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Meat-Storage

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An Investigation of the Carcass Quality of Lambs and Hoggets with particular reference to the Cold-Storage of Home-bred Lamb

J. H. D. Prescott and C. E. Hinks

UNIVERSITY OF NEWCASTLE UPON TYNE

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Contents

INTRODUCTION

It is a characteristic of lamb production in the United Kingdom that in most years large numbers of home-bred lambs are fit for slaughter in late July, August and September. This leads to oversupply so that the price received for prime home-bred lamb is depressed. Faced with falling prices many farmers retain fat lambs into the autumn and carry them to heavier weights before sale. If the main feed for these lambs is autumn pasture then the enterprise attracts low variable costs and may be economically attractive. The prime lambs, however, may grow into excessively fat hoggets at the heavier weights and this may reduce the value of their carcasses to the butcher and the acceptability of their meat to the consumer.

As an alternative to retaining lambs on the farm, there have been suggestions that it might be appropriate to take a proportion of the prime home-bred lamb slaughtered in July, August and September and to preserve it in cold storage for retail sale in January, February and March. Prime home-bred lamb, frozen and handled in this way would then have to sell in direct competition with New Zealand lamb, and with fresh hogget mutton from late-finished stores. It would no longer enjoy any premium over New Zealand lamb on account of freshness, but differences in carcass composition and the eating quality of the meat might influence the relative acceptability of frozen home-bred and frozen New Zealand lamb to the butcher and consumer. If frozen home-bred lamb were shown to be more acceptable than New Zealand lamb or indeed fresh home-bred hogget mutton, then it might be worth while developing cold storage facilities for this type of lamb. This might reduce seasonal fluctuations in price and facilitate standardisation of production.

Investigations of the carcass quality of different types of lamb have been undertaken in order to provide information on the relative merits of different methods of processing the prime home-bred lamb that is fit for slaughter in late summer. Two 'breeds' of home-bred lamb have been selected to represent relatively early and late-maturing types. New Zealand lamb, of the weight and type that is in greatest demand in the United Kingdom, has also been used.

The samples of different types of lamb are too small to be representative of United Kingdom or New Zealand lamb populations as a whole, but do permit a useful comparison of the relative carcass quality of home-bred lambs and hoggets processed in different ways. In order to improve the precision of these comparisons by reducing extraneous variation, both fat and store lambs of each breed-type were drawn from single flocks, and all the lambs retained in the summer for sale the following autumn and winter were kept under standard management.

The investigation involved the objective definition of the separate elements contributing to carcass quality, as follows: visual appearance and shape; cut-out value of the carcasses; the tissue composition of selected joints; the eating qualities of the meat.

Cut-out value was determined assuming that similar joints from different types of lamb may be characterised by a standard value per pound. This measures only the effect of variation in carcass proportions on the value of the carcass to the retail butcher. Separate studies of joint composition and the eating quality of the meat provide information relating to differences in the relative saleability and the value of similar joints from different types of lamb. The final phase of this study, which will be the subject of a second report, is a marketing exercise designed to identify quantitative differences in the acceptability of joints from frozen home-bred and New Zealand lamb.

CHAPTER I

MATERIAL & METHODS

Experimental Design

(*a*) *Material*

A total of 80 home-bred and 20 New Zealand lambs were involved in this investigation. The home-bred lambs comprised equal numbers of Clun Forest and Suffolk X Greyface lambs*. The New Zealand lambs were No. 2 carcasses supplied by F.M.C. (Meat) Ltd., in February, 1966.

(*b*) *Treatments*

The lambs were allocated to five treatment groups, as follows:

Group I Home-bred lamb, slaughtered *August*, retailed *fresh* in August.
II Home-bred lamb, slaughtered *August*, retailed *frozen* in February.
III Home-bred hogget, slaughtered *November*, retailed *fresh* in November.
IV Home-bred hogget, slaughtered *February*, retailed *fresh* in February.
V *New Zealand No. 2*, lamb, retailed frozen in February.

Lamb Selection

In each of the two flocks, 30 fat lambs and 10 store lambs were selected in the first week of August, 1965. The fat lambs were selected on a basis of condition, assessed subjectively, and only those falling within a certain live-weight range were accepted (Suffolk X, 80-94 lb; Clun, 82-87 lb.). These lambs were grouped in trios on a basis of weight and were then allocated at random to group I, II or III. The store lambs were selected from the same flocks at the same time as the fat lambs. They were the smaller lambs in the flocks selected to fall within a lower liveweight range (Suffolk X, 63-71 lb; Clun, 63-67 lb.), and only those that appeared to be in a healthy condition were accepted. These store lambs comprised group IV. The New Zealand lambs for group V were selected by the local F.M.C. manager and were part of a batch received by him in January, 1966 and stored for 2-4 weeks (at 15°F) before despatch to the retailer.

The treatment groups contained equal numbers of each breed, but since it was not possible to control the distribution of lambs of different sex there was variation in sex ratio (table 1). Subsequent statistical analysis of the results revealed that treatment and breed differences were not influenced by the variation in sex ratio, and sex differences as such are not presented in this report.

Table 1. **Numbers of lambs of different Breeds and Sexes in each Treatment Group**

Group / Treatment		I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Breed	Sex					
Suffolk X	Ewe	8	8	6	6	—
	Wether	2	2	4	†2	—
Clun	Ewe	7	4	5	5	—
	Wether	3	6	5	5	—
Overall	Ewe	15	12	11	11	9
	Wether	5	8	9	7	11
Total Number/Group		20	20	20	18	20

† Two died of pneumonia.

* The Clun Forest sheep were all from the pure-bred flock at the University of Newcastle, Cockle Park Experimental Farm, Northumberland.
The Suffolk-cross lambs were by Suffolk rams out of Suffolk x Scottish Half-bred ewes from the flock of J. Maxwell, Esq., Ellingham, Northumberland.

MANAGEMENT OF HOGGETS

The two groups of lambs retained on the farm for later slaughter as hoggets were managed as a single flock. The prime lambs (Group III) were sold off grass in November and the store lambs (Group IV) were sold off roots in February.

The feeding programme employed for these sheep and estimated feed costs are summarised in tables 2 and 3 respectively.

TABLE 2. **Feeding Programme for Hoggets**

Date	Feed
15/8/65 onwards	Grazing—Lucerne/Rye mixture
3/9/65 onwards	Concentrate feeding commenced ¼lb. rising to 1 lb./day
14/9/65 onwards	Concentrate feeding 1 lb./day
18/11/65 onwards	Roots—Swedes
	Concentrate feeding 1 lb./day

Note: Concentrate: Barley 80%, Flaked Maize 15%, Fish Meal 2½%, Groundnut 2½%, plus minerals and vitamins.

TABLE 3. **Estimated Feed Costs for Hoggets**

Group	III	IV
Treatment	Fresh November Hogget	(1) Fresh February Hogget
	£ s. d.	£ s. d.
(2) Grazing	5 0	5 0
(2) Swedes		1 0 0
(2) Concentrates	16 8	1 18 10
Total Feed	1 1 8	3 3 10

(1) No allowance has been made for the two casualties.
(2) Grazing—estimate.
Swedes—cost £20/acre: 100 lambs/5 acres.
Concentrates—cost £28/ton.

The liveweight gains of these hoggets over the autumn and winter period are summarised in table 4. The liveweight gain of the hoggets was much reduced on roots. This is probably associated with the adverse weather conditions, particularly the frequent rain, to which the sheep were subjected.

TABLE 4. **Liveweight Gain of Hoggets (lb.)**

Time of Slaughter	Breed	15/8	13/10	ADG	22/11	†ADG	10/2	†ADG
November	Suffolk X	87	98	0.19	108*	0.21	—	—
	Clun	85	101	0.27	113*	0.28	—	—
February	Suffolk X	68	87	0.32	—	—	104*	0.21
	Clun	65	82	0.29	—	—	89*	0.14

†ADG (Average Daily Gain) in liveweight: 15/8 to slaughter.

*Estimated liveweights from cold carcass weight, actual farm liveweights were unreliable due to variable moisture content of the fleeces.

Slaughter Procedure for Home-Bred Lambs and Hoggets

Lambs in Group I and II were selected for slaughter on the basis of weight and finish, the hoggets in group III and IV were not selected for slaughter on weight and finish but were despatched at pre-arranged dates (table 5). Those in Group IV were allocated at random to slaughter over a four week period, synchronised with the disposal of the frozen lamb.

Table 5. **Age, Liveweight and Date of Slaughter of home-bred Lambs and Hoggets**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget
Estimated Age at Slaughter (mths.)	4-5	4-5	7-8	9-10
Liveweight at Slaughter (lbs.)	85.5	86.6	*110.5	*96.5
Date of Slaughter	15/8/65	15/8/65	22/11/65	21/2/66

*estimated from cold carcass weights, as actual farm liveweights were unreliable due to variable moisture content of fleeces.

The lambs and hoggets were transported 20 miles to an abattoir. Pre-slaughter treatment was standardised, the lambs being rested 16-18 hours between arrival at the lairage and subsequent slaughter. During this time they had access to water but not to feed. They were slaughtered in the normal commercial manner and after slaughter the carcasses were hung on 9″ gambrels in the slaughter hall†. Six hours after slaughter they were weighed and the cold carcass weights recorded, measurements were made on the suspended carcasses and visual appraisal of carcass 'shape' and 'finish' was carried out by an experienced meat buyer*. Details of the carcass measurement and appraisal procedure is presented in Appendix I.

Twenty-four hours after slaughter the carcasses were transported two miles either to the blast-freezer or to the premises of a co-operating retail butcher.

Handling of Home-Bred Lamb for Freezing

The carcasses of lambs for freezing were wrapped in muslin and transported on 9″ gambrels in an unrefrigerated van to the blast-freezer. They were re-weighed immediately before freezing. Blast freezing at –40° F was carried out for 16 hours and the carcasses then remained in the freezer for a further 4 hours. They were then re-weighed and stacked in the cold store (air temperature 22°F; relative humidity 0%). They remained in this store for 5 to 6 months, and on removal the carcasses were immediately re-weighed and then transported two miles to the premises of the co-operating retail butcher.

† The lamb for freezing had the fore-limbs 'strung-forward' (New Zealand Style), the fresh lamb had the fore-limbs 'skewered-back' (United Kingdom Style).

* The F.M.C. Manager.

Butchering Procedure

(*a*) *Hanging*

All carcasses were weighed on arrival at the shop and the frozen August lamb and New Zealand No. 2's which arrived 'hard-frozen' were re-weighed 24 hours later to obtain a 'thawed' weight. All carcasses were hung on 9″ gambrels before measurement and jointing. The atmospheric conditions in the hanging room were an air temperature of 48°F and relative humidity of 73%.

(*b*) *Carcass Measurements*

Six to seven hours after arrival (in the case of fresh lamb and hogget) or thawing (in the case of frozen lamb) the carcasses were sawn down the vertebral column. Due care was taken to ensure even division of the carcass into two sides. Linear measurements were then made on the hanging left side. It was subsequently separated into fore and hind-quarters by a cut between 12th and 13th ribs, following the line of the 12th rib, and measurements of Eye-muscle development and fat depth were made on the cut surface of the 12th rib. Details of these measurements are presented in Appendix I.

(*c*) *Jointing Procedure*

Twenty-four to thirty-three hours after arrival or thawing the left side of each carcass was cut, by the same experienced butcher-technician into standard bone-in joints. The right side of each carcass of the Group II, IV and V lambs was cut into larger joints and the 'Leg' and 'Shoulder' were boned-out and trimmed to the specifications of the co-operating Newcastle retailer*. All the joints were weighed to the nearest ounce.

The joints were cut along lines defined by reference to the anatomical structure of the carcass where possible. This definition was necessarily least precise with respect to the removal of kidney and channel fat and the fat trimmed off the leg and shoulder joints of the right sides. With the Group, II, IV and V lambs which were all jointed on the same day special precautions were taken to obviate any differences in cutting technique, in that the carcasses were first grouped in trios (comprising one of each type) and they were then jointed in random order. The jointing procedures are described in detail in Appendix I.

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* Loin and Best Neck, Lap, Scrag and Kidney and Channel fat were jointed out of the right sides of the Group I and III lambs to check the accuracy of the half carcass separation.

(*d*) *The Calculation of Cut-out Value*

In the calculation of cut-out value the individual joints of the different types of lamb were assumed to have standard values, as shown in table 6.

TABLE 6. **Standard Values for Joints used in the Calculation of Carcass Cut-out Value**

Joints	Value s. d./lb.	Value Relative to Loin=100
Leg	5s. 0d.	100
Shoulder	4s. 2d.	83
Chump	5s. 0d.	100
Loin	5s. 0d.	100
Best Neck	4s. 10d.	97
Middle Neck	3s. 4d.	67
Scrag	1s. 8d.	33
Lap	1s. 4d.	27
Breast	10d.	17
Fat	4d.	6.7
Bone	1d.	1.7

Since retail prices vary with season and type of lamb, and in particular frozen lamb usually realises a lower price than fresh lamb, the commercial value of the different types has also been estimated using the retail prices prevailing at the time of sale (table 7).

TABLE 7. **Retail Prices of Joints prevailing at the time of sale of the different types of Lamb**

Joints	RETAIL PRICES		
	August and November Fresh s. d./lb.	February Fresh s. d./lb.	February Frozen s. d./lb.
Leg	5s. 0d.	4s. 8d.	4s. 2d.
Shoulder	4s. 2d.	3s. 6d.	3s. 0d.
Chump	5s. 0d.	4s. 8d.	4s. 2d.
Loin	5s. 0d.	4s. 8d.	4s. 2d.
Best Neck	4s. 10d.	4s. 6d.	4s. 2d.
Middle Neck	3s. 4d.	3s. 4d.	2s. 8d.
Scrag	1s. 8d.	1s. 8d.	1s. 4d.
Lap	1s. 4d.	1s. 4d.	1s. 0d.
Breast	10d.	1s. 0d.	6d.
Fat	4d.	4d.	4d.
Bone	1d.	1d.	1d.

