Reply: I have not unfortunately, Dr. Geddes. In each of our years that we have been doing this, the rape has been mature, judged from the colour point of view, when we came to feed it; so I have no information on putting lambs on immature rape. So far as second growth rape is concerned, I have no information on weight changes.

----------oOo----------

SOME FURTHER OBSERVATIONS ON FAT LAMB PRODUCTION IN CANTERBURY

by

Miss D.E. Walker, Ruakura Animal Research Station.

The previous paper has dealt with some of the many problems of feeding and management associated with the business of fat lamb production. Since quality of product is an unavoidable consideration in efficient production, and to extend still further the broad issues raised by Mr Ewer, I have taken the liberty of altering the somewhat restricted title of my paper as it appears on the programme, to "Some further observations on Canterbury Lamb".

Quality has been defined as what the consumer will pay for, and is dependent fundamentally upon the relative proportions of the body and its composition in terms of bone, muscle, fat and offals. Both conformation and composition are therefore important. Of recent years carcase measurements have been employed by workers overseas as an obvious and logical means of objectively describing the conformation of the meat producing animal.

This approach to the study of Canterbury fat lamb has been used in an intensive investigation of 1,000 carcases of different breeds and crosses of lambs, of different sex, and reared under different nutritive conditions. The present paper should be regarded as a very brief summary of this work, the complete results of which are being published elsewhere (1).

THE MEASUREMENTS USED:

Since any system of measurements designed to evaluate carcase quality should be practicable under commercial conditions, we have concentrated attention on the external measurements proposed by Palsson. (2) Certain of these measurements can be justified on purely quantitative grounds. Thus the length of tibia + tarsus, "T", provides an indication of the amount of waste bone in the leg. On the other hand, some like "G", the width of gigots have a qualitative significance. Width in this region is desirable since it is usually associated with a short blocky type of hindquarter and is indicative of deep fleshing. Both a qualitative and quantitative significance can be attached to other measurements, a good example being the length of leg, "F", which partially reflects the length of tibia + tarsus and also gives some indication of the amount of filling in the crutch. Thus, shortness in "F" is desirable from both points of view. These measurements have proved to be of value and their use has been justified by complete anatomical dissection work.

TABLE 1:

MEAN CARCASS MEASUREMENTS

Group	Weight	G.	Th.	F.	T.	L.	Cannon		F-T.	T x G.
							Weight	Length		
Breed and weight-	Lb.	Mm.	Mm.	Mm.	Mm.	Mm.	G.	Mm.	Mm.	Mm.
S.D. Cross:										
Light	34.24	220	248	230	175	547	30.7	106	55.1	38,474
Heavy	38.48	223	253	231	179	559	32.7	108	51.9	39,894
Corriedale:										
Light	34.60	218	252	259	190	573	36.2	116	65.3	41,407
Heavy	38.79	226	261	264	195	587	39.1	120	68.8	44,169
Romney x Corriedale:										
Light	34.2	217	254	245	185	576	..	..	60.2	40,116
Heavy	39.0	223	264	256	191	592	..	..	64.4	42,679
Breed and feed -										
S.D. Cross:										
Milk	36.21	221	250	230	177	553	31.7	107	56.6	39,123
Rape	35.76	224	251	228	180	548	30.3	106	48.1	40,187
Corriedale:										
Milk	37.13	222	257	262	193	581	37.7	118	67.1	42,870
Rape	35.12	219	257	249	193	561	35.6	116	56.3	42,275
Sex -										
S.D. Cross:										
Wethers	36.48	223	254	230	179	553	32.5	108	50.9	39,926
Ewes	35.63	221	246	230	175	550	29.4	105	54.6	38,565
Kirwee -										
Corriedale (nine months)	41.24	234	274	276	208	617	38.7	123	67.7	48,713
B.L. x Corriedale (nine months)	46.36	247	278	268	206	626	43.4	124	62.21	50,877
S.D. x Corriedale (nine months)	44.41	244	269	241	189	594	35.1	110	52.9	46,063
S.D. x Romney (nine months)	44.71	246	271	241	191	608	35.9	109	50.12	47,130

From the results of the dissection of 28 Canterbury lambs selected from the three export grades we have established that correlations of a high order exist between various measurements and the total amount of bone and the total amount of muscle in the carcass. Since the total amount of muscle was found to be strongly correlated with the total amount of bone, a fact which supports the contention that good skeletal development is essential in the meat animal - the same measurements can be used to assess the amount of each of these tissues.

