SIGNIFICANT FACTORS IN THE DETERMINATION OF CARCASS QUALITY IN LAMB

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE

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A THESIS

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WILLIAM A. LJUNGDAHL

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SIGNIFICANT FACTORS IN THE DETERMINATION OF CARCASS QUALITY IN LAMB

Introduction

Animal Husbandmen have long had quite definite ideas regarding the more important factors in determining the value of lambs, either on foot or in the carcass. There is, however, a lack of specific information as to what factor or factors are the most accurate basis for such work. It is, therefore, the purpose of this study to try to arrive at some more definite criteria whereby the true value of the lamb carcass may be determined.

At the present time carcass grade is determined by general excellence with respect to such factors as form, or shape of body; finish or fatness; and quality. The quality is determined by the color and texture of the fat, lean, and bone, as well as by smoothness and refinement in general.

"Type", as defined by Vaughan (12), is "an ideal or standard of perfection, combining all the characteristics which contribute to the animal's value and efficiency for the purpose specified", and is the standard upon which our breeding animals are selected. These standards are, and to a large extent, should be determined by the requirements for the most desirable carcass, as well as by efficiency from a production standpoint.

There are among the several breeds considerable differences in the appearance of the carcass. It is necessary, therefore, to prove very carefully the advantages of one type of carcass over another before any definite standards can be set up to compare either breeds or animals

of different types. Any method of predicting the percentage of the various wholesale cuts and a more accurate system of grading would be extremely beneficial to the producer as well as to the meat retailer.

This study is limited to the correlation and relationship of certain carcass characteristics and does not include any feeding or management studies. An effort was made to find specifically what factors are the most significant in the determination of the proportion of wholesale cuts and the carcass value.

Review of Literature

A number of investigators in this country as well as in England, Scotland, and South Africa have made studies comparing various breeds of sheep as to carcass characteristics. There is a great difference in the type of these various breeds and in making these comparisons certain carcass relationships have been shown.

Branaman (3), in comparing the Southdown and Hampshire breeds at Illinois, indicated that the difference in the total percentage of the four most valuable cuts (namely: leg, loin, hotel rack and shoulder) was very small and not statistically significant in these two breeds. The fatness of the lambs varied considerably, and with an increase in fatness, the proportion of lean decreased. There was a significant difference in percentage of bone in the two breeds. The average difference in area of the eye muscle (a cross-section of the longissimus dorsi) measured in square inches, was not statistically significant in the two breeds, but there was a marked difference in the carcass weight of the two breeds. Correlations were high between area of eye muscle and weights of the following parts when Hampshires and Southdowns were considered as one group: right half carcass, lean in the half carcass, loin eye muscle, loin lean, and rib eye muscle. No consistent difference was noted in any of these animals in the color of the lean meat when examined with the spectrophotometer.

Both physical and chemical analyses of the carcasses of the two breeds showed a similar average degree of finish, and although the Southdowns averaged slightly higher in ether extract and dry matter, the difference was not significant. This work would indicate that comparisons

of these factors can be made irrespective of breed if the lambs are of similar finish. Branaman also points out in his work that from an economic standpoint lambs reaching the proper slaughter weight early in the summer have some advantage in market price. Rather than market unfinished lambs early in the season, this advantage in price may be partially off-set by a higher market grade when the lambs become finished later in the summer.

In predicting the live weight of steers, Barton (1) points out that there is some correlation with certain body measurements in cattle weighing between 200 and 1,000 pounds. He does not advocate this method of weight prediction. It is doubtful if such correlations would be of value in predicting lamb weights due to their relatively light market weight of from 75 to 100 pounds. An individual with experience and practice can usually estimate weight "by the eye" and "by the touch" with considerable accuracy.

In "The Report of The Review Committee on Cooperative Meat Investigations" (10), under "Grades and Measures", the firmness grade of fat on the lamb carcass showed a high negative correlation with the amount of moisture in the tissue. The amount of fat in the tissues, rather than the character of the fat determined the firmness of the fat grade under the ordinary feeding conditions studied.

The cutting yields in relation to carcass weight and grade showed that the cuts with more natural lean and bone make up a decreasing percentage as lambs increase in weight and grade. When grades and weights were constant, there were no consistent differences in cutting yields of mutton-type and Rambouillet lambs.

A number of lamb grading relationships were determined in that

study. The method of obtaining the correlations and the point of significance were not given. Correlations between:

Composite slaughter and carcass grade	+ 0.83 ± 0.005
Live and carcass grade for width of body	+ 0.84 ± 0.005
Live and carcass grade for thickness of finish	+ 0.80 ± 0.006
Live and carcass grade for plumpness of leg	+ 0.82 ± 0.006
Composite live grade and width of body	+ 0.97 ± 0.001
Composite live grade and thickness of finish	+ 0.98 ± 0.001
Composite live grade and plumpness of leg	+ 0.97 ± 0.001
Composite carcass grade and width of body	+ 0.96 ± 0.001
Composite carcass grade and thickness of fat	+ 0.97 ± 0.001
Composite carcass grade and plumpness of leg	+ 0.96 ± 0.001

Correlation coefficients between such other factors as carcass grade with weight of rib eye, rate of gain, and tenderness, ranged from ± 0.1 to ± 0.3. The above-mentioned study was a grouping of the results of a number of individual experiments which included 1,547 lambs.