Assessment of Joint Composition

The Best-Neck (7th-12th rib inclusive) and Neck-Lap from the left side of each carcass were retained at the time of jointing, sealed in polythene and frozen and stored at 22°F for subsequent dissection.

The joints were stored thus for 1-4 months and were handled in two batches comprising Group I and III and Groups II, IV and V respectively. The joints were removed in random order within batches and dissected by the same experienced butcher-technician into lean, fat and bone. After removal from the deep-freeze the joints were allowed to thaw for 24 to 30 hours before dissection and during the progress of the dissection, which took approximately $1\frac{1}{4}$ hours for each Best-Neck and $\frac{3}{4}$ hour for each Neck-Lap joint, the tissues were covered with damp towels to minimise evaporation. The joints and tissues were weighed to the nearest gram.

The Best-Neck was selected for dissection as a sample joint since Timon (1963) has shown that with Clun lambs, similar to those in Group I and II of this investigation, it may provide sufficiently precise estimates of carcass composition in large scale experiments*. The Neck-Lap was also dissected since this is recognised (Timon, 1963) as one of the latest maturing parts of the carcass and it is a joint whose consumer acceptability and value may be much influenced by variation in its fat content.

Meat Quality Appraisal

(*a*) *Cooking Losses and Shear Characteristics*

Chops from the Chump (which included the sacrum) and from the Loin (4th and 5th lumbar vertebrae) of the left-side of each carcass were retained for subsequent cooking and shear tests (table 8). The chops were stored in a domestic refrigerator at an air temperature of 34°F and relative humidity of 0% for a standard time before cooking.

Table 8. **Origin, Number and Storage time of Chops used for Cooking and Shearing**

Origin	Group I and III		Group II, IV and V
	Chump (Sacrum)	Loin (4th & 5th)*	Chump (Sacrum)
Number of Chops	2	2	2
Storage Time (hrs.)	18	56	24

*lumbar vertebrae

They were roasted as approximately $1\frac{1}{2}''$ thick chops in a ventilated electric oven at 500°F until the internal meat temperature reached 78°C, as recorded by thermocouple at the centre of the lean. The meat was then allowed to cool and $\frac{1}{2}''$ cores were taken from the *Longissimus dorsi* muscle and used in the Warner-Bratzler shear. Three to four cores were obtained from each chop.

* "The maximum probable errors in the percentages of carcass fat, muscle and bone as predicted by respective tissue percentages in the Best-Neck are ± 0.79, ± 0.73, ± 0.65 respectively for group mean estimates," when $n = 12$ (Timon, 1963).

The cooking time, percentage loss of weight in cooking and the shear strength of the muscle fibres, which is indicative of the tenderness of the meat, were recorded.

(*b*) *Tasting Panel Appraisal of the Eating Quality of the Meat*

A large portion of the loin (13th rib to 4th lumbar vertebra) was retained from the left side of the lambs in Group II, IV and V for tasting panel appraisal.

The joints were stored for a standard time in a domestic refrigerator (24 or 72 hours) at an air temperature of 34°F and relative humidity of 0%. The *Longissimus dorsi* muscle was then dissected out and cleared of any intermuscular fat. A $\frac{1}{2}''$ wide strip of subcutaneous fat (originally overlying the muscle) was placed on the dissected muscle steak and the whole was wrapped in foil. The meat was roasted in a ventilated electric oven at 500°F until the internal meat temperature rose to 78°C, as recorded by a thermocouple in the middle of the muscle. The foil-wrapped meat was then removed from the oven and kept warm for up to 3 minutes in a holding oven set at 150°F until all samples required for a particular test were cooked. The samples were then unwrapped and immediately cut into cross sectional slices $\frac{1}{2}''$ thick. These slices were rapidly re-wrapped in warm foil and placed on cardboard trays marked with a letter code and were offered to the panellists at an appropriately warm temperature within five minutes of leaving the oven.

The panel test was conducted in a darkened room lit only with red lights so that the panellists could not distinguish between the samples on appearance. Each panellist was seated in a separate booth and no communication was permitted during the test. The panel had previously undergone a month of training during which tasting tests on lamb had been carried out on 20 separate occasions.

The panel members were asked to assess the flavour, juiciness and tenderness of the three cores in turn, first rating them for degree of expression of each characteristic on a 5 point scale and then ranking them in order of preference 1 to 3 and this ranking has then been transformed to a score on a 0-5 scale. A copy of the score card is presented in Appendix I.

THE PRESENTATION AND STATISTICAL ANALYSIS OF THE RESULTS

Mean values for the carcass characteristics of the different 'types' are presented, together with standard errors of the differences between means. The influence of breed and sex on certain carcass characteristics is presented in the same way. The statistical significance of these differences have been evaluated using the 'Student t' test. In selected cases differences in carcass characteristics which are influenced by breed or sex as well as 'type' have also been evaluated by analysis of variance.

The tasting panel assessment of the eating quality of the meat has also been evaluated using the 't' test and by analysis of variance, and in addition Kendall's Coefficient of Concordance test has been used to measure the overall correlation between the ranking of the three types of meat by the six panellists and its significance (Kendall, 1948).

CHAPTER II

CARCASS AND MEAT QUALITY CHARACTERISTICS

In this chapter selected information is presented to illustrate the major differences between types and breeds, comprehensive tables of the results are presented in Appendix II.

CARCASS CHARACTERISTICS

Comparison of Fresh August Lambs with Fresh November Hoggets

THE INFLUENCE OF TYPE

Characterisation: Extending the feeding period of adequately "finished" lamb by three months resulted not only in an increase in carcass weight but also a disproportionate increase in fatness. The November hoggets were 60% older and 30% heavier than the August lambs and the weight of fat in their Best Neck joints was 80% greater and the percentage of fat in these joints was 40% greater (table 9).

TABLE 9. **Comparison of 'Fresh August Lamb' and 'Fresh November Hogget' with respect to weight and fatness; visual appraisal and carcass shape** (1)

Group / Treatment		I Fresh August Lamb	III Fresh November Hogget	Standard Error of Difference
CHARACTERISATION				
Carcass weight	(lb.)	39.45	51.75	1.51***
Fatness (2)	(%)	31.60	44.19	3.55**
'VISUAL APPRAISAL (optimum score 5)				
'Finish' on Carcass		4.05	4.55	0.40
'Fullness' of Loin		3.75	4.55	0.45
Fullness' of Leg		3.90	3.90	0.42
CARCASS SHAPE				
Carcass Length	(mm.)	59.28	61.85	2.25
Weight/Length ratio		0.67	0.84	0.06*
Chest Depth	(mm.)	17.27	19.15	0.59**
Depth/Length ratio		0.29	0.31	0.08
Shoulder Depth	(mm.)	24.49	27.55	0.59***
Shoulder Width	(mm.)	18.95	21.45	0.59***
Width/Depth ratio		0.78	0.78	0.13
Leg Length	(mm.)	36.86	39.29	0.72**
Leg Thickness	(mm.)	10.45	12.58	0.56***
Thickness/Length ratio		0.29	0.32	0.08

(1) Statistically significant differences in this and subsequent tables are identified as follows:
† significant at the 10% level of Probability.
* significant at the 5% level of Probability.
** highly significant at the 1% level of Probability.
*** very highly significant, at the 0.1% level of Probability.

(2) Per cent Fat in the Best Neck.

Visual Appraisal: The hoggets were not considered to be excessively fat on visual appraisal, but were scored higher than the lambs for 'finish' and 'fullness' of the loin. These differences were not significant (table 9).

Carcass Shape: The older sheep had grown less in linear size (carcass and leg length) than in weight and had a greater weight/length ratio, indicative of more blocky carcass shape. Their carcasses were only slightly deeper and their hind legs slightly thicker in relation to their length than those of the younger sheep and these differences were not significant. The width and depth of the shoulders was greater in hoggets than lambs, but the ratio of width to depth was the same in both (table 9).

Eye Muscle and Fat Development: The size of the eye-muscle of the hoggets was little different to that of the lambs, but it had increased in depth rather than in width. Fat depth over the eye-muscle was greater in the hoggets than the lambs, and this was almost significant ($P<0.05$). The flesh depth between the ribs and over the loin was markedly and significantly greater in the older sheep (table 10).

TABLE 10. **Comparison of 'Fresh August Lamb' and Fresh November Hogget' with respect to the development of the Eye-muscle, fat depth over the Eye-muscle and flesh depth between the ribs and over the loin**

Group / Treatment		I Fresh August Lamb	III Fresh November Hogget	Standard Error of Difference
EYE-MUSCLE (12TH RIB)				
Width	(mm.)	6.00	5.78	0.25
Depth	(mm.)	2.70	3.08	0.23
Width & Depth	($mm.^2$)	16.18	17.77	1.52
Mean Fat Depth	(mm.)	0.41	0.69	0.16†
FLESH DEPTH				
Rib	(mm.)	2.05	4.38	0.31***
Loin	(mm.)	3.07	3.70	0.23**

TABLE 11. **Comparison of 'Fresh August Lamb' and 'Fresh November Hogget' with respect to combinations of bone-in joints and cut-out value (for left-side)**

Group / Treatment		I Fresh August Lamb	III Fresh November Hogget	Standard Error of Difference
Side weight	(lb.)	19.78	25.36	0.82***
Leg and Shoulder	(%)	44.82	43.18	1.07†
Chump-Loin and Best Neck	(%)	25.47	25.61	1.34
Middle Neck and Scrag	(%)	13.62	13.26	0.69
Lap and Breast	(%)	13.27	14.57	0.63†
Kidney and Channel Fat	(%)	2.83	3.75	0.52†
Prime Joints (1)	(%)	69.99	68.97	1.21
Cut-out Value	(d/lb.)	45.96	45.84	2.54

(1) Prime Joints comprises Leg, Shoulder, Chump, Loin and Best Neck.

Joint Proportions: Differences in joint proportions between the lambs and hoggets were not significant ($P<0.05$), though the fatter hoggets had an appreciably higher percentage of Lap, and relatively more Kidney and Channel fat but a lower percentage of Leg and Shoulder joints (table 11). Overall differences in joint proportions did not result in appreciable differences in cut-out value.

Joint Composition: The hogget joints were considerably fatter than those of the lambs and the differences in lean/fat ratio were evident to a similar extent in both Best Neck and Neck Lap (table 12). However the heavier hoggets had a higher lean/bone ratio and a lower percentage of bone in these joints than the lambs. In the Best Neck and, to a lesser extent, in the Neck Lap this lower percentage of bone offset their higher percentage of fat so that the difference in percentage lean in favour of the lambs was relatively small and not significant.

TABLE 12. **Comparison of 'Fresh August Lamb' and 'Fresh November Hogget' with respect to the tissue composition of the Best Neck and Neck Lap (as a per cent of joint weight)**

Group Treatment		I Fresh August Lamb	III Fresh November Hogget	Standard Error of Difference
BEST NECK				
Lean	(%)	43.68	40.45	2.50
Fat	(%)	31.60	44.19	2.14***
Bone	(%)	22.07	14.09	2.03***
Lean/Bone ratio		2.04	2.95	0.30**
Lean/Fat ratio		1.44	0.94	0.18**
NECK LAP				
Lean	(%)	46.12	40.97	3.27
Fat	(%)	39.78	48.13	3.38*
Bone	(%)	12.79	10.65	1.24†
Lean/Bone ratio		3.67	3.92	0.38
Lean/Fat ratio		1.21	0.86	0.16*

THE INFLUENCE OF BREED

The Cluns were similar in carcass weight but considerably fatter than the Suffolk-crosses, both as lambs and as hoggets (table 13). The Suffolk-crosses however, apparently increased more in fat percentage and fat cover but less in per cent Kidney and Channel fat than the Cluns in growing to the heavier weight (table 14).

TABLE 14. **The Relative Fatness of Hoggets of two breeds compared with Lambs = 100**

	Suffolk-crosses	Cluns
Total Fat(1)	147	134
Subcutaneous Fat(1)	150	133
Fat Depth	207	150
Per cent Kidney and Channel Fat	119	144

(1) In Best Neck.

TABLE 13. **Breed Differences in Carcass Characteristics of 'Fresh August Lamb' and 'Fresh November Hogget'**

Group / Treatment			I Fresh August Lamb		III Fresh November Hogget		Standard Error of Difference
Carcass weight	(lb.);	Suffolk X	39.85	±1.57(1)	50.80	±2.59	2.04***
		Clun	39.04		52.70		2.12***
Fatness(2)	(%);	Suffolk X	27.51	±3.62*	40.52	±3.48†	3.13***
		Clun	35.69		47.85		4.07**
Eye-muscle Area(3)	(mm.2);	Suffolk X	17.39	±2.35	18.30	±1.69	2.17
		Clun	14.96		17.25		1.88
Mean Fat Depth	(mm.);	Suffolk X	0.29	±0.13*	0.60	±0.28	0.16
		Clun	0.52		0.78		0.25
Leg and Shoulder	(%);	Suffolk X	45.62	±1.38	43.47	±1.24	1.04*
		Clun	44.02		42.90		1.38
Chump-Loin, Best Neck	(%);	Suffolk X	24.41	±1.41	25.33	±2.02	1.09
		Clun	25.91		25.90		2.34
Loin and Neck Lap	(%);	Suffolk X	7.40	±0.63	9.52	±0.86	0.78**
		Clun	8.00		9.15		0.69
Kidney, Channel Fat	(%);	Suffolk X	2.64	±0.52	3.13	±0.76	0.76
		Clun	3.03		4.37		0.52*
Cut-out Value	(d/lb.);	Suffolk X	46.08	±2.27	45.72	±2.18	2.59
		Clun	45.84		45.84		1.86
Lean(2)	(%);	Suffolk X	46.96	±2.66*	42.88	±2.21*	2.62
		Clun	40.41		38.02		2.26
Lean/Bone ratio(2)	;	Suffolk X	2.06	±0.30	2.96	±0.47	0.28*
		Clun	2.03		2.93		0.48†
Lean/Fat ratio(2)	;	Suffolk X	1.74	±0.25*	1.07	±0.10*	0.24*
		Clun	1.15		0.80		0.11**

(1) Standard Errors of Breed Differences shown thus.
(2) In Best Neck.
(3) Width × Depth.