TABLE 2A:

CORRELATIONS BETWEEN CARCASE MEASUREMENTS & WEIGHT OF BONE

Population	No.of Pairs	Measure-ment	r.	P.	Regression Equation	Se. (gms)
Lambs:						
Canterbury						
2's & 8's	18	TxG	0.934	SS	X=0.0865Y-1364	125
2's,8's & 4's	28	TxG	0.913	SS	X=0.063Y - 525	145
2's,8's & 4's	28	T	0.799	SS		
North Island Down						
2's,8's & 4's	29	TxG	0.816	SS	X=0.0525Y-711	126
North Island Prime						
2's,8's & 4's	26	TxG	0.909	SS	X=0.0352Y+108	97
Ewes:						
Canterbury						
1's,7's,3's,9's,5's	25	TxG	0.870	SS		
Wethers:						
Canterbury						
1's,7's,3's & 9's	23	TxG	0.847	SS		

TABLE 2B:

CORRELATIONS BETWEEN CARCASE MEASUREMENTS & WEIGHT OF MUSCLE

Population	No.of Pairs	Measure-ment	r.	P.	Regression Equation	Se. (gms)
Lambs:						
Canterbury						
2's & 8's	18	TxG	0.894	SS	X=0.257Y-1758	486
2's,8's & 4's	28	TxG	0.872	SS	X=0.286Y-2652	826
North Island Down						
2's,8's & 4's	29	TxG	0.898	SS	X=0.290Y-5147	482
North Island Prime						
2's,8's & 4's	26	TxG	0.907	SS	X=0.151Y+ 565	392
Ewes:						
Canterbury						
1's,7's,3's,9's,5's	25	TxG	0.803	SS		
Wethers:						
Canterbury						
1's,7's,3's & 9's	23	TxG	0.929	SS		
Lambs:						
Canterbury						
2's & 8's	18	FxT	0.802	SS		
2's & 8's		F	0.746	SS		
2's & 8's		T	0.718	SS		
2's & 8's		$\frac{FxT}{G}$	0.717	SS		
2's & 8's		G	0.672	SS		

In this respect the product of T and G provided the most satisfactory index of both muscle and bone development. This formula also gave highly significant correlations with bone and muscle for North Island lambs and for Canterbury ewes and wether mutton carcases. Regression equations have been developed from which the total amount of bone and muscle can be estimated.

In respect to fat the situation is rather more difficult. Since fat depots are largely independent of skeletal development and since the primary dimension concerned is that of depth, it would be unreasonable to expect any close association between linear carcase measurements and the total amount of fat in the carcass. Internal measurements (such as those relating to fat depths at the last rib cut) undoubtedly offer some scope but these cannot be obtained except under special conditions. Therefore the most practicable method that can be suggested for estimating the amount of fat is that of difference between the total carcass weight and the weight of bone and muscle after deducting 2½% from the carcass weight for wastage (tendons, ligaments, etc.) This wastage figure is based on the actual dissection results of approximately 150 lambs of all weights and grades. Summarising these results it is clear that the two measures T and G can provide complete information on composition. By their use we are able to summarise in general terms from a factual background the major characteristics of the principal breeds and crosses of New Zealand fat lamb. In addition they can be used to assess the absolute and relative effects of such factors as weight, nutrition, sex and age.

INFLUENCE OF BREED & CROSS:

While the relative merits based on farmer experience and works grading are fairly well recognised, no attempt has previously been made to examine the chief breeds on a comparative measurement basis. From such an examination on the scale previously mentioned, the following conclusions are apparent. The pre-eminence of the S.D. as the ram breed in fat lamb crosses is strikingly demonstrated. S.D. Cross lambs have a superior conformation in terms of British market requirements. This is shown up by their wide gigots and short F. & T measures which characterise a well developed hind quarter. Also they show a high proportion of fat at light weights which places them in a class well above all other breeds studied. The major weakness of the S.D. Cross lamb, apparent both in its Cross with the Corriedale and the Romney, is a lower yield of muscle and an excessively high yield of fat at heavy weights, as compared with other breeds of the same weight class.

