THE RELATIONSHIP BETWEEN GREASY FLEECE WEIGHT AND CLEAN FLEECE WEIGHT AND ITS APPLICATION.

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SUMMARY.

For seven flocks examined there was a high correlation between greasy and clean fleece weights.

At low culling levels, selection of sheep on greasy fleece weight is sufficient, but at higher selection intensities, scouring fleece samples to estimate clean weight is justified.

A judicious combination of culling for low greasy fleece weight and selection for high clean fleece weight can be expected to give most of the potential gain in clean fleece weight, with a considerable saving of time and labour.

I. OBSERVATIONS ON QUEENSLAND FLOCKS.

(1) Introduction

The ideal basis for selecting sheep is an index which takes into account the economic values, heritabilities and inter-relationships of all the characters contributing to sheep and wool production. Morley (1951) reviewed the problems involved in the construction of such an index and contributed to the accumulation of the necessary basic data. Schinckel (1956) also discussed the difficulties involved in defining the characters of economic importance and assessing their relative values. For the present, and probably for many years, other systems of selection must be followed. These need not be greatly inferior in efficiency to the index or total score method (Hazel and Lush 1942).

The field application of fleece measurement has been reviewed by Moule and Miller (1956). Where it has been incorporated in flock improvement, a three-stage mass selection programme is normally followed. This involves:—

(1) Culling of grossly undesirable animals.

(2) Selection for wool weight.

(3) Rejection of animals falling below acceptable standards for characters other than wool weight.

It is generally accepted that maximum selection pressure should be applied at the second stage. This view may have to be modified should negative genetic correlations between wool weight and other economically important characters prove a limiting factor. It is also possible that inbreeding may cause trouble after some generations. Morley (1955) suggested ways by which this may be avoided.

Wool weight can be defined in a number of ways. Fundamentally, the sheep breeder should be concerned with clean wool production per acre, per labour unit or some other related measure of economic outlay. It would be almost impossible to measure these accurately on an individual sheep basis. It is also impracticable to scour large numbers of whole fleeces, but fortunately there is a close relationship between the yield of a fleece sample and that of the whole fleece (Lockart 1955; Beattie and Chapman 1956). Clean fleece weight is to be understood in this paper as the product of greasy fleece weight and sample yield, where the sample yield is the ratio of clean to greasy wool in a small sample taken for scouring.

Although fleece sampling can be easily fitted into the normal shearing shed routine and scouring small samples is not difficult, there is inevitably some delay in returning results to the flock or stud owner. It is logical, therefore, to examine the efficiency of greasy fleece weight (which is very easily measured) as an estimate of clean fleece weight.

In 1949, when a wool laboratory was set up in this Department, available references indicated that fairly high correlations could be expected between clean and greasy wool weights. It remained to verify that this was the case for the Queensland flocks using fleece measurement, and to obtain a measure of the variation in the strength of this association from flock to flock.

Terrill, Pohle, Emik and Hazel (1945), working with Rambouillet, Targhee, Corriedale and Columbia ewes, found that inclusion of staple length as a second variable improved their prediction of clean wool weight from greasy weight. This was particularly the case for breeds with shorter staples and finer wools.

Analyses of results were therefore extended to include staple length measurements to find if this, too, was true under Queensland conditions.

(2) Materials and Methods.

Greasy fleece weights were obtained at shearing time and samples of approximately 4 oz. were taken from the right mid-side area of the fleece. This area had been raddled before shearing to ensure that it was accurately identified on the wool table. The samples were forwarded to the laboratory in airtight tins, and scoured by the method described by Beattie and Chapman (1956). The bone-dry sample yield was multiplied by the greasy fleece weight to find the clean fleece weight.

Staple length was measured to the nearest $\frac{1}{2}$ cm. on three adjacent staples of each fleece sample. Check measurements were made by a second observer.