There were no significant differences between the breeds in bone-in joint proportions (table 13). However, the relative size of the Lap was greater in hoggets than lambs of both breeds, the difference being more marked in the Suffolk-crosses (+24%) than in the Cluns (+15%). There were no significant differences in cut-out value.

The Cluns had a significantly higher proportion of fat to lean in the Best Neck than the Suffolk-crosses, both as lambs and as hoggets (table 13). However the two breeds had similar proportions of lean to bone at both stages. The greater fatness of the Cluns was reflected in a slightly lower percentage of bone and a markedly lower percentage of lean in this joint. The proportion of fat to lean, in hoggets compared with lambs, increased more in the Suffolk-crosses than the Cluns, whereas the proportion of lean to bone increased to a similar extent in both groups.

Comparison of Frozen August Lamb (Home-Bred) with Fresh February Hoggets and New Zealand No. 2 Carcasses

THE INFLUENCE OF TYPE

Characterisation: In August the lambs selected for late slaughter as 'February hoggets' were 20 lb. lighter than those selected for immediate slaughter. These light lambs gained more than 2 lb. liveweight per week over the first two months on grass but their gains were much slower (1 to ½lb./week) over the remaining four months they were on roots in adverse weather conditions (see page 9, table 4). In view of this performance, they were considered to be reasonably representative of the slowly grown hoggets that are sold in late winter. At slaughter these February hoggets

TABLE 15. **Comparison of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand No. 2 Carcasses' with respect to weight and fatness: visual appraisal and carcass shape**

Group Treatment	II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Error of Differences II v IV	 II v V
CHARACTERISATION					
Carcass Weight (lb.)	40.46	45.12	33.68	2.71	1.65***
Fatness(1) (%)	34.62	34.69	43.10	5.53	5.13
VISUAL APPRAISAL(2)					
'Finish' on Carcass	4.15±0.13	4.50±0.19	5.20±0.09		
'Fullness' of Loin	4.00±0.15	4.33±0.16	5.00±0.00		
'Fullness' of Leg	4.10±0.14	4.22±0.17	4.90±0.07		
CARCASS SHAPE					
Carcass Length (mm.)	59.43	61.31	53.39	1.03†	0.79***
Weight/Length ratio	0.68	0.74	0.63	0.03*	0.05
Chest Depth	17.26	19.12	15.47	0.49***	0.54**
Depth/Length ratio	0.30	0.31	0.29	0.06	0.06
Leg Length	37.43	38.46	33.81	0.80	0.79***
Leg Thickness	11.76	11.87	10.97	0.58	0.42
Thickness/Length ratio	0.31	0.31	0.33	0.03	0.03

(1) Per cent fat in Best Neck.

(2) Time of appraisal, varied in relation to freezing—see text

yielded 11% heavier carcasses but were similar in fatness to the August lambs (table 15). They were however much more variable than the lambs in these respects. The New Zealand lamb carcasses were characteristically lighter than those of the home-bred lamb (by 16½%) but were considerably fatter (by 25%).

Visual Appraisal: The hoggets were scored slightly but not significantly higher than the lambs for 'finish' and 'fullness' of the loin and were considered to be close to the optimum in these respects (table 15).

The visual appraisal scores for the New Zealand lamb indicated that they were considered to have almost optimal development of 'finish' and 'fullness' of both leg and loin (table 15). However, since their origin was known to the judge, the possibility that he was subconsciously biased in their favour by previous experience of this type of carcass cannot be excluded. Furthermore, the home-bred lamb was appraised before blast-freezing whereas the New Zealand lamb was appraised after coming out of cold storage and there are certain indications that freezing may have caused the subcutaneous fat to rise on the home-bred lamb carcasses (see page 24). This might have improved their subsequent appearance and it is therefore inappropriate to compare the visual appraisal scores for the two types.

Carcass Shape: The hoggets had a greater ratio of carcass weight to length than the lambs and were both deeper in the chest and also deeper and wider in the shoulder. Their greater depth was not however out of proportion to their length and width (table 15).

The New Zealand carcasses were longer in relation to their weight than the home-bred lamb but were similarly proportioned with respect to depth/length ratio. The former had however slightly more blocky hindquarters as indicated by the ratio of Leg thickness to Leg length (table 15).

Eye-Muscle and Fat Development: Eye-muscle development was only slightly and not significantly greater in hoggets than lambs and was more evident as increased depth than increased width (table 16). There were no marked or consistent differences between lambs and hoggets in depth of fat or flesh.

The Eye-muscle of the New Zealand lamb was less wide but almost as deep as that of the heavier home-bred lamb, but was covered by a thicker layer of subcutaneous fat. This was also associated with a thicker depth of flesh between the ribs (table 16).

Joint Proportions and Cut-out Value: There were no significant differences between lambs and hoggets in the percentage of bone-in joints (table 17). The frozen lambs had a slightly higher percentage of prime joints but neither this nor the small difference in cut-out value was significant.

New Zealand and home-bred carcasses had a similar percentage of prime joints and similar cut-out values (table 17). It was notable, that the fatter New Zealand carcasses did not contain an appreciably higher percentage of Kidney and Channel fat than the home-bred.

TABLE 16. **Comparison of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand No. 2 Carcasses' with respect to the development of the Eye-muscle, fat depth over the Eye-muscle and flesh depth between the ribs and over the loin**

Group / Treatment		II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Error of Differences II v IV	Standard Error of Differences II v V
EYE-MUSCLE (12th Rib)						
Width	(mm.)	5.93	6.08	5.25	0.24	0.28*
Depth	(mm.)	2.55	2.87	2.48	0.20	0.20
Width x Depth	(mm.^{2})	15.07	17.41	12.95	0.17	1.17
Mean Fat Depth	(mm.)	0.71	0.61	0.85	0.18	0.21
FLESH DEPTH						
Rib	(mm.)	2.68	3.21	3.21	0.44	0.38
Loin	(mm.)	3.11	3.07	3.16	0.35	0.31

TABLE 17. **Comparison of 'Frozen August Lamb', Fresh February Hogget' and 'New Zealand No. 2 Carcasses' with respect to combinations of bone-in joints and cut-out value (for left-side)**

Group / Treatment		II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Error of Differences II v IV	Standard Error of Differences II v V
Side Weight	(lb.)	19.40	22.73	16.69	1.38*	0.82**
Leg, Shoulder	(%)	44.39	42.97	43.88	1.55	1.37
Chump-Loin,Best Neck	(%)	26.41	26.02	26.09	0.94	1.14
Middle Neck, Scrag	(%)	12.61	13.11	12.84	0.90	1.05
Lap and Breast	(%)	14.02	14.26	14.27	0.78	0.90
Kidney, Channel Fat	(%)	3.34	3.40	3.40	0.86	0.82
Prime Joints(1)	(%)	70.82	69.01	69.97	1.52	1.51
Cut-out Value	(d/lb.)	46.56	45.96	46.44	2.03	1.86

(1) Prime Joints comprises Leg, Shoulder, Chump, Loin and Best Neck.

Joint Composition: The Best Neck and Neck Lap of both lambs and hoggets were similar in composition (table 18). The New Zealand lamb had more fat and bone in relation to the lean content of Best Neck and Neck Lap than the home-bred lamb. However the greater leanness of the home-bred lamb though appreciable was only significant at the 10% level of probability since there was considerable within-type variation (coefficient of variation 13%). Both English and New Zealand lamb were equally variable in this respect.

TABLE 18. **Comparison of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand No. 2 Carcasses' with respect to the tissue composition of the Best-Neck and Neck Lap (as a per cent of joint weight)**

Group / Treatment		II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Error of Differences II v IV	Standard Error of Differences II v V
BEST NECK						
Lean	(%)	45.35	47.13	38.55	3.64	3.53†
Fat	(%)	34.62	34.69	43.10	5.47	5.13
Bone	(%)	19.32	18.72	18.70	2.45	2.38
Lean/Bone ratio		2.38	2.61	2.12	0.25	0.21
Lean/Fat ratio		1.43	1.47	0.95	0.35	0.28†
NECK LAP						
Lean	(%)	45.50	45.79	39.43	5.05	4.48
Fat	(%)	42.19	43.13	48.57	5.96	5.43
Bone	(%)	14.04	12.02	13.34	1.30	1.28
Lean/Bone ratio		3.26	3.82	2.99	0.25*	0.31
Lean/Fat ratio		1.17	1.15	0.85	0.30	0.24

THE INFLUENCE OF BREED

The Cluns gained less weight during the feeding period and were lighter and less fat than the Suffolk-crosses in February and whereas the Suffolk-cross hoggets were heavier and fatter than the August lambs of the same breed, the Clun hoggets were similar in weight but less fat than the Clun lambs (table 19). These differences in fatness were not however significant and were not associated with significant differences in joint proportions or cut-out value.

In the comparison of home-bred and New Zealand lamb, the Cluns were slightly fatter than the Suffolk-crosses but by no means as fat as the New Zealand No. 2 carcasses (table 19).

TABLE 19. **Breed Differences in Carcass Characteristics of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand No. 2 Carcasses'**

Group / Treatment		II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Error of Difference II v IV	Standard Error of Difference II v V
Carcass Weight (lb.);	Suffolk X	41.46 ±2.48	49.19 ±3.84	33.68	2.66	1.96***
	Clun	39.46	41.86		1.82	1.99**
Fatness(1) (%);	Suffolk X	32.54 ±7.16	36.99 ±3.58	43.10	7.97	5.47†
	Clun	36.70	32.86		7.49	6.77
Eye-muscle Area (mm^2)	Suffolk X	15.63 ±1.97	17.66 ±1.38	12.95	1.44*	1.38
	Clun	14.51	17.22		1.48	0.93
Mean Fat Depth (mm.);	Suffolk X	0.63 ±0.28	0.68 ±0.23	0.85	0.28	0.23
	Clun	0.80	0.55		0.23	0.28
Leg & Shoulder (%);	Suffolk X	44.89 ±0.92	42.06 ±1.34	43.88	2.47	1.44
	Clun	43.89	43.71		1.88	1.88
Chump-Loin & Best Neck (%);	Suffolk X	25.63 ±0.98	26.25 ±1.16	26.09	1.17	1.10
	Clun	25.24	25.84		1.28	1.28
Loin & Neck Lap (%);	Suffolk X	8.11 ±0.82	8.20 ±0.90	8.76	0.87	0.78
	Clun	8.56	8.67		0.79	0.72
Kidney & Channel Fat (%);	Suffolk X	3.32 ±1.42	3.62 ±1.03	3.40	1.54	1.24
	Clun	3.76	3.23		0.92	0.80
Cut-out Value (d/lb.);	Suffolk X	46.08 ±1.86	45.48 ±1.18	46.44	2.03	2.20
	Clun	47.16	46.32		2.57	2.03
Lean(1) (%)	Suffolk X	46.74 ±5.31	46.20 ±3.88	43.10	3.67	4.02
	Clun	43.96	47.88		5.29	3.53
Lean/Bone ratio(1)	Suffolk X	2.40 ±0.31	2.56 ±0.52	2.12	0.38	0.28
	Clun	2.37	2.65		0.38	0.25
Lean/Fat ratio(1)	Suffolk X	1.52 ±0.51	1.38 ±0.49	0.95	0.52	0.32
	Clun	1.33	1.54		0.48	0.38

(1) in Best Neck

Comparison of 'Fresh' and 'Frozen' August Lamb

THE INFLUENCE OF TYPE

The home-bred lambs retailed fresh and those retailed frozen were not significantly different in weight, fatness, carcass shape, per cent prime joints, cut-out value or joint composition (table 20).

There were however certain significant differences in fat and flesh depth that might be ascribed to the effects of freezing and differences in the percentage of Scrag that might be ascribed to the method of dressing for freezing.

The fat depth over the eye-muscle and flesh depth between the ribs, was considerably greater on the frozen than the fresh lamb carcasses (table 20). Furthermore, the differences were out of proportion to variation between the two treatments in the fat content of the Best Neck (table 21). It is suggested that freezing has caused the subcutaneous fat to rise and so increased fat and flesh depth measurements.

TABLE 20. **Comparison of 'Fresh August Lamb' and 'Frozen August Lamb' with respect to selected carcass characteristics** (1)

Group / Treatment		I Fresh August Lamb	II Frozen August Lamb	Standard Error of Difference
CHARACTERISATION				
Carcass Weight	(lb.)	39.45	40.46	1.48
Fatness(2)	(%)	31.60	34.62	4.43
VISUAL APPRAISAL				
'Finish' on Carcass		4.05	4.15	0.38
CARCASS SHAPE				
Carcass Length	(mm.)	59.28	59.43	1.03
Weight/Length ratio		0.67	0.68	0.02
Chest Depth	(mm.)	17.27	17.26	0.52
Depth/Length ratio		0.29	0.30	0.07
EYE-MUSCLE AND FAT DEVELOPMENT				
Eye-muscle area	($mm.^2$)	16.18	15.07	1.62
Mean Fat Depth	(mm.)	0.41	0.71	0.16†
Rib Flesh Depth	(mm.)	2.05	2.68	0.30*
Loin Flesh Depth	(mm.)	3.07	3.11	0.28
JOINT PROPORTIONS AND CUT-OUT VALUE				
Prime Joints(3)	(%)	69.99	70.82	1.37
Cut-out Value	(d/lb.)	45.96	46.56	2.03
COMPOSITION OF BEST NECK				
Lean	(%)	43.68	45.35	3.14
Lean/Bone ratio		2.04	2.38	0.23
Lean/Fat ratio		1.44	1.43	0.31

(1) Full details of all carcass characteristics are tabulated in Appendix II.