As McMeekan and Clarke (3) have pointed out, this situation results in a higher calorific value (though a lower protein yield) per carcass and per lb. In normal times when the consumer is free to exercise preference, this is a real disadvantage in view of the increasing demand for lean rather than fat meat.

In marked contrast the straight Corriedale is by far the poorest of the different breeds and crosses studied. Long and narrow, with shallow muscles, narrow gigots and long F and T measures, wasteful bone and an insufficiency of fat, it falls well below the other types in quality.

The Border Leicester X Corriedale lamb occupies an intermediate position. The sire here has effected some degree of improvement, the cross approaching the desired blockiness of form. The extremely long legs of the Border Leicester, however, places it at some disadvantage. The Border Leicester shows up as a later developing breed than the S.D., and it is unfortunate that the only data available on the Cross were for lambs of heavy weights and greater ages than normal in fat lamb production, thus conferring an advantage on the Cross in these comparisons. From the general trend of results it seems reasonable to conclude that the improvement noted would not be so pronounced at lighter weights and younger ages. This summary of the Border Leicester as a fat lamb sire is in line with its decreasing use in practice in favour of the S.D. and its retention mainly for specialised local trade requirements.

Carcases from the crossing of the two breeds recognised as fat lambs ewe breeds - Romney and Corriedale - are in line with the attributes of their parents. Lambs are far from ideal in conformation but are a definite improvement on the Corriedale. Lambs of this type are unlikely to be a permanent feature of the industry coming mainly as by-products from flocks using the Romney ram to grade up Corriedale ewes to the Romney type.

Only a limited amount of data was available for the S.D. X Romney - the most popular fat lamb cross in the North Island and in Southland. Little difference was found between these lambs and a comparable group of S.D. X Corriedales, but since these data pertained to lambs slaughtered at the age of 9 months, these results must be accepted with reservation.

Some further interesting data relating to breed differences were obtained from a study of groups of lambs representing the main breeds and crosses - Corriedale, B.L. X Corriedale, S.D. X Corriedale and S.D. X Romney raised under identical conditions at Kirwee. The dams were run together in the same paddock from mating and the lambs remained there until slaughter at approximately 9 months of age. There were about 16 lambs of each breed group, and this number was found to be adequate to permit differences in the more important carcass measurements to show up to a statistically significant degree

The variability in type of carcass produced both within and between breeds can be seen from taking the best and worst carcase from each breed group. The S.D. X Corriedale shows up as the most desirable type- a short blocky carcase, wide in loin and gigots, with a short F measure and well filled crutch. The shoulder is well developed and the neck and fore legs short. The S.D. X Romney also gives a good type of carcase, slightly better in the loin than the S.D. X Corriedale, but the leg development is not so good. The Border Leicester X Corriedale carcass shows a good loin development, but a poorer leg. Also, the shoulder is not as well developed, and the neck and thorax and relatively cheap parts, are longer. The length of body is greater than in the other carcasses. In comparison, the Corriedale carcass shows up poorly. The legs tend towards an undesirable Y shape. A long I measure is associated with a long F and poor filling in the crutch. The loin and gigots are narrow. The shoulder is poorly developed and the neck too long.

The effect of the sire in improving carcass quality is seen by comparing the first three carcasses. Some improvement has been effected by use of the Border Leicester, but the S.D. Cross is infinitely superior. The average weight of these best carcasses was 51 lbs., while the average weight of the worst carcasses shown below was only 35 lbs., or no better than that normally expected from fat lambs of 4-5 months of age. Poorer muscle and fat development is evident in these carcasses. The very poor type of carcass that a badly grown Corriedale yields is well illustrated and the S.D. X Corriedale shows the type of carcass which results when the Cross throws to the Corriedale. The relative compactness of the carcass is illustrated when all carcasses are scaled to the same leg length and the superior conformation of the S.D. Cross lambs is outstanding. In contrast, the long legged breeds show up poorly.

