapezium approach, a software programme was written in which the data obtained from the trapeziums obtained from each of the 20 staples referred to in Fig 6 was accumulated, as if in fact these 20 staples represented a single blend or sale lot of wool. The resulting cumulative fibre diagrams obtained from this data are illustrated in Fig 8 and it can be seen that the two diagrams are in remarkably close agreement.

CONCLUSIONS

In conclusion, it seems that the measurement of the profile of staples on the SAWTRI length/strength testing machine, together with the use of a technique such as that described in this paper and involving the use of best-fit trapeziums to the staple profiles, has potential in the rapid estimation of the mean fibre length and length distribution of a raw wool lot.

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REFERENCES

1. Cizek, J., and Turpie, D.W.F., *SAWTRI Tech. Rep.* No. 561 (March 1985).
2. Turpie, D.W.F., and Cizek, J., *SAWTRI Tech. Rep.* No. 572 (Nov. 1985).
3. Turpie, D.W.F., Strydom, M.A. and Cizek, J., *Proc. 2nd World Merino Conf.,* Madrid (April 1986).
4. Turpie, D.W.F., Some of SAWTRI'S Important Research Findings on Mohair, *SAWTRI Special Publication* WOL 69, (June 1985).
5. Cizek, J., and Turpie, D.W.F., *Proc. 7th Int. Wool Text. Res. Conf.,* Tokyo, **II**, 137 (1985).

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