(2) Per cent of fat in Best Neck.

(3) Prime Joints comprise Leg, Shoulder, Chump, Loin and Best Neck.

TABLE 21. **Relative differences between 'Frozen' and 'Fresh' August Lamb in the fat content of the Best Neck compared with Fat depth and Flesh depth measurements**

	Fresh	Frozen
Weight Total Fat in Best Neck	100	100
Weight Subcutaneous Fat in Best Neck	100	104
Mean Fat Depth	100	175
Rib Flesh Depth	100	131

It was a marked feature of the frozen lambs that they had significantly less Scrag than the fresh, presumably because their forelimbs were 'strung-forward' before freezing in New Zealand style rather than 'skewered-back' in the United Kingdom style. This apparently reduced the proportion of meat in the Scrag and increased the proportion in the Middle Neck and Shoulder (table 22). The effect was less evident with the system of jointing used on the right sides of the carcasses than with that followed for the left sides, since with the former a considerably smaller Scrag was removed.

TABLE 22. **Comparison of 'Fresh' and 'Frozen' August Lamb with respect to the proportion of bone-in Scrag, Middle Neck and Shoulder**

Treatment		Fresh	Frozen	Standard Error of Difference
LEFT SIDE				
Scrag	(%)	5.75	3.75	0.54***
Middle Neck	(%)	7.87	9.01	0.65
Shoulder	(%)	19.29	19.66	0.85
RIGHT SIDE				
Scrag	(%)	2.71	2.09	0.31*

The most important direct effect of the freezing process was expected to be the loss in carcass weight during blast-freezing, six months cold-storage and subsequent thawing. However, with the frozen home-bred lamb the total loss up to 24 hours after removal from storage averaged only 1 lb. per head, approximately $2\frac{1}{2}\%$). The greater part of this loss apparently occurred during blast-freezing and relatively little further loss occurred during storage and thawing (table 23).

TABLE 23. **Weight Changes of August Lambs in the Freezing Process (lb.)**

Cold Carcass weight into Blast-freeze	41.45 ± 0.52
Frozen Carcass weight out of Blast-freeze	40.69 ± 0.56
Thawed Carcass weight (24 hrs. after removal)	40.48 ± 0.65
Weight Loss in Freezing	0.76 ± 0.11
Weight Loss in Storage and Thawing	0.23
Total Weight Loss	0.99 ± 0.11

Comparison of November and February Hoggets

THE INFLUENCE OF TYPE

The lambs selected for late slaughter in February were, in August, 20 lbs. lighter than those allocated to November slaughter and ultimately, the older February hoggets were on average lighter and less fat than those slaughtered in November (table 24).

Both types were rated similar on visual appraisal and differed little in carcass shape except that the older lambs were longer in the body in relation to their carcass weight (table 24). The February hoggets had a similar eye-muscle area and only slightly less fat cover but much less flesh (fat) depth between the ribs and over the loin than the November hoggets. Bone-in joint proportions did not differ significantly between the two types and they had similar cut-out values. The older, lighter lambs had a significantly higher ratio of lean to fat in their joints but a slightly, and not significantly, lower ratio of lean to bone (table 24).

TABLE 24. **Comparison of 'Fresh November Hogget' and 'Fresh February Hogget' with respect to selected Carcass characteristics** (1)

Group / Treatment		III Fresh November Hogget	IV Fresh February Hogget	Standard Error of Difference
CHARACTERISATION				
Carcass Weight	(lb.)	51.75	45.12	2.74*
Fatness(2)	(%)	44.19	34.69	4.51*
VISUAL APPRAISAL				
'Finish' on Carcass		4.55	4.50	0.47
CARCASS SHAPE				
Carcass Length	(mm.)	61.85	61.31	1.26
Weight/Length ratio		0.84	0.74	0.07
Chest Depth	(mm.)	19.15	19.12	0.56
Depth/Length ratio		0.31	0.31	0.07
EYE-MUSCLE AND FAT DEVELOPMENT				
Eye-muscle Area	($mm.^2$)	17.77	17.41	1.07
Mean Fat Depth	(mm.)	0.69	0.61	0.18
Rib Flesh Depth	(mm.)	4.38	3.21	0.45*
Loin Flesh Depth	(mm.)	3.70	3.07	0.30*
JOINT PROPORTIONS AND CUT-OUT VALUE				
Prime Joints(3)	(%)	68.97	69.01	1.36
Cut-out Value	(d/lb.)	45.84	45.96	3.05
COMPOSITION OF BEST NECK				
Lean	(%)	40.45	47.13	2.82*
Lean/Bone ratio		2.95	2.61	0.31
Lean/Fat ratio		0.94	1.47	0.23*

(1) Full details of all carcass characteristics are tabulated in Appendix II.

(2) Per cent of fat in Best Neck.

(3) Prime Joints comprise Leg, Shoulder, Chump, Loin and Best Neck.

TABLE 25. **Breed Differences in the Carcass Characteristics of 'Fresh November Hogget' and 'Fresh February Hogget'**

Group / Treatment			III Fresh November Hogget		IV Fresh February Hogget		Standard Error of Difference
Carcass weight	(lb.);	Suffolk X	50.80	±2.59	49.19	±3.84	3.96
		Clun	52.70		41.86		2.47
Fatness(1)	(%);	Suffolk X	40.52	±3.48*	36.99	±8.29	6.67
		Clun	47.85		32.86		5.06
Eye-muscle Area	(mm.2);	Suffolk X	18.30	±1.69	17.66	±1.38	1.68
		Clun	17.25		17.22		1.40
Mean Fat Depth	(mm.);	Suffolk X	0.60	±0.28	0.68	±0.23	0.28
		Clun	0.78		0.55		0.23
Leg & Shoulder	(%);	Suffolk X	43.62	±1.68	42.06	±1.34	2.45
		Clun	42.73		43.71		1.56
Chump-Loin & Best Neck	(%);	Suffolk X	25.33	±2.02	26.25	±1.16	1.21
		Clun	25.90		25.84		1.96
Loin & Neck Lap	(%);	Suffolk X	9.52	±0.86	8.20	±0.90	0.97
		Clun	9.15		8.67		0.79
Kidney & Channel Fat	(%);	Suffolk X	3.13	±0.76	3.62	±1.03	1.04
		Clun	4.37		3.23		0.75
Cut-out Value	(d/lb.);	Suffolk X	45.72	±1.86	45.48	±2.37	1.68
		Clun	45.84		46.32		1.40
Lean(1)	(%);	Suffolk	42.88	±2.21	46.20	±5.08	4.00
		Clun	38.02		47.87		3.29**
Lean/Bone ratio(1)	;	Suffolk X	2.96	±0.47	2.56	±0.46	0.41
		Clun	2.93		2.65		0.51
Lean/Fat ratio(1)	;	Suffolk X	1.07	±0.10**	1.38	±0.49	0.37
		Clun	0.80		1.54		0.23***

(1) In Best Neck.

The Cluns gained less liveweight than the Suffolk-crosses while on roots, and the gains of both groups were low and highly variable over this period. The Cluns which were initially 2 or 3 lbs. lighter (liveweight) than the Suffolk-crosses, were 5 lb. heavier as November hoggets but 15 lbs. lighter as February hoggets (see page 10, table 4). The latter difference was reflected in the 7.3 lb. lighter carcass weight of the Cluns than the Suffolk-crosses in February, a difference that was almost significant (table 25).

As well as being lighter the February Cluns were also less fat than the Suffolk-crosses; they had less depth of fat over the Eye-muscle, a lower percentage of Kidney and Channel fat and a lower proportion of fat to lean in the Best Neck (table 25). The breed difference in the fatness of the February hoggets contrasts with the differences in the November hoggets, where there was consistent evidence that the Cluns were fatter than the Suffolk-crosses.

Analysis of variance for lean/fat ratio in the Best Neck of these two groups revealed highly significant effects of Breed ($P<0.001$) as well as Type ($P<0.001$) and a significant Breed x Type interaction ($P<0.01$).

COOKING AND EATING QUALITY OF THE MEAT

Comparison of Fresh August Lamb and Fresh November Hogget

Cooking time, cooking loss and Resistance to Shear

Both types of meat cooked equally quickly but there was a greater loss during cooking from the hogget mutton than from the lamb and the hogget muscle had a considerably greater resistance to shear, indicating that the hogget was likely to be tougher than the lamb (table 26)

TABLE 26. **The cooking time, cooking loss and resistance to shear of the *Longissimus dorsi* muscle from 'Chump' and 'Loin' chops of 'Fresh August Lamb' and 'Fresh November Hogget'**

Group Treatment	I Fresh August Lamb	III Fresh November Hogget	Standard Error of Difference
COOKING TIME (mins./100 gm.)			
Chump	10.90	11.33	1.44
Loin	14.19	12.68	1.24
COOKING LOSS (% initial wt.)			
Chump	29.69	39.00	2.98**
Loin	34.89	38.70	2.31
WARNER-BRATZLER SHEAR (lb.)			
Chump	3.66	8.04	0.54***
Loin	3.83	6.85	0.65***

Comparison of Frozen August Lamb, Fresh February Hogget and New Zealand Lamb

Cooking time, cooking loss and Resistance to Shear

The New Zealand lamb took slightly longer to cook to constant internal temperature than the other two types but there were no significant differences between the three types in cooking loss or resistance to shear (table 27).

TABLE 27. **The cooking time, cooking loss and resistance to shear of the *Longissimus dorsi* muscle from 'Chump' chops of 'Frozen August lamb', 'Fresh February hogget' and 'New Zealand lamb'**

Group Treatment	II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Error of Differences II v IV	 II v V
COOKING TIME (Mins./100 gm.) Chump	12.79	11.71	15.06	1.49	1.30†
COOKING LOSS (% initial wt.) Chump	31.86	34.21	36.53	4.50	3.98
WARNER-BRATZLER SHEAR (lb.) Chump	4.78	4.76	5.75	0.79	0.96

Tasting Panel Evaluation

The mean scores for degree of flavour and juiciness and the panel's rating of the three types in order of preference for these characteristics were not significantly different. There were however more marked differences in tenderness. The frozen August lamb was the most tender, the fresh February hogget the least tender and the New Zealand lamb intermediate in this respect. The differences between the August lamb and February hogget were significant (tables 28 and 29).

TABLE 28. **Panel scores for degree of flavour, tenderness and juiciness of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand Lamb' (maximum score 5)**

Group Treatment	II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Errors of Differences II v IV	 II v V
Flavour	2.67	2.57	2.57	0.69	0.69
Tenderness	3.98	3.30	3.70	0.21**	0.21
Juiciness	2.47	2.57	2.27	0.37	0.39

TABLE 29. **Panel Preference for flavour, tenderness and juiciness of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand Lamb' (maximum score 5)**

Group / Treatment	II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Standard Errors of Differences II v IV	II v V
Flavour	2.78	2.48	2.98	0.53	0.43
Tenderness	3.43	2.28	2.93	0.58*	0.58
Juiciness	2.88	2.88	2.60	0.58	0.45

In none of the three types were the scores for tenderness and flavour so low as to suggest they would be generally unacceptable.

TABLE 30. **Panel ranking of 'Frozen August Lamb', Fresh February Hogget' and 'New Zealand Lamb' for degree of flavour, tenderness and juiciness and preference for these characteristics†**

Group / Treatment		II Frozen August Lamb	IV Fresh February Hogget	V New Zealand No. 2's	Significance of Ranking*
DEGREE OF FLAVOUR					
	1st	4	2	1	
Rank	2nd	2	1	2	
	3rd	0	3	3	
Overall Rank		1st	=2nd	=2nd	NS
PREFERENCE FOR FLAVOUR					
	1st	1	1	4	
Rank	2nd	5	1	1	
	3rd	0	4	1	
Overall Rank		2nd	3rd	1st	NS
DEGREE OF TENDERNESS					
	1st	5	0	1	
Rank	2nd	1	0	5	
	3rd	0	6	0	
Overall Rank		1st	3rd	2nd	***
PREFERENCE FOR TENDERNESS					
	1st	6	0	0	
Rank	2nd	0	1	5	
	3rd	0	5	1	
Overall Rank		1st	3rd	2nd	***
DEGREE OF JUICINESS					
	1st	3	5	0	
Rank	2nd	2	1	1	
	3rd	1	0	5	
Overall Rank		2nd	1st	3rd	**
PREFERENCE FOR JUICINESS					
	1st	3	3	0	
Rank	2nd	1	1	6	
	3rd	2	2	0	
Overall Rank		=1st	=1st	2nd	NS

† Figures in table are number of panellists giving a particular verdict.

* From Kendall's Coefficient of Concordance Test (Kendall, 1948).

The significance of differences in the eating quality of the meat from the three types is assessed in tables 33 and 34 with respect to the individual animal variation. These differences have also been evaluated with respect to variation between the six members of the tasting panel in the order in which they ranked the three types for eating quality characteristics (table 30). This ranking shows that 4 out of the 6 panellists scored the frozen home-bred lamb as having the greatest *degree* of flavour, but that 4 out of the 6 preferred the *quality* of flavour of the New Zealand lamb to that of the home-bred. The hogget mutton was ranked similar in degree of flavour to the New Zealand but was the least preferred of the three types for quality of flavour. However, these differences in ranking for flavour were not significant.