Correlations among the three wool characters—clean weight, greasy weight and staple length—were determined for a total of 706 samples received during 1952-53. These came from seven properties in the Darling Downs, south-western, central-western and north-western sheep areas of Queensland. With the exception of 25 samples, all were from Merino sheep. The location of the properties is shown in the following table:—

Property.	Location.	Sheep Sampled.
1	Central-western	A — 2-tooth rams. B — 4-tooth ewes.
2	Central-western	Rams.
3	South-western	Rams.
4	North-western	Rams (6 months' wool).
5	Darling Downs	3-year-old ewes and wethers.
6	Darling Downs	Ewes (mixed ages).
7	Darling Downs	2-year-old Corriedale ewes (11 months' wool).

Except on properties 4 and 7, the sheep were carrying 12 months' growth of wool. Any differences due to age and sex within a property were removed from the results by analysis of variance. For property 1 the results are presented separately for the two sexes.

(3) Data and Discussion.

The relationships found among greasy fleece weight, staple length and clean fleece weight for each batch of samples are shown in Tables 1 and 2. For a fairly large range in mean values of these three characters over the seven properties, the correlation coefficients found are in reasonably good agreement.

Table 1.

Mean Greasy Fleece Weights, Staple Lengths and Clean Fleece Weights with Standard Errors of Estimate for Sheep from 7 Properties.

Property.	Number of Sheep.	Means.			Standard Deviation (s_y).	Standard Errors of Estimate.	
		Greasy Fleece Weight (x_1).	Staple Length (x_2).	Clean Fleece Weight (y).		Based on r_{y1} ($s_{y \cdot 1}$).	Based on R ($s_{y \cdot 12}$).
		Lb.	Cm.	Lb.			
1A	53	14·04	9·17	8·36	0·69	0·48	0·48
1B	320	10·56	8·60	6·19	0·87	0·49	0·47
2	24	12·71	8·12	6·46	0·94	0·75	0·75
3	60	16·07	9·52	8·97	1·60	0·78	0·79
4	41	5·77	5·43	3·11	0·48	0·21	0·22
5	68	6·98	8·11	4·28	0·77	0·25	0·24
6	115	8·78	8·47	4·97	0·67	0·36	0·34
7	25*	14·98	12·90	9·19	1·05	0·50	0·45

* Corriedales—all other sheep Merinos.

In general, staple length is related more closely to clean fleece weight than to greasy fleece weight, but in neither case is the correlation strong.

Between 40 per cent. and 90 per cent. of the variation in clean fleece weights within a group can be ascribed to variation in greasy fleece weights and only an additional 0·5 per cent. to 5 per cent. to the residual relationship

Table 2.

CORRELATION AND PARTIAL REGRESSION COEFFICIENTS FOR ESTIMATING CLEAN FLEECE WEIGHT (Y) FROM GREASY FLEECE WEIGHT (X_1) AND STAPLE LENGTH (X_2).

Property.	Number of Sheep.	Correlation Coefficients.			Partial Regression Coefficients.			Multiple Correlation Coefficient (R).
		r_{y1}.	r_{y2}.	r_{12}.	a.	$b_{y1\cdot2}$.	$b_{y2\cdot1}$.	
1A ..	53	0·71***	0·35*	0·33	+0·05	0·50	0·15	0·72***
1B ..	320	0·83***	0·31***	0·18**	−1·62	0·58	0·19	0·85***
2 ..	24	0·63***	0·39	0·40*	+0·20	0·33	0·25	0·65**
3 ..	60	0·87***	0·32*	0·32*	+0·56	0·48	0·07	0·87***
4 ..	41	0·90***	0·43***	0·37*	+0·08	0·43	0·10	0·90***
5 ..	68	0·95***	0·17	0·11	+0·40	0·58	0·08	0·95***
6 ..	115	0·85***	0·37***	0·27**	−0·61	0·52	0·12	0·86***
7 ..	25	0·89***	0·15	−0·08	−3·83	0·68	0·22	0·91***

* P < 0·05.
** P < 0·01.
*** P < 0·001.

with staple length. This increase in prediction efficiency is much less than that found by Terrill *et al.* (1945) for the Dubois flocks. It shows that for Queensland Merino flocks there is no worthwhile gain from including staple length in any clean fleece weight prediction equation. Staple length is, of course, still a useful wool character to measure because of its relationship to price per pound.