The consuming public is guided to a considerable extent by the eating quality of the carcass, which is determined by tenderness and flavor. In Reference 44 (10) in the tenderness ratings reported by the palatability committee no correlation above 0.40 was given with any item except tenderness as judged by the mechanical shear. Murphey (9) discussing the effect of fatness on the tenderness of lamb, states that it does not seem that fatness in itself is a good measure of the tenderness of lamb. He suggests that fatness cannot be discarded because of its effect on other palatability factors, and that certain inherited character-

istics may have an effect on tenderness.

Hirzel (7) drew a number of conclusions relative to the muscle, fat and bone in the lamb carcass. The cannon bone showed a variable length measurement with increase in carcass weight, indicating that bone growth is not a weight determining factor at any one age. A long, thin bone (cannon or shank) is more objectionable than a short, thick bone. If the bone is too short and not thick enough, there is a decrease in the thickness of the muscle covering. When the proportion of fat, lean and bone was compared to weight of carcass, he found that light carcasses (28 - 30 pounds) could be obtained at the expense of finish. In heavy carcasses (over 50 pounds), there was a surplus of fat which lowered the value of the carcass.

In most cases there was a quite constant increase in muscle and fat measurements with an increase in weight. Contrary to Palsson's (8) investigations, Hirzel (7) reported that there were considerable breed differences in the width of the eye muscle. This may have been due, however, to the different breeds his work included, some of which are not found in this country. The depth of eye muscle showed greater variation than did the width. The measurement of thickness of fat over the eye muscle increased steadily with weight gain, although the greatest amount of weight was added by the increasing thickness of fat over the ribs.

In discussing the growth and development of the sheep, Hammond (5 and 6) stated that although the percentage of fat, lean and bone in the carcass can be predicted accurately from the composition of the leg, the shoulder corresponds more closely to the composition of the carcass as a whole than does any other cut.

Palsson (8) in studying meat quality in sheep at Edinburgh found

that as an index of muscle, external factors are only of indirect value. The weight of the forecannon can be used as an index of bone weight of the skeleton. His results duplicated those of Hammond (5 and 6) in predicting the percentage of fat, lean and bone in the carcass from the percentages found in the leg.

Workers in the Bureau of Animal Industry (11) found a correlation of + 0.98 between the fat (ether extract) content of the edible portion of the lamb carcass and the similar content of the edible portion of the nine-rib cut from the same carcasses. The same correlation value was given between the separable fat content of lamb carcasses and the separable fat content of the nine-rib cut of those carcasses. Predicting equations were developed for both of these factors. The respective equations developed were: Percentage of fat (ether extract) in the edible portion of carcass equals 3.58 plus 0.73 times the percentage of ether extract in the edible portion of the nine-rib cut, and the percentage of separable fat in the carcass equals 4.28 plus 0.72 times the percentage of separable fat in the nine-rib cut.

Objects of the Investigation

The objects of the investigation were:

1. To study the factors most closely associated with carcass grade and with the percentage yield of the wholesale cuts.

2. To determine the relative importance of width and depth of eye muscle upon its area, and to find the best predicting equation for area from these measurements.

3. To find the relation of the size of eye muscle to carcass yield.

4. To study the importance of the thickness of fat over the eye muscle.

5. To study the effect of an increase in finish on the chemical analyses of the fat and the lean from the hotel rack.

Experimental Material

This study was made during the summer of 1941. The experimental material used was taken from the Michigan State College flock, and included six breeds and crosses of sheep: five Hampshires, four Oxfords, four Shropshires, six Rambouillets, six Rambouillet X Cotswold, and seven Hampshire X (Rambouillet X Cotswold). Records were kept separately on the various breeds, but this study is a composite of the six breeds and crosses. A comparison of the breeds and crosses was made from this same experimental material, but not as a part of this study.

All of the lambs used were spring lambs, dropped during 1941, and all groups were handled similarly prior to slaughter. The lambs were creep-fed before being turned on pasture, but did not receive grain while on pasture during the early summer. Those which did not reach slaughter weight until late summer received grain after the pastures became dry.

Experimental Procedure

Periodic killings were made as the lambs approximated the weight of 85 pounds. The lambs were on pasture so it was impossible to kill them all at the same weight, but groups of from two to six as nearly alike as possible were killed together. The average of the final slaughter weights was 82½ pounds.

The lambs were all handled similarly immediately prior to slaughter, being placed in a dry-lot the evening before slaughter. The ewes were put in with them to keep the lambs from becoming too excited.

A committee of five members of the Animal Husbandry staff determined the slaughter grades the day before slaughter. After