The panel members were almost unanimous in ranking the frozen home-bred lamb, New Zealand lamb and fresh hogget; first, second and third respectively for tenderness.

Five of the six panellists ranked the New Zealand lamb lower in degree of juiciness than the other types, but their rankings with respect to preference for juiciness were not consistent with there being any important differences in this respect.

There were no significant breed or sex differences in cooking or eating quality characteristics.

CHAPTER III

DISCUSSION

Differences in Carcass Characteristics

As lambs grow, bone, muscle and fat develop at different rates and their body shape and composition changes (Palsson & Verges, 1952). The changes in bone and muscle are closely associated with the increase in weight and are largely independent of age, but the most notable change in composition, as animals grow older and heavier is the increase in carcass fat (Elsley, McDonald & Fowler, 1964). The rate of development of fat relative to bone and muscle is influenced both by the genotype of the individual animal and also by its plane of nutrition (Berg & Butterfield, 1966) and variation in fatness is a major determinant of the proportion of lean and bone in the carcass (Callow, 1949). Timon (1963) for example has shown that in Clun lambs an increase in carcass fat of 1.00 percentage unit is associated with a decrease in muscle and bone percentage of 0.74 and 0.25 respectively.

Differences in carcass characteristics between the several types of lamb used in this investigation are subsequently discussed in relation to variation in carcass weight and fatness.

*Visual Appraisal of Finish and Carcass Shape**

The scores for visual appraisal of all types of home-bred lamb and hogget, suggested that they were adequately finished and reasonably well shaped. Both groups of hoggets were scored slightly higher than the lambs for these features. The New Zealand lamb was rated very close to the optimum in all respects and the scoring was much less variable for this type than for the others. A physical effect of freezing in causing the subcutaneous fat cover to rise on the New Zealand lamb may have contributed to their apparent advantage in this respect. This effect has been suggested to explain the difference in fat and flesh depth between fresh and frozen home-bred lambs of similar fatness. Timon (1963) and Gatherum *et al* (1960) have shown that visual assessment of carcass merit is more influenced by fatness than by any other trait.

*Body Shape, Eye-Muscle Development and Flesh Depth**

In general the heavier types had a greater weight/length ratio than lighter types, a reflection of the slower increase in linear skeletal dimensions than in flesh weight (Hammond, 1932). They also had a greater depth of chest relative to carcass length, a feature associated with the relative greater extension of the ribs, the latest maturing bones in the body (Palsson & Verges, 1952). Differences between the types in Eye-muscle shape were also associated with carcass weight and it is notable that there was more marked variation between types in Eye-muscle depth than width. Palsson & Verges (1952) found that depth increased more than width in post-natal life. It is of interest that the Eye-muscle of the New Zealand lamb was almost as deep but less wide than that of the heavier home-bred lamb. Possibly, this is a reflection of the fact that

* Summary tables are presented in Appendix II.

the New Zealand lamb had reached a later stage of development at this lighter weight. Their greater fat cover over the Eye-muscle lends support to this conclusion.

Variation in fatness between the types may be associated with differences in shoulder width, Leg thickness and Flesh depth between the ribs and over the loin.

*Joint Proportions and Cut-out Value**

With respect to joint proportions, the variation between the types was small and the more consistent differences appear to reflect variation in fatness. Timon (1963) has shown that as lambs become fatter there is a decline in the proportion of Leg and Shoulder, and an increase in Loin and Best Neck as well as Lap and Breast. It was notable in his study that increasing fat deposition in the carcass as a whole was associated with more rapid increases in the fatness of Best Neck and Loin (expensive joints) than the Scrag and Breast (cheap joints); viz.

Increase in % Fat in the Joint per Unit Increase Carcass Fat %

Best Neck	1.39
Loin	1.37
Scrag	1.07
†Breast	1.03
Shoulder	0.85
Middle Neck	0.75
Leg	0.67

† Includes Lap (Timon, 1963)

In the present investigation the fatter types of lamb generally had relatively more weight in the Best Neck and Loin as well as the Scrag, Breast and Kidney fat, but less weight in the Leg and Shoulder. The proportion of Kidney fat and of Trim Lap was highly correlated with overall fatness, as indicated by the per cent fat in the Best Neck (table 31). However, the overall effect of these differences was not associated with a significant reduction in cut-out value (table 32).

TABLE 31. **The Relationship of per cent Kidney Fat and Trim Lap to Carcass Weight and Fatness (Pooled information; all groups of lambs combined; n = 96)**

Independent Variable (Y)	Dependent Variable (X)	Correlation Coefficient (r)	Regression Constant (a)	Regression Coefficient (b)	Residual S.D. of Regression
Kidney Fat (%)					
	Carcass Weight (lb.)	—0.13^{NS}	—	—	—
	Fatness(1) (%)	+0.37**	0.51	+0.03±0.01**	0.70
Trim Lap (%)					
	Carcass Weight (lb.)	+0.27*	1.91	+0.04±0.01***	0.47
	Fatness(1) (%)	+0.60***	2.07	+0.04±0.01***	0.43

(1) Per cent Fat in the Best Neck.

* Summary tables are presented in Appendix II.

*Joint Composition**

The composition of the carcass and its component parts is influenced by both variation in fatness and lean/bone ratio.

The November hoggets were considerably fatter than the August lambs but also had a higher lean/bone ratio, probably a feature associated with their greater carcass weight (Berg & Butterfield, 1966). This higher lean/bone ratio considerably offset the influence of greater fatness, with respect to the reduction in the percentage of lean. In the comparison of home-bred and New Zealand lamb on the other hand, the New Zealand lambs were fatter and had also a lower lean/bone ratio; both features contributing to their considerably lower percentage of lean.

Variation in fatness, as such, is influenced both by genotype and environment (Berg & Butterfield, 1966) and in the present study there were indications of the former in that the Cluns were fatter than Suffolk-crosses at the same carcass weight and the New Zealand lambs were considerably fatter than either of the home-bred breeds at much lighter weights. There is also some indication of a difference between the New Zealand and home-bred lambs in fat distribution, in that the New Zealand lambs though fatter overall did not have proportionately more Kidney and Channel fat. The deposition of fat on and in the flesh of the carcass rather than in the Kidney and Channel fat is recognised as a feature of mutton breeds of sheep (Robinson, 1961) and beef breeds of cattle (Callow, 1945; Anon, 1966). It is usually associated, in cattle at least, with a difference in the relative development of subcutaneous and intermuscular fat (Anon, 1966). In the present investigation however, both the New Zealand and home-bred lamb had a similar proportion of the fat in the Best Neck in the subcutaneous layer (see Appendix II, table 8).

Relationships between Cut-out Value and Selected Carcass Characteristics

Cut-out value was negatively correlated with carcass weight and with fatness but only a minor proportion of the total variation in cut-out value was associated with variation in carcass weight and fatness (8.4% and 4.0% respectively). The proportion of Kidney fat and of Trim Lap was not significantly correlated with cut-out value (table 32).

TABLE 32. **The relationship of Cut-out Value to selected Carcass Characteristics Pooled information: (All groups of lambs combined; n = 96)**

Independent Variable (Y)	Dependent Variable (X)		Correlation Coefficient (r)	Regression Constant (a)	Regression Coefficient (b)	Residual S.D. of Regression
Cut-out Value (d/lb.)	Carcass Weight	(lb.)	—0.29**	48.72	—0.06±0.02**	1.38
	Fatness(1)	(%)	—0.20*	47.42	—0.03±0.02NS	1.41
	Kidney Fat	(%)	+0.13NS	—	—	—
	Trim Lap	(%)	—0.03NS	—	—	—

(1) Per cent Fat in the Best Neck.

* Summary tables are presented in Appendix II.

The relationship between cut-out value and carcass weight has also been estimated for the different types of lamb separately (table 33), as well as from the pooled information on all types combined (table 32). The correlation was significant for the August lambs and the February hoggets, but not significant for the November hoggets or the New Zealand No. 2's. Within types variation in carcass weight was associated with 13-21% of the variation in cut-out value. In four out of the five types cut-out value declined by 1.1d.–1.7d. with each 10 lb. increase in carcass weight.

TABLE 33. **The relationship of Cut-out Value (d/lb.) to Carcass Weight (lb.) in different types of lamb**

Type of Lamb	Number in Group (n)	Correlation Coefficient (r)	Regression Constant (a)	Regression Coefficient (b)	Residual S.D. of Regression
(1) August Lambs	40	—0.36*	56.22	—0.25±0.11*	1.61
November Hoggets	20	—0.36^{NS}	52.31	—0.12±0.08^{NS}	1.00
February Hoggets	18	—0.46*	51.95	—0.13±0.06*	1.41
New Zealand No. 2's	20	—0.36^{NS}	52.27	—0.17±0.11^{NS}	1.56

(1) The regression coefficients for fresh and frozen groups of August lambs respectively were: —0.11±0.12^{NS} and—0.36±0.16*.

The Commercial Implications of the Results of this Investigation

The investigation has not revealed any important differences between the various types of lamb and hogget in joint proportions that would markedly influence cut-out value.

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Carcass weight (lb.)	39.5±0.4	40.5±0.7	51.8±0.7	45.1±1.3	33.7±0.5
Fatness (%)	31.6±1.3	34.6±1.8	44.2±1.2	34.7±2.0	43.1±1.8
Cut-out Value (d/lb.)	46.0±1.0	46.6±0.5	45.8±1.2	46.0±1.0	46.4±0.8

Some of the differences between the types might however influence the acceptability of the meat to the consumer and hence its saleability and the retail return to the butcher. Three factors likely to influence acceptability and saleability have been identified, these are: (i) joint size and value; (ii) leanness; (iii) the eating quality of the meat.

As far as size of joint is concerned attention is focussed on the bone-in Shoulder, since this is the joint that is the least divisible for retail sale. The weight and value of Shoulder joints*, the leanness of the Best Neck and the eating quality of the meat from the various types is discussed hereafter.

* See Appendix II, tables 3 and 6, for details of other joints.

August Lambs v November Hoggets

	I August Lamb	II November Hogget
Weight of Shoulder	3.8 lb.	4.9 lb.
Price of Shoulder	15/10	20/2
% Lean in Best Neck	43.7	40.5
Lean/Fat ratio in Best Neck	1.4	0.9
Tenderness of Loin (W-B Shear)	3.75	7.45

Much is heard of the demand for small joints but there is little published information to use as a standard in the assessment of the results of the present investigation. Marsh (1960) on the basis of his consumer survey of meat buying habits has suggested that in lamb the demand for small joints is associated with the desire to eat the whole joint hot at one sitting, since many consumers consider cold lamb fat relatively unpalatable. Bolitho (1966), from his experience within a large meat trading organisation that had conducted consumer surveys, states that "the limit for spending on a joint appears to be some 12/– for the average household of $3\frac{1}{4}$". Thus as a whole joint it may be that the hogget shoulder will find a less ready sale at 20/– than the lamb at 16/–, but as half-joints at 10/– or 8/– respectively there would presumably be only a small advantage in flavour of the smaller carcass.

The difference in leanness in favour of the lamb is slight but the extra fat on the hogget carcass, though it is offset by a lower bone content would be evident to the consumer and possibly reduce its saleability, since Marsh (1960) found consumers have a particular aversion to excess lamb fat. While the W-B shears suggest a marked difference in tenderness it is unlikely that the hogget would be distinctly less acceptable on this count.

For the butcher the heavier hogget has certain advantages in that it leaves a heavier pelt, that is mainly extra fleece, and slaughtering and butchering charges per unit weight of lamb will be lower. The producer in this study has also increased his margin slightly (8/2 per lamb) by keeping the lamb to a heavier weight (see table 34).

Home-bred v New Zealand Lamb

	II Frozen Home-bred	V Frozen New Zealand
Weight of Shoulder	3.8 lb.	3.25 lb.
Price of Shoulder	11/5	9/9
% Lean in Best Neck	45.4	38.6
Lean/Fat ratio in Best Neck	1.4	1.0
Panel Preference (max. score 5)		
Tenderness	3.43	2.93
Flavour	2.78	2.98
Juiciness	2.88	2.60

The difference in shoulder weight and value between Home-bred and New Zealand lamb though small is such that the New Zealand shoulders sell for slightly less than 10/– while the home-bred cost appreciably more than this. This might influence the saleability of the two types in favour of the New Zealand. Furthermore, the better shape of the New Zealand legs and loins as appraised visually may be associated with better shaped bone-in joints which may appear to be more desirable to the consumer. On the other hand, the greater leanness and lower fat content of the joints from home-bred lambs in this study might be sufficiently obvious for them to be preferred to the New Zealand lambs in this respect. Both types were of similar eating quality, as judged by the tasting panel.