The length of cannon bone and also its weight reflects the order of merit. The Corriedale cannon is typically that of a relatively unimproved meat breed in its length and comparative narrowness. The Border Leicester X Corriedale is slightly broader in proportion and indicative of the semi-improved type of carcase. In contrast, the bones from the S.D. Cross lambs are relatively short and broad and typical of the improved meat animal. These comparisons strongly support Palsson's (2) suggestion that the quality of a fat lamb carcase is closely associated with the type of cannon bone. The practical applications in view of the readily observable nature of this part of the body are obvious.

INFLUENCE OF RATE OF GROWTH:

The importance of rate of growth in its effect on carcase composition of sheep has been demonstrated by Verges (4) and McMeekan (5). The average growth curves followed by the four best and four worst lambs shown in comparison with the mean growth curve for 64 lambs indicates that the resulting carcass quality is closely linked to the growth curve. The divergences from the mean have been greatest during the period from 90 days - 150 days. From about 3 months after lambing the milk supply of the ewe falls off very rapidly. (6). Some lambs suffer a setback at this time while others possibly because they have become more reliant on pasture, continue to grow rapidly. Weaning occurs when the lambs are about 5 months old and the discrepancy between the growth curves of the fast and slow growing lambs is most marked at this time. Later there is a tendency for the growth rate to even up.

The following table shows the estimated carcass composition based on the T x G formula, corresponding to the mean growth curves.

TABLE 5:

CARCASS COMPOSITION

	BONE.		MUSCLE.		FAT.	
	Weight	Percentage Mean Worst.	Weight	Percentage Mean Worst.	Weight	Percentage Mean Worst.
	G		G		G	
Mean Worst (slow growing)	2,356	100	10,045	100	2,700	100
Mean - all Lambs	2,506	106	11,106	111	5,909	223
Mean Best (fast growing)	2,577	109	11,430	114	8,568	317

Brody (7) has shown that during the self-accelerating phase of growth, the curve is made up of several segments or cycles. When data plotted on arithlog paper are distributed about a straight line, it may be concluded that the percentage rate of growth is constant. In the upper section of the graph the mean curve has been plotted in this way. The curve may be divided (somewhat arbitrarily) into three distinct phases during which rate is constant. Thus during the age period of 30-90 days, growth takes place at 1.3% per day. From 90-150 days when pasture growth falls off and the milk supply of the ewe decreases rapidly, a lower rate is shown. (0.63% per day). Weaning is followed by another fall in growth rate to a constant level of 0.12% per day. This rate persists until the lambs are approximately 9 months old. On a gain per week basis, these figures agree fairly closely with those of Hammond (8). It appears that a self-inhibiting phase of growth has been reached, although it is unlikely that these lambs have reached the age of puberty. (9).

EFFECT OF NUTRITION:

In addition to breed differences, Canterbury fat lamb production is characterised by two types on a nutritive basis. Approximately half of the output is fattened off the mother - the so-called milk lambs - while the remainder are fattened after weaning on forage crops - the so-called rape lambs.

Comparison of . . . Cross and Corriedale lambs fattened under each of these two systems has yielded extremely interesting results. Lambs of the superior fat lamb type - the Down Cross - improved on rape feeding, while lambs of the unimproved type (Corriedale) deteriorated in quality. Quite obviously a strong breed feed interaction effect exists. Calculation of this interaction from analyses of variance data shows this to be highly significant and of the order of 3-5% for most measurements. It is suggested that the probable explanation of this situation is that most Down Cross lambs are capable of being fattened to the desired conformation and retain this capacity for a considerable time. Small lambs of this type, too light to go away fat off the mothers, can be very efficiently finished on rape, to which they respond in a manner similar to animals changed from a low to a high plane of nutrition. Conversely, the Corriedale yields fewer lambs fat off the mother, leaving behind for subsequent rape fattening animals that are so late developing in character that even improved nutrition results merely in additional growth rather than in fattening.