(4) Conclusions.

For almost all the properties from which samples were received there is a strong correlation between greasy and clean fleece weights. In general, selection of sheep on greasy fleece weight can be expected to result in about 80 per cent. of the potential selection differential for clean fleece weight. When relatively little culling is possible, it is rarely worth striving for the remaining 20 per cent. of gain.

In the selection of rams and of ewes to breed rams, high selection differentials can be obtained and scouring is highly desirable. Laboratory facilities can be used to the best advantage if sampling for yield determination is restricted to such cases.

II. APPLICATION OF THE OBSERVED RELATIONSHIP.

(1) Introduction.

It is generally recognised, at least implicitly, that high clean fleece weight is unlikely to be associated with low greasy fleece weight, and it is common practice to take scouring samples only from the heaviest fleeces. A few sheep with clean fleece weights abnormally high in relation to their greasy weights are missed, but against this fewer samples have to be scoured in the laboratory and results can be returned more quickly to the woolgrower.

The object of this study was to provide a basis for deciding what proportion of fleeces should be sampled to give a selection differential for clean wool weight acceptably close to that which would be obtained by scouring samples from all the fleeces.

(2) Methods.

It is assumed that greasy fleece weight and clean fleece weight are distributed in the normal bivariate form. This mathematical model would give a good fit in most unclassed flocks. Even if some culling has been practised for characters other than fleece weight, the frequency surface would probably be only slightly distorted. Two cases are examined:—

(*a*) A typical joint distribution specified by a correlation coefficient (r) of 0·8.

(*b*) A distribution in which the association was weaker (r = 0·6).

The second case is included because it is as poor a relationship as has been found, and therefore provides lower limits for the expectations found from the more likely value, 0·8.

(3) Results and Discussion.

Figs. 1 and 2 were constructed, using Pearson's (1931) tables, to show, for r = 0·8 and 0·6 respectively, the percentage of sheep with clean fleece weights exceeding the mean by any given amount (expressed in units of standard deviation). Curves were drawn for the whole population and for that part remaining when 50-60-70-80 per cent. have been removed on the basis of low greasy weight.

When the number of sheep to be selected from a flock is decided, these curves provide estimates of the proportion of sheep with high clean fleece weights which will be missed if only the heaviest cutting fleeces are sampled for yield determination. They also show the lowest clean fleece weight which it is necessary to accept among the selected sheep.

However, they do not provide an estimate of the mean clean fleece weight of the selected sheep. These mean values, or selection differentials since all values are expressed as deviations from the flock mean, were calculated by approximate integration. They are believed accurate to the second decimal point as shown in Table 3.

For lower selection intensities this table can still be applied by considering the negative selection differential of the culls. For example, if 90 per cent. are selected by scouring samples from the lowest 20 per cent. on greasy fleece weight, and then rejecting half of these on clean fleece weight, the positive selection differential can be calculated (assuming r = 0·8) as $\frac{1\cdot67 \times 10}{90} = 0\cdot19$, compared with 0·16 if selection is based on greasy weight alone.

Table 3.

SELECTION DIFFERENTIALS EXPECTED WHEN ONLY A PERCENTAGE OF SAMPLES ARE SCOURED.