TABLE 34. **Economic Summary: The Influence of Different Methods of Handling Home-bred lambs on returns to Producer, Wholesaler and Retailer in the particular circumstances of this investigation**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget
(1) Farm Liveweight (lb.)	85	85	111	97
(1) Carcass Weight (lb.	41	41	52	46
PRODUCER	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Feed Costs	—	—	1 2 0	3 4 0
(2) F.M.C. buying Price (per lb.)	3 2	3 2	3 1	3 5
Return to Producer	6 9 10	6 9 10	8 0 0	7 17 2
Return relative to Group 1	—	—	1 10 2	1 7 4
COST OF STORAGE				
Freezer Space	—	8 0	—	—
Weight Loss	—	3 10	—	—
Total	—	11 10	—	—
WHOLESALER				
Pelt Value	11 0	11 0	1 8 0	1 6 0
(3) F.M.C. Selling Price (per lb.)	2 11	2 2	2 4	2 8
Total Wholesale Price	5 19 7	4 8 10	6 1 4	6 2 8
(4) Return to Wholesaler	6 10 7	4 19 10	7 9 4	7 8 8
Return relative to Group 1	—	1 10 9 (loss)	18 9	18 1
RETAILER				
(5) Retail Price (per lb.)	3 10	3 2	3 10	3 8
Retail Value	7 13 4	6 5 4	9 14 8	8 6 6
Return relative to Group 1	—	1 8 0 (loss)	2 1 4	13 2
Cut-up Weight (lb.)	40	40	51	45

(1) Group I and II adjusted to constant liveweight and carcass weight.
(2) F.M.C. Price for payment to the Producer at time of despatch from farm including guarantee payment.
(3) F.M.C. Price for sale to the Retailer at time of despatch from slaughterhouse and cold store. Frozen home-bred lamb at New Zealand prices.
(4) Return to Wholesaler assumed to be Total Wholesale Price and Pelt Value.
(5) Variable retail prices as applied at time of sale—defined in page 6, table 7 and Appendix II, table 6.

August Lambs v February Hoggets

In this particular comparison, the difference between frozen lamb and late finished hoggets in carcass weight, leanness and eating quality were quite small. It is clear however that it was quite unprofitable for the producer to retain hoggets through to the late winter, incurring in the process relatively high feed costs but obtaining only low weight gains (table 34).

The Relative Value of August Lamb, Fresh or Frozen

Freezing itself has the most marked effects on 'apparent' acceptability, if it is assumed that the lower price of New Zealand lamb relative to fresh lamb is largely due to its frozen condition. Small differences in cut-out value, joint size, leanness and eating quality pale into insignificance beside the fact that the Frozen lamb retailed in February at New Zealand prices realised 9d./lb. less than it would have done in August (37.6 v 46.6) (table 34). The cost of freezing including an allowance for the weight lost in storage, which might be greater than that recorded in this study if the time from cold store to sale is more than 24 hours, was almost 12/– per lamb and the loss in value due to reduction in price was 30/– per lamb (121.4/– v 151.2/–). It seems unlikely that the marginal advantage of frozen home-bred lamb over New Zealand lamb in terms of greater leanness could substantially offset this apparent reduction in value and the extra costs incurred when home-bred lamb is frozen.

The Degree of Uniformity of Different Types of Lamb in Selected Carcass Characteristics

It is of interest that the apparent uniformity of the New Zealand lamb, which is frequently suggested to be one of its greatest commercial virtues, was only evident in the scores for visual assessment (table 35). The visual scores for 'finish' placed 2/3rds of the New Zealand lambs within $\pm 7.7\%$ of the mean, whereas the home-bred lambs

TABLE 35. **Coefficients of Variation on Selected Carcass Characteristics of different Types of Lamb** (1)

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Finish(2)	14.8	14.0	13.8	17.9	7.7
Carcass Weight	4.6	7.2	5.8	13.2	7.0
Cut-out Value	10.4	7.0	11.2	9.8	8.0
Fat (%)(3)	18.4	23.8	12.4	27.8	18.6
Lean (%)(3)	10.0	13.2	8.6	12.4	13.4
Fat/Lean ratio(3)	27.8	40.6	19.0	38.4	33.0
Lean/Bone ratio(3)	19.6	13.2	18.2	19.8	16.8

(1) The Coefficient of Variation ($\times$) is expressed as a percentage of the Mean Value and ($\pm \times$) represents the range within which two-thirds of individual values are expected to fall.
(2) Visual Appraisal.
(3) of the Best Neck.

and hoggets were twice as variable (table 35). However with respect to carcass weight, cut-out value and joint composition the selected group of New Zealand lambs were no less variable than the selected groups of home-bred lambs and November hoggets, though as might be expected the late-finished February hoggets were more variable in both weight and fatness than the other types. The uniformity of the New Zealand lamb on visual appraisal may be associated with the evenness of its fat cover a feature that may be enhanced by freezing if this causes the subcutaneous fat to rise.

Conclusions

In this study, differences in major joint proportions and cut-out value between groups of lambs and hoggets varying considerably in both genotype and nutritional history as well as in age, weight and fatness at slaughter were not significant. Differences in the lean percentage of sample joints from August lambs and November or February hoggets were also small and not significant, though those from the November hoggets were significantly fatter than those from August lambs. New Zealand No. 2 carcasses were appreciably fatter than those from home-bred August lambs and February hoggets.

Laboratory tests indicated that the meat from the November hogget was likely to lose more weight on cooking and be tougher than that from August lambs. Tasting panel evaluations of the eating quality of lamb showed that the frozen English lamb in this comparison was more tender than New Zealand lamb or fresh hogget mutton.

Freezing prime home-bred lamb did not result in any excessive carcass weight loss up to 24 hours after removal from the store nor did it result in meat of poor eating quality.

Retaining prime lambs on the farm for a further three months feeding mainly on autumn grass was increased carcass weight and pelt value and did not seriously reduce carcass cut-out value or lean percentage in the Best Neck or Neck Lap, but it did significantly increase the percentage of fat in these joints and joint size.

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CHAPTER IV

SUMMARY

(i) AIM OF INVESTIGATION

An investigation has been made of the carcass quality of 'prime' home-bred lambs retailed fresh in August and similar lambs blast-frozen at that time, stored and retailed in February or retained on the farm, grass-fed and retailed fresh in November. The carcass quality of the frozen home-bred lamb has also been compared with that of New Zealand No. 2 carcasses and with fresh mutton from 'root-fed' hoggets, retailed in February.

(ii) ORIGIN OF CARCASSES

The investigation involved 80 home-bred lambs (twenty per type) and 20 New Zealand No. 2 lamb carcasses. The home-bred stock comprised equal numbers of Clun Forest and Suffolk X Greyface lambs. The fresh and frozen August lambs and the November hoggets were selected at random from a group of 60 prime lambs in August. The February hoggets were smaller store lambs selected from the same flocks at the same time.

(iii) CARCASS QUALITY PARAMETERS

Carcass quality has been defined with respect to:

(*a*) the visual appearance and shape of the carcasses;
(*b*) internal and external linear measurements;
(*c*) joint proportions and cut-out value;
(*d*) the tissue composition of Best Neck and Neck Lap;
(*e*) the cooking characteristics and eating quality of the meat.

(iv) CARCASS CHARACTERISTICS OF DIFFERENT TYPES OF LAMB

(*a*) *Comparison of August Lambs and November Hoggets*

Carrying the lambs to heavier weights as hoggets increased the fatness of their carcasses but not to an excessive extent as judged by visual appraisal and though they had a higher proportion of Lap and Kidney fat the net effect on cut-out value was small and not significant. The greater fatness of the Best Neck and Neck Lap in the hoggets was largely offset by a reduction in the proportion of bone in these joints and the proportion of lean was only slightly and not significantly less in the hoggets than the lambs.

The Cluns were fatter than the Suffolk-crosses both as lambs and hoggets, but the increase in fatness in the older lambs was greater in the Suffolk-crosses than the Cluns except with respect to Kidney and Channel fat which increased relatively more in the latter. The greater fatness of the Cluns was not associated with any significant differences between the breeds in carcass proportions, except with respect to Kidney and Channel fat. It was associated however, with a lower percentage of lean in the Best Neck and Neck Lap in the Cluns than the Suffolk-crosses.

There were no significant differences between ewes and wethers.

(*b*) *Comparison of Frozen August Lambs and Fresh February Hoggets*

These slowly grown hoggets had on average almost 5 lb. heavier carcasses than the prime lambs but were similar in fatness, though more variable in both these respects. They score slightly higher on visual appraisal but were not different in carcass shape, joint proportions or cut-out value. Their joints were similar to those of the lambs in their ratio of lean to fat and only slightly higher in ratio of lean to bone.

There was a marked breed difference in the hoggets, the Cluns being lighter and less fat than the Suffolk-crosses.

(*c*) *Comparison of Frozen August Lambs (Home-Bred) and New Zealand No. 2 Carcasses*

The New Zealand carcasses were considerably lighter but much fatter than those of the prime home-bred lamb, and were considered near optimum in all respects on visual appraisal. The two types differed little in shape on the basis of carcass measurements, but the New Zealand lamb had a smaller eye-muscle and more fat cover.

There were no major differences in joint proportions or bone content and cut-out value was similar for both the home-bred and the New Zealand lamb. The Best Neck and Neck Lap of the New Zealand lamb had a considerably but not significantly lower lean content, associated particularly with a relatively higher content of fat and to a less extent a lower lean/bone ratio.

(*d*) *Comparison of Fresh and Frozen August Lambs*

The home-bred lambs retailed fresh and those retailed frozen were not significantly different in weight or composition. Freezing appeared to increase the subcutaneous fat depth of the lambs and the New Zealand method of dressing the fore-limbs reduced the proportion of Scrag. The frozen carcasses lost 1 lb. weight (almost 2.5%) during blast-freezing, six months cold storage and 24 hours thawing. Three quarters of this loss occurred during blast-freezing.

(*e*) *Comparison of November and February Hoggets*

The February hoggets were lighter and less fat than the November hoggets, but had similar mean visual appraisal scores, proportions of bone-in joints and cut-out values. They had leaner Best Necks and Neck Laps.

There was a marked breed x type interaction, the Cluns being fatter than the Suffolk-crosses as November hoggets but lighter and less fat as slowly grown February hoggets.

(v) The Cooking and Eating Quality of Meat from Different Types of Lamb

(*a*) *Comparison of August Lamb and November Hogget*

The lamb lost less weight during cooking than the hogget mutton, though there was no difference in cooking time. The hogget muscle had a considerably greater resistance to shear.

(*b*) *Comparison of Frozen August Lamb* (*Home-Bred*), *Fresh February Hogget and New Zealand No. 2 Carcasses*

There were no significant differences between the three types in cooking time, cooking loss or resistance to shear. On taste panel evaluation home-bred August lamb compared well with the New Zealand lamb in eating quality and was considered to be more tender. The frozen August lamb was also more tender than the fresh hogget and preferred to it for quality of flavour.

(vi) Discussion of Differences in Carcass Characteristics

The difference between types and breeds in carcass characteristics have been discussed in relation to variation in carcass weight and fatness. The results were in general agreement with published information on these relationships. However only a minor proportion of the total variation in cut-out value was associated with variation in carcass weight and fatness, 8.4% and 4.0% respectively, on the basis of pooled information on all types of lambs, though within types 13-21% of the variation in cut-out value was associated with variation in carcass weight and in four out of the five types cut-out value declined by 1.1d.–1.7d. with each 10 lb. increase in carcass weight.

(vii) Discussion of the Commercial Implications of the Results of this Investigation

In absence of any differences between the various types that markedly or significantly influenced cut-out value attention was focused on differences that might influence the acceptability of the meat to the consumer.

Comparing the August lamb and November hogget, it was suggested that only differences in joint size, with respect to the shoulder, and possibly the proportion of fat in the joints might be likely to reduce the acceptability of the hogget. Differences in eating quality are likely to pass unnoticed by the consumer.

Comparing the frozen home-bred lamb with New Zealand, carcasses differences in joint size would seem to be small but span what may be a critical price of ten shillings. The better shape of the New Zealand legs and loins on the one hand and the greater leanness of the home-bred lamb on the other may have opposing effects on the acceptability of joints from the two types. The results of the tasting panel evaluation are considered to indicate that both are of similar and acceptable eating quality.

There were no commercially important differences between frozen August lamb and fresh February hogget, except that under current conditions the meat trade and presumably the meat buying public is prepared to pay much less for frozen lamb than for fresh lamb. The effect of this was to reduce the price realised by frozen August lamb in February to 9d./lb. below that available for fresh lamb in August and this together with the costs of freezing and storage at rather more than 3d./lb., resulted in a total reduction in return of approximately £2 per lamb.

Compared with this the retention of prime lambs on the farm for grass-feeding and sale as hoggets in November increased the margin obtained by both producer and meat trader, but there may have been some reduction in the saleability of the meat.

Finally attention was drawn to the contrast between the apparent uniformity of New Zealand lamb on visual appraisal and the evidence that the selected group of New Zealand lambs was no more uniform than the selected groups of home-bred lambs and November hoggets in carcass weight, cut-out value and joint composition. It was suggested that apparent uniformity on visual appraisal is associated with their even cover of subcutaneous fat which may be improved in appearance by the freezing process.

(viii) CONCLUSIONS

There were no differences in joint proportions and cut-out value between the different types of lamb. The frozen home-bred lambs were leaner than the New Zealand No. 2 carcasses and their meat was more tender. Freezing resulted in only a small weight loss (2.5%) and did not seriously reduce the eating quality of the lamb compared with fresh February hogget. Retaining prime lambs on the farm for a further three months feeding increased carcass weight and pelt value and did not markedly reduce cut-out value or lean percentage

APPENDIX I

1. Procedure for Visual Appraisal of Carcasses

On separate occasions 6-7 hours after slaughter the carcasses of Group I and II, Group III and Group IV lambs were hung in line on 9″ gambrels and a visual appraisal of the 'finish' [1] 'fullness of leg' and 'fullness of loin' of each carcass was carried out by the same experienced meat buyer. Each characteristic was scored in turn for each carcass. The judge was instructed to give 5 marks for optimum development of any characteristic and to rate carcasses 1-5 for 'fullness of leg' and 'fullness of loin'. For 'finish he was asked to rate carcasses 1-5 and over, a score greater than 5 indicating that the carcass carried excessive finish'.

The New Zealand lamb was appraised separately in the same way when it was removed from freeze.