RELATIVE EFFICIENCY OF BREED, FEED, SEX & WEIGHT:

Relevant to the above discussion, and of considerable importance from many angles, is the relative effect of the factors mentioned. Analyses of variance data have permitted an estimate of the percentage of the total variance in each carcass measurement associated with breed, weight, feed and sex. These are summarised in Table 6.

TABLE 6:

APPROXIMATE PERCENTAGE OF VARIANCE THAT CAN BE ASSOCIATED WITH GROUPING.

Measurement	Breed		Weight Five Months	Feed Five Months	Sex Five Months	Interaction	
	Nine Months	Five Months				Breed and Weight	Breed and Feed
G	29	1.1	17	0	3	1.2	3.0
T	59	48	0.6	2.5	7	-	-
T X G	28	-	-	-	-	-	-
F	72	58	1.5	0.5	0	-	3.8
F - T	-	19	0	4.2	5	1.5	3.5
Th	3	4.1	17	0.1	4	1.2	3.0
I	14	31	8.4	2.7	0	-	5.1
Cannon Length	66	56	4.1	1.0	14	0.3	-
Cannonweight	36	31	7.3	3.8	22	19.1	-

The two columns shown for "breed" are not strictly comparable, since different breeds are involved in the two sets of data, in addition to the age difference. It is clear, that of the factors studied, breed contributes most to variability, accounting for from 30 per cent to 50 per cent of the total variance. Weight is of much less importance, but this result must be related to the relatively small difference (approximately 4 lbs.) in the weight groups involved. Feed effects account for still less of the total variance, while sex appears to exert a comparable influence. The magnitude of the breed effects upon what are essentially measurements of conformation is of special interest in view of the recently reported work of McMahon (10) and others (11) as to the low intensity of inheritance of conformation in sheep. The apparent conflict between our results and these findings can be resolved in terms of a "dominance" explanation. The low heritability correlations referred to have been obtained from studies within a breed, where additive gene effects are apparently most important. In this work, extremes in breed types have been crossed with marked effects upon the conformation of progeny, suggesting that

the short-boned structure of an "improved" meat breed has exerted some degree of dominance over the longer skeletal form of the "unimproved" breed. It seems reasonable to suggest that while differences in conformation within a breed may not be inherited to a degree which permits ny effective control through straight selection, considerable control over the conformation of sheep can be obtained by interbreed crosses of appropriate types. This is made practical use of by all specialised producers offat lambs.

REFERENCES.

1. Walker. D.E. & McMeekan C.P. (1944) N.Z. Jour. Sci.& Tech.(in press
2. Palsson, H. (1939) J. Agr. Sc. 29, 544 (1940) Ibid 30, 1.
3. McMeekan. C.P. & Clarke, E.A. (1943) Roy. Agr. Soc. of N.Z. Gazette No. 47.
4. Verges J. (1939) Suffolk Sheep Soc. Year Books.
5. McMeekan C.P., Stevens, P.G. & Lambert R.C. (1942) N.Z. Jour. Sci. & Tech. 4A, 215A.
6. Bonsma. F.N. (1939) Onders. J. Vet. Sci. & An. Ind. 12, 379.
7. Brody. S. (1928) "Growth", Robbins, W.J. et. al. Yale Univ.Press
8. Hammond. J. (1932) "Growth & Development of Mutton Qualities in the Sheep" Oliver & Boyd, Edinburgh.
9. Walker D.E. Unpublished data.
10. McMahon. P.R. (1944) Proc. N.Z. Soc. An. Prod., 70.
11. Ensminger, ME. et. al. (1943) J. An. Sci. 2, 157.