Percentage of Sheep Culled on Greasy Weight.	Percentage of Sheep Finally Selected*.				
	50 Per cent.	40 Per cent.	30 Per cent.	20 Per cent.	10 Per cent.
0	0·80	0·97	1·16	1·40	1·75
50	0·64 (0·48)†	0·90 (0·78)	1·13 (1·04)	1·39 (1·33)	1·75 (1·73)
60		0·77 (0·57)†	1·08 (0·94)	1·36 (1·27)	1·74 (1·69)
70			0·93 (0·70)†	1·32 (1·16)	1·72 (1·64)
80				1·12 (0·84)†	1·67 (1·52)
90					1·40 (1·05)†

* The first figure is for r = 0·8 ; that in parentheses for r = 0·6.

† In these cases no samples are scoured, as all available sheep must be selected.

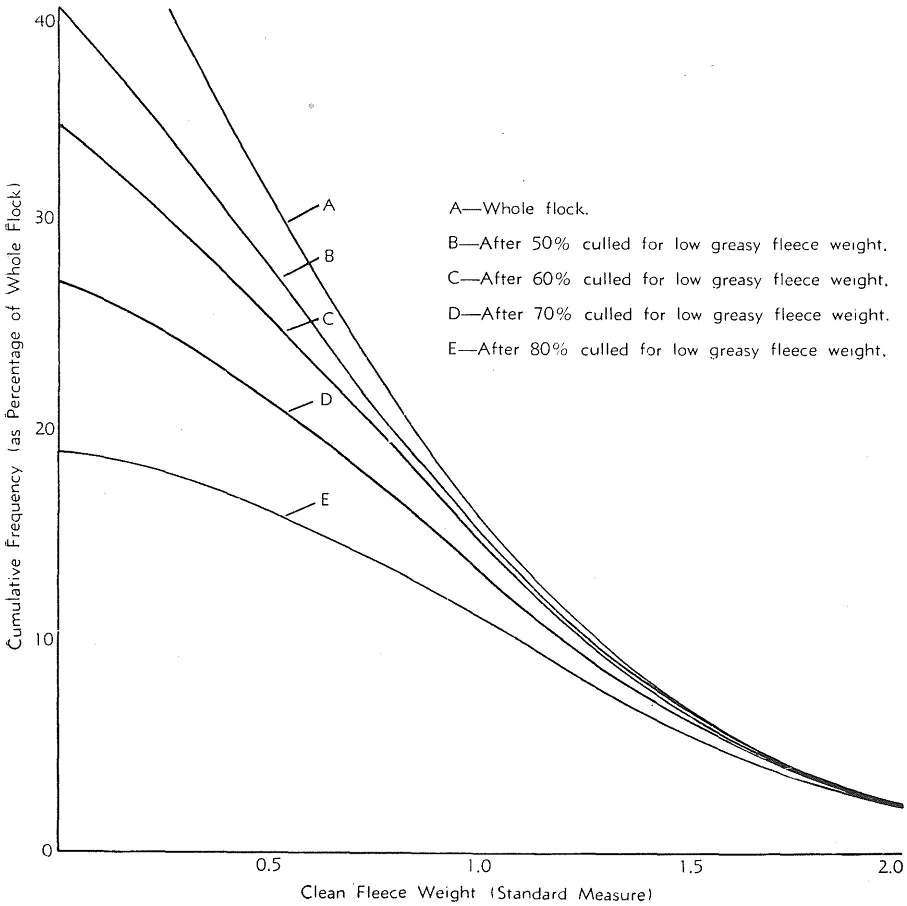

Fig. 1.

Distribution of Clean Fleece Weights When Some Sheep are Eliminated for Low Greasy Fleece Weight (assuming r = 0·8).

Selection differentials of the order shown for r = 0·8 can be expected if:—

(1) The flock concerned is of moderate size.

(2) The correlation between clean and greasy weights is high (there will often be results from previous years or adjacent properties and these will serve as a guide).

(3) The distribution of greasy fleece weights is approximately normal.