1 'finish' was taken to be the evenness and depth of fat cover on the carcass.

2. Procedure for Carcass Measurement

All measurements were made to the nearest mm.

External measurements on the hanging cold carcass

Shoulder Width	(W)	Using steel calipers; the maximum width across the shoulders from the elbow.
Shoulder Depth	(D)	Using steel calipers; the maximum depth of the shoulders.

Internal measurements on the hanging left side

Side Length	(CT)	Using steel tape; measured from the anterior edge of the *symphysis pubis* of the pelvis to the middle of the anterior edge of the 1st rib.
Chest Depth	(LS)	Using steel tape; measured from the middle of the ventral edge of the 7th thoracic vertebra to the posterior edge of the bone tip of the last sternebra.
Leg Length	(CA)	Using steel tape; measured from the anterior edge of the *symphysis pubis* of the pelvis to the inner edge of the proximal sesamoid at the distal edge of the tibia.
Leg Thickness	(CG)	Using steel tape; measured from the anterior edge of the *symphysis pubis* of the pelvis to the distal, cut edge of the subcutaneous fat, along the line to the inner edge of the proximal sesamoid at the distal edge of the fibia.
Rib Flesh Depth	(S)	Using steel probe; inserted between the 6th and 7th ribs, from ventral to dorsal surface, 1/3rd of the distance along the ribs from the inferior surface of the vertebra to the superior surface of the sternebra.
Loin Flesh Depth	(MN)	Using steel probe; inserted at the 4th lumbar vertebra parallel to the cut section of the vertebra from dorsal surface of the flesh to the transvers process, a distance PQ from the midline.

Internal Measurements at the posterior cut surface of the 12th Rib

Eye-Muscle Width	(A)	Using steel rule; the maximum distance across the *Longissimus dorsi muscle.*
Eye-Muscle Depth	(B)	Using steel rule; the maximum depth of the *Longissimus dorsi* muscle at right angles to line A.
Fat Depth over the Eye-Muscle	(C)	Using steel tape; measured over the deepest part of *Longissimus dorsi*; extension of line B.
	(D)	Using steel tape; measured minimum depth of fat over *Longissimus dorsi.*

Expressed as Mean Fat Depth: $\frac{C + D}{2}$

Fig. 1

DIAGRAM OF LOIN FLESH DEPTH MEASUREMENT (MN) — *after Yeates (1952)*

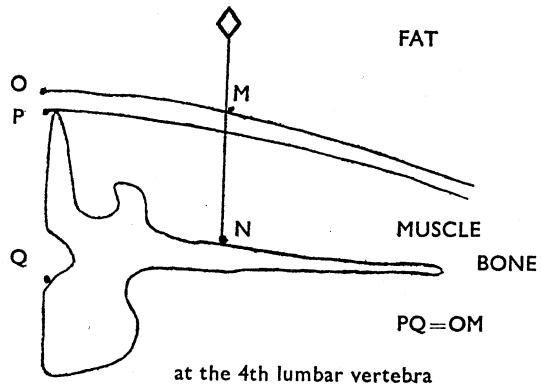
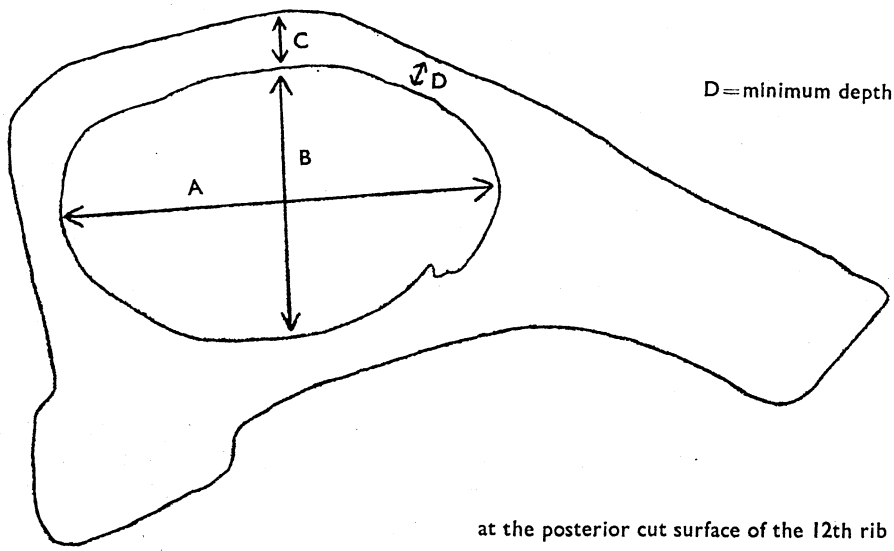


Fig. 2

EYE-MUSCLE MEASUREMENTS



3. Procedure for Jointing

1. The sides were separated in fore and hind-quarters by a cut between the 12th and 13th rib. The point of cutting was located from the inside and the cut passed at right angle to and through the vertebral column and passed down to the ventral edge of the flank following the posterior surface of the 12th rib.

Left Sides—Bone-in Joints

Hindquarter: The kidney and kidney fat remained in the hindquarter.

2. The Kidney 'Knob' was lifted and severed in the pelvic region in the normal commercial manner. The kidney was then removed from the peri-nephric fat (kidney fat). The retro-peritoneal fat (channel fat) remaining in the pelvic channel was then removed.
3. The Leg was removed by a cut 1″ anterior to the *symphysis pubis* of the pelvis and passing between the last sacral and first caudal vertebra.
4. The Loin Lap was separated from the Chump and Loin by a cut passing from the distal tip of the 13th rib and across the tip of the prominent muscle, leaving $\frac{1}{4}$″ of fat at this point.
5. The Chump and Loin were separated by inserting the knife between the 5th and 6th Lumbar vertebrae and cutting ventrally parallel to the other cut surface of the Chump.

Forequarter

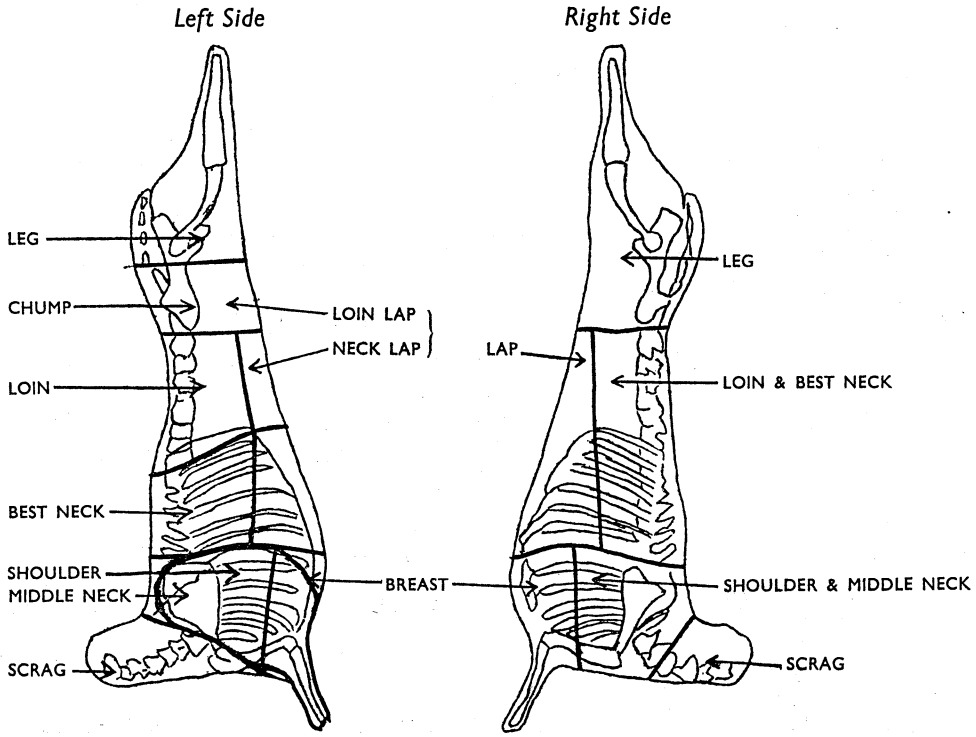
6. The Best Neck was separated from the remainder of the fore-quarter by a cut starting between the 6th and 7th ribs and passing up through the vertebral column and down to the ventral edge of the Lap following the posterior surface of the 6th rib.
7. The Neck Lap was removed from the Best Neck by a cut starting at the mid-point of the 7th rib and passing parallel to the vertebral column and across to the tip of the 12th rib.
8. The Shoulder was removed by inserting the knife close to the 'cartilage' end of the scapula and severing the muscles attaching the shoulder to the sternum. Traction was applied to the limb and a circular cut was made along the outline of the scapula continuing around the neck, and then around the remainder of the shoulder. Applying further pressure on the limb, the shoulder was raised and freed from its loose attachment on the ribs; the knife blade was then pressed down towards the neck to sever the trapezius and brachiocephalus muscles.
9. The Scrag was removed from the Middle Neck and Breast by a cut following the anterior edge of the 1st rib.
10. The Breast was separated from the Middle Neck by a cut passing across the ventral tip of the 1st rib and 2/3 of the distance down the 6th rib.

Right Sides—'Bone-out' Joints

1. The sides were separated into fore and hind-quarters by a cut between the 6th and 7th ribs and following the posterior surface of the 6th rib, as in cut 6—Left Side.
2. The Kidney, Kidney fat and Channel fat were removed as described in cut 2—Left Side.

3. The Leg was removed by a cut starting between the last lumbar and first sacral vertebra and passing ventrally parallel to the cut surface of the 7th rib. This joint was then boned out and excess fat was trimmed.
4. The Lap was separated from the Loin and Best Neck by a cut starting at the mid-point of the 7th rib and passing posteriorly parallel to the vertebral column, similar to cuts 4 and 7—Left Side. These joints were not boned or trimmed.
5. The Breast was separated from the remainder of the fore-quarter by a cut passing across the ventral tips of the 1st and 6th ribs. This joint was not boned or trimmed.
6. The Scrag was separated from the Shoulder by a cut passing between the 4th and 5th Cervical verterbrae. This joint was not boned or trimmed.
7. The Shoulder, which included the Middle Neck, was then boned out and excess fat was trimmed.

Fig. 3 JOINTING OF LAMB SIDES



Score Card used in the Tasting Panel Evaluation of the Eating Quality of Lamb

LAMB TASTE PANEL

Score Card

NAME .....

DATE .....

TIME .....

You are offered three samples of lamb.

1. Assess the *intensity* of FLAVOUR of the three samples.

SAMPLE	(1) Order of Preference	Rating	1 No Flavour	2 Slight Flavour	3 Moderate Flavour	4 Full Flavour	5 Strong Flavour
.....	.....	.....					
.....	.....	.....					
.....	.....	.....					

2. Assess the JUICINESS of the three samples.

SAMPLE	(1) Order of Preference	Rating	1 Not Juicy	2 Slightly Juicy	3 Moderately Juicy	4 Very Juicy	5 Extremely Juicy
.....	.....	.....					
.....	.....	.....					
.....	.....	.....					

3. Assess the TENDERNESS of the three samples.

SAMPLE	(1) Order of Preference	Rating	1 Not Tender	2 Slightly Tender	3 Moderately Tender	4 Very Tender	5 Extremely Tender
.....	.....	.....					
.....	.....	.....					
.....	.....	.....					

4. Comment on any other characteristics of this meat that influenced your eating satisfaction.

SAMPLE		
.....	.....	.....
.....	.....	.....
.....	.....	.....

(1) The order of preference should be indicated 1, 2, 3; but if there are no differences between some samples =1, =1, =1, or =1, =1, 2 or 1, =2, =2, may be used.

APPENDIX II

SUMMARY TABLE 1. **Type—Carcass weight, Fatness, Visual appraisal scores and Carcass shape**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
CHARACTERISATION					
Carcass Weight (lb.)	39.45±0.40	40.46±0.65	51.75±0.67	45.12±1.27	33.68±0.52
(1) Fatness (%)	31.60±1.30	34.62±1.84	44.19±1.22	34.69±2.04	43.10±1.80
VISUAL APPRAISAL (optimum score 5)					
'Finish' Carcass	4.05±0.14	4.15±0.13	4.55±0.14	4.50±0.19	5.20±0.09
'Fullness' of Loin	3.75±0.18	4.00±0.15	4.55±0.14	4.33±0.16	5.00±0.00
'Fullness' of Leg	3.90±0.16	4.10±0.14	3.90±0.14	4.22±0.17	4.90±0.07
CARCASS SHAPE					
Carcass Length (mm.)	59.28±0.54	59.43±0.19	61.85±0.35	61.31±0.54	53.39±0.37
Weight Length ratio	0.67±0.01	0.68±0.003	0.84±0.03	0.74±0.02	0.63±0.03
Chest Depth (mm.)	17.27±0.21	17.26±0.16	19.15±0.21	19.12±0.19	15.47±0.22
Depth/Length ratio	0.29±0.04	0.30±0.01	0.31±0.02	0.31±0.03	0.29±0.03
Shoulder Depth (mm.)	24.49±0.20	24.01±0.25	27.55±0.12	27.09±0.31	22.98±0.15
Shoulder Width (mm.)	18.95±0.25	18.80±0.26	21.45±0.17	22.01±0.24	18.92±0.25
Width/Depth ratio	0.78±0.01	0.78±0.01	0.78±0.08	0.81±0.07	0.82±0.01
Leg Length (mm.)	36.86±0.20	37.43±0.30	39.29±0.31	38.46±0.27	33.81±0.26
Leg Thickness (mm.)	10.45±0.16	11.76±0.15	12.58±0.24	11.87±0.26	10.97±0.15
Thickness/Length ratio	0.29±0.005	0.31±0.004	0.32±0.007	0.31±0.02	0.33±0.02

(1) Per cent fat in Best Neck.