DISCUSSION

Dr F.B. Shorland: It seems especially valuable that carcase measurements can be used to indicate the amount of bone in the carcase. The other method would be to dissect the carcase and assess the amount of bone by that method. That would be a very tedious job. In the agricultural chemical laboratory in association with Dr. Barnicoat normally exportable lambs, ewes and wethers from Canterbury as well as from the North Island, have been submitted to chemical examination, and although we have got the chemical data in some time ago, the statistical analysis of the data which has been undertaken in conjunction with the Investigational Section, has taken some time, but it may be of interest in this connection to report some of the findings. It has been found that it is possible to take the chemical composition of the neck of the lambs or ewes or wethers and to predict from that the amount of fat in the whole carcase, the correlation coefficient over all grades examined being remarkably high; of the order of about 0.953, which is a very good correlation indeed. We have also tested out the formulae which have been applied by Callow in England to the mutton carcase, and it seems to apply remarkably well here. It does not apply however to the dissected fat or meat. You have to deal with the joint as a whole. For arriving at the chemical composition it is necessary to separate the meat from the fat. The job could be short circuited presumably by just taking the neck of the animal and performing a chemical analysis of that particular joint.

Dr. P.R. McMahon: What was the factor used for correlating with T X G in the first slide?

Reply: Bone and muscle.

Dr P.R. McMahon: Were weight differences taken out of that? I was interested in the inheritance figures. There is of course no conflic there within breeds. All the work which has been published by myself and by other workers in dairy cattle, suggesting a very low intensity in inheritance for production features in livestock, has been done within a single breed and has been done with a view to devising breeding plans for breed improvement - for improvement within breeds, and is I suppose almost implied in that low figure for within breeds

plus the common observation that there are big differences between breeds, but the intensity of inheritance measured in the way in which the speaker has reported must give a very much higher figure. There seems to be some confusion even among people who have given their close attention to this, when they say "this is strongly inherited". That 10% figure does apply to the proportion of hereditary variance to total variance in a group of animals taken as representative of the breed being studied. As soon as you go outside the breed then you increase both the hereditary fraction and the total fraction, but the hereditary fraction of variance is increased much more rapidly because of the tendency of breeds to be more or less homogeneous. That automatically increases this hereditability figure when one is considering data in which more than one breed has been used.

Reply: I referred to the fact that such confusion was "apparent" rather than real, but I also suggest that dominance provides at least part of this explanation.

Dr F.W. Dry: Average number of lambs at a birth is a feature in which variation within the Wensleydale breed appears to be without genetical basis, although in crosses between breeds lambing percentage is manifestly inherited. On the one hand, within the Wensleydale breed there is no dam-daughter correlation. On the other hand, ewes sired by Wensleydale rams out of Mountain ewes give the same high figure, 1.7 lambs per ewe put to the ram, as Wensleydale ewes. Clearly the Wensleydale rams transmit one or more dominant factors for which the breed seems to be substantially homozygous.

Dr C.P. McMeekan: This paper does call for one or two comments. You yourselves last night drew attention to the great need for established normals. Those of us here who are agricultural graduates will remember that, when we took lectures in animal husbandry, particularly lectures on the various characteristics of the different breeds, the information passed on to us consisted largely of the products of imagination of the protagonists of different breeds. In fact most of it, to put it mildly, has been straight out breed propaganda. I think Miss Walker is to be congratulated on what has been a very painstaking job in which she has attempted to debunk some of the propaganda which exists in this country about breeds and crosses of sheep, and to put our information about these matters on to a factual basis. There are two points of special interest to those of us who are faced with the job of carrying out experiments with sheep: I am very interested in the apparently fairly well defined three phases of growth in a fat lamb. I am not necessarily satisfied with the existing explanation. It does appear that Brody's theories as to growth do apply in this country and that lambs grow at a fairly constant rate for a period then they drop to another constant rate and then they fall to a still lower level. For a fairly definite period in each case that rate is relatively constant. It is a matter of opinion as to just how these three rates should be defined, but the trend does appear to be there. Why is it? I think that finding is related perhaps to some of Mr. Ewer's problems re his observation of lambs on rape.

As regards design: Miss Walker made the statement that the work with the sheep at Kirwee, which were made available by the generosity of Mr. Ewer, indicates that 16 animals are adequate in order to measure differences in carcase quality of the order that we are interested in from a carcase quality point of view. Obviously the application of that finding, if sound, to the design of sheep work is well worth remembering.

Relative to Dr. Shorland's comments re working on the neck: I would like to suggest to him that it is possible to short circuit still more an attempt to estimate the chemical composition of the carcase, in that on exactly the same data the weight of the carcase alone will give you correlations with total calorific value and