In most other cases the results shown for r = 0·6 are probably sufficiently conservative to serve as a basis for deciding how many samples should be taken. All calculations have in any event been based on large sample theory, and allowance should be made for sampling variation in individual flocks.

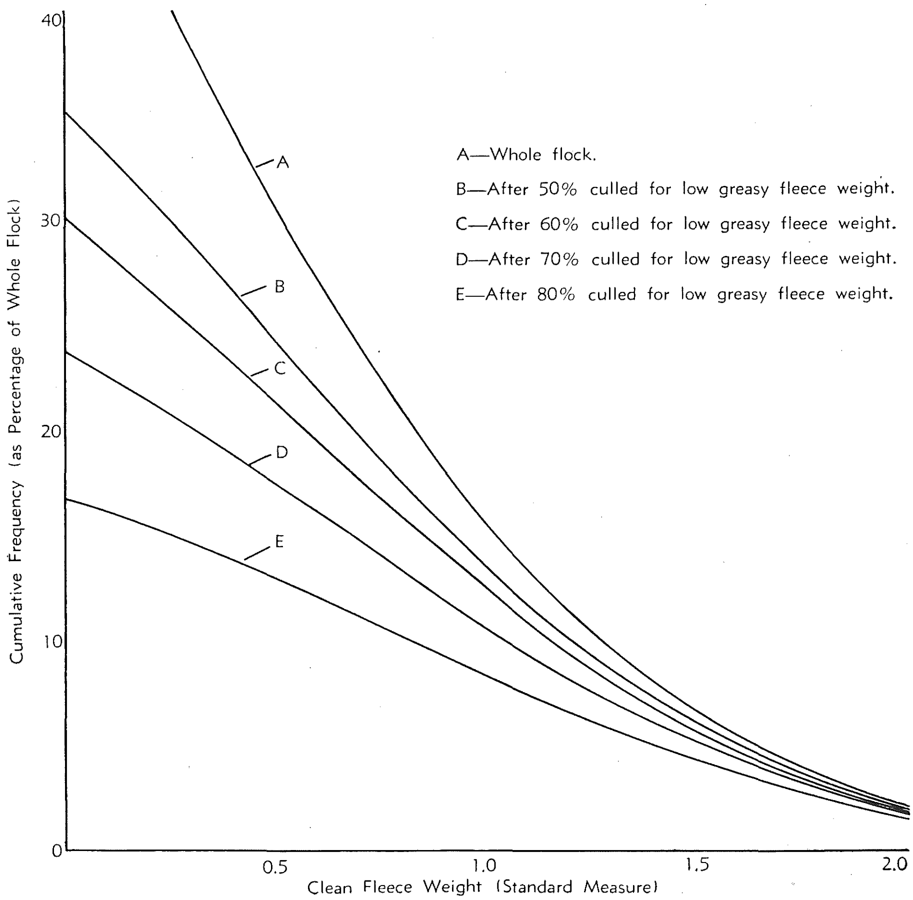

Fig. 2.

Distribution of Clean Fleece Weights When Some Sheep Are Eliminated for Low Greasy Fleece Weight (assuming r = 0·6).

Figs. 1 and 2 and Table 3 show that at high selection intensities there is very little to be gained by scouring samples from the whole flock. If only, say, 10 per cent. of a flock were to be selected, there would usually be little point in sampling more than the top 20-30 per cent. selected on greasy fleece weight. Even if one or more of the conditions listed above were violated, most of the potential improvement in clean fleece weight would still be obtained by scouring samples from the top one-third of the flock.

When the total culling level is lower, before selecting on clean fleece weight a balance must be struck between the probable loss in efficiency of selection and the saving in time and handling which will result from culling on greasy fleece weight. Scouring samples to estimate clean fleece weight is a simple operation, but any reduction in the number of samples received from an individual flock means that the time between shearing and final selection can be shortened. Alternatively, it may permit a more extensive use of additional measurements, such as fibre thickness and fibre density.

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