SUMMARY TABLE 2. **Type—The Development of the Eye-muscle, Fat depth over the Eye-muscle and Flesh depth between the ribs and over the loin**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
EYE-MUSCLE (12th Rib)					
Width (mm.)	6.00±0.09	5.93±0.10	5.78±0.09	6.08±0.07	5.25±0.10
Depth (mm.)	2.70±0.10	2.55±0.08	3.08±0.06	2.87±0.06	2.48±0.06
Width x Depth ($mm.^2$)	16.18±0.65	15.07±0.50	17.77±0.43	17.41±0.33	12.95±0.33
Mean Fat Depth (mm.)	0.41±0.04	0.71±0.07	0.69±0.07	0.61±0.06	0.85±0.05
FLESH DEPTH					
Rib (mm.)	2.05±0.07	2.68±0.14	4.38±0.15	3.21±0.17	3.21±0.13
Loin (mm.)	3.07±0.09	3.11±0.11	3.70±0.07	3.07±0.14	3.16±0.11

SUMMARY TABLE 3. **Type—The Weights of Bone-in Joints (lbs.)**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Left Side	19.77±0.25	19.40±0.31	25.36±0.34	22.73±0.67	16.69±0.27
Leg	5.04±0.07	4.79±0.10	6.07±0.08	5.40±0.12	4.08±0.04
Shoulder	3.81±0.05	3.80±0.07	4.87±0.07	4.33±0.12	3.25±0.05
Chump	1.46±0.04	1.54±0.02	1.80±0.04	1.75±0.06	1.21±0.04
Loin	2.05±0.07	2.21±0.08	2.91±0.07	2.45±0.10	1.81±0.05
Best Neck	1.42±0.04	1.37±0.02	1.84±0.06	1.73±0.06	1.34±0.03
Middle Neck	1.56±0.05	1.74±0.05	2.12±0.06	2.00±0.08	1.51±0.04
Scrag	1.14±0.04	0.72±0.04	1.24±0.06	0.98±0.05	0.65±0.04
Loin Lap	0.59±0.02	0.61±0.03	0.92±0.04	0.74±0.04	0.59±0.03
Neck Lap	0.95±0.03	1.01±0.03	1.45±0.05	1.18±0.05	0.88±0.03
Breast	1.01±0.03	1.10±0.03	1.32±0.03	1.32±0.05	0.94±0.03
Kidney & Channel Fat	0.56±0.03	0.64±0.07	0.96±0.06	0.79±0.07	0.57±0.05
Cut-up Weight	19.59	19.53	25.50	22.67	16.83

SUMMARY TABLE 4. **Type (2)—Bone-in Joint proportions (as a per cent of side weight)**

Group Treatment		I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Side Weight	(lb.)	19.78±0.24	19.40±0.31	25.36±0.34	22.73±0.67	16.69±0.27
Leg	(%)	25.53±0.30	24.73±0.42	23.97±0.26	23.92±0.53	24.54±0.30
Shoulder	(%)	19.29±0.22	19.66±0.38	19.22±0.18	19.06±0.16	19.51±0.20
Chump	(%)	7.39±0.16	7.98±0.12	7.09±0.15	7.70±0.15	7.27±0.18
Loin	(%)	10.34±0.32	11.37±0.33	11.45±0.19	10.75±0.25	10.83±0.24
Best-Neck	(%)	7.20±0.19	7.09±0.12	7.29±0.23	7.59±0.12	8.01±0.12
Middle Neck	(%)	7.87±0.21	9.01±0.25	8.40±0.23	8.82±0.29	9.04±0.23
Scrag	(%)	5.75±0.19	3.75±0.19	4.87±0.19	4.29±0.17	3.86±0.20
Loin lap	(%)	2.99±0.12	3.14±0.12	3.61±0.14	3.26±0.11	3.55±0.15
Neck lap	(%)	4.82±0.12	5.20±0.12	5.71±0.15	5.20±0.17	5.26±0.15
Breast	(%)	5.13±0.12	5.68±0.14	5.23±0.12	5.80±0.09	5.63±0.14
Kidney & Channel Fat	(%)	2.83±0.14	3.34±0.36	3.75±0.23	3.40±0.25	3.40±0.22
Total	(%)	99.72	99.95	100.59	99.79	100.90

SUMMARY TABLE 5. **Type— The Value of Joints at Standard Prices (Shillings)**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Leg	25.22±0.37	23.96±0.50	30.36±0.39	26.98±0.58	20.42±0.21
Shoulder	15.82±0.19	15.79±0.29	20.22±0.31	17.95±0.49	13.49±0.18
Chump	7.31±0.18	7.72±0.10	8.99±0.23	8.74±0.30	6.07±0.19
Loin	10.23±0.35	11.06±0.41	14.54±0.36	12.25±0.51	9.05±0.26
Best Neck	6.91±0.21	6.66±0.12	8.95±0.29	8.39±0.31	6.49±0.15
Middle Neck	5.23±0.17	5.84±0.15	7.12±0.19	6.70±0.26	5.05±0.15
Scrag	1.88±0.07	1.19±0.06	2.05±0.09	1.62±0.09	1.07±0.06
Loin Lap	0.80±0.03	0.82±0.03	1.24±0.05	1.00±0.05	0.79±0.04
Neck Lap	1.29±0.04	1.36±0.04	1.96±0.06	1.60±0.07	1.18±0.04
Breast	0.86±0.02	0.94±0.03	1.12±0.03	1.12±0.04	0.80±0.02
Kidney & Channel Fat	0.19±0.01	0.23±0.02	0.32±0.02	0.26±0.03	0.19±0.01
Total Side Value	75.74	75.57	96.87	86.61	64.60
Cut-out Value/lb.	3.83±0.08	3.88±0.04	3.82±0.09	3.83.±0.08	3.87±0.07

SUMMARY TABLE 6. **Type—Retail Value of Joints at Variable Prices (Shillings)**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Leg	25.22	19.96	30.36	25.20	17.00
Shoulder	15.82	11.40	20.22	15.16	9.75
Chump	7.31	6.42	8.99	8.17	5.04
Loin	10.23	9.21	14.54	11.43	7.54
Best Neck	6.91	5.71	8.95	7.79	5.58
Middle Neck	5.23	4.64	7.12	6.67	4.03
Scrag	1.88	0.96	2.05	1.63	0.87
Loin & Lap	0.88	0.61	1.24	0.99	0.59
Neck Lap	1.29	1.01	1.96	1.57	0.88
Breast	0.86	0.55	1.12	1.32	0.47
Kidney & Channel Fat	0.19	0.21	0.32	0.26	0.19
Total Side Value	75.74	60.68	96.87	80.19	51.94
Retail Value/lb.	3.83	3.13	3.82	3.53	3.11

SUMMARY TABLE 7. **Type—Joint proportions in the Right Side [1] (as a per cent of side weight)**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
Side Weight (lb.)	19.05±0.19	19.38±0.34	25.49±0.34	22.08±0.61	16.82±0.26
Rolled Leg (%)		24.76±0.47		25.89±0.52	24.86±0.32
Loin & Best Neck (%)	19.12±0.23	18.20±0.52	18.81±0.20	18.24±0.33	18.66±0.42
Rolled Shoulder (%)		24.67±0.42		24.87±0.45	25.18±0.40
Lap (%)	6.20±0.14	6.47±0.14	8.28±0.15	7.18±0.25	7.12±0.19
Breast (%)		3.19±0.11		3.20±0.16	3.31±0.16
Scrag (%)		2.09±0.11		2.40±0.11	1.85±0.16
Fat (%)		4.14±0.36		4.10±0.28	3.83±0.25
Bone (%)		15.90±0.40		14.63±0.38	15.29±0.40
Total (%)		100.42		100.51	100.10

[1] Leg and Shoulder boned-out.

SUMMARY TABLE 8. **Type—The Tissue composition of Best Neck and Neck Lap (as a per cent of joint weight)**

Group Treatment	I Fresh August Lamb	II Frozen August Lamb	III Fresh November Hogget	IV Fresh February Hogget	V New Zealand No. 2's
BEST NECK					
Lean (%)	43.68±0.99	45.35±1.34	40.45±0.78	47.13±1.24	38.55±1.16
Fat (%)	31.60±1.30	34.62±1.84	44.19±1.22	34.69±2.04	43.10±1.80
Bone (%)	22.07±0.90	19.32±0.73	14.09±0.54	18.72±1.01	18.70±0.86
Lean/Bone ratio	2.04±0.09	2.38±0.07	2.95±0.12	2.61±0.11	2.12±0.08
Lean/Fat ratio	1.44±0.09	1.43±0.13	0.94±0.04	1.47±0.12	0.95±0.07
Subcutaneous fat (%)	20.37±3.12	21.33±1.35	28.69±1.14	34.11±1.29	27.73±0.70
Subcutaneous Fat as % total Fat	64.68±0.28	61.08±1.42	65.01±1.35	63.03±0.63	64.21±1.30
NECK LAP					
Lean (%)	46.12±1.05	45.50±1.75	40.97±1.27	45.79±1.83	39.43±1.43
Fat (%)	39.78±1.42	42.19±2.01	48.13±0.98	43.13±2.22	48.57±1.84
Bone (%)	12.79±0.48	14.04±0.44	10.65±0.40	12.02±0.48	13.34±0.47
Lean/Bone ratio	3.67±0.12	3.26±0.11	3.92±0.15	3.82±0.08	2.99±0.11
Lean/Fat ratio	1.21±0.07	1.17±0.10	0.86±0.04	1.15±0.11	0.85±0.07

SUMMARY TABLE 9. **Scoring by Individual Panellists of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand Lamb' for degree of flavour, juiciness and tenderness (maximum score 5)**

Group	II	IV	V
Treatment	Frozen August Lamb	Fresh February Hogget	New Zealand No. 2's
PANEL MEMBER			
NUMBER OF SAMPLES			
1	15	13	15
2	14	12	14
3	20	18	20
4	20	18	20
5	19	17	19
6	20	18	20
DEGREE OF FLAVOUR (Ranking)			
1	3.0 (2)	3.3 (1)	2.9 (3)
2	3.5 (1=)	3.5(1=)	3.4 (3)
3	2.1 (1)	1.8 (3)	2.0 (2)
4	2.6 (1)	2.0 (3)	2.3 (2)
5	2.3 (2)	2.4 (3)	2.5 (1)
6	2.5 (1)	2.4 (2)	2.3 (3)
Mean	2.67±0.21	2.57±0.28	2.57±0.21
DEGREE OF JUICINESS (Ranking)			
1	2.3 (2)	2.4 (1)	2.0 (3)
2	2.4 (3)	2.8 (1)	2.6 (2)
3	2.9 (1=)	2.9 (1=)	2.6 (3)
4	2.0 (2)	2.3 (1)	1.7 (3)
5	2.8 (1=)	2.8 (1=)	2.6 (3)
6	2.4 (1)	2.2 (2)	2.1 (3)
Mean	2.47±0.14	2.57±0.12	2.27±0.16
DEGREE OF TENDERNESS (Ranking)			
1	3.9 (2)	3.8 (3)	4.0 (1)
2	4.5 (1)	3.8 (3)	4.1 (2)
3	4.8 (1)	3.8 (3)	4.6 (2)
4	3.7 (1)	2.9 (3)	3.2 (2)
5	3.9 (1)	3.0 (3)	3.3 (2)
6	3.1 (1)	2.5 (3)	3.0 (2)
Mean	3.98±0.08	3.30±0.07	3.70±0.06

SUMMARY TABLE 10. **Scoring by Individual Panellists of 'Frozen August Lamb', 'Fresh February Hogget' and 'New Zealand Lamb' for their order of preference with respect to flavour, juiciness and tenderness (Scores 1st, 2nd or 3rd)**

Group	II	IV	V
Treatment	Frozen August Lamb	Fresh February Hogget	New Zealand No. 2's
PANEL MEMBER			
NUMBER OF SAMPLES			
1	15	13	15
2	14	12	14
3	20	18	20
4	20	18	20
5	19	17	19
6	20	18	20
PREFERENCE FOR FLAVOUR (Ranking)			
1	2.06 (2=)	1.61 (1)	2.06 (2=)
2	1.93 (2)	2.08 (3)	1.85 (1)
3	1.95 (2)	2.00 (3)	1.75 (1)
4	1.75 (1)	1.83 (2)	1.95 (3)
5	1.84 (2)	2.18 (3)	1.58 (1)
6	1.80 (2)	2.33 (3)	1.65 (1)
Mean	1.89±0.05	2.01±0.10	1.81±0.07
PREFERENCE FOR JUICINESS (Ranking)			
1	2.06 (2=)	1.61 (1)	2.06 (2=)
2	1.93 (3)	1.75 (1)	1.79 (2)
3	1.70 (1)	2.17 (3)	2.00 (2)
4	2.00 (3)	1.61 (1)	1.95 (2)
5	1.63 (1)	1.95 (3)	1.93 (2)
6	1.75 (1)	2.00 (2=)	2.00 (2=)
Mean	1.85±0.07	1.85±0.09	1.96±0.04
PERFORMANCE FOR TENDERNESS (Ranking)			
1	1.60 (1)	1.70 (3)	1.66 (2)
2	1.50 (1)	2.16 (3)	1.86 (2)
3	1.65 (1)	2.33 (2)	1.75 (2)
4	1.85 (1)	1.89 (2)	2.10 (3)
5	1.47 (1)	2.11 (3)	1.73 (2)
6	1.65 (1)	2.33 (3)	1.90 (2)
Mean	1.62±0.06	2.09±0.10	1.83±0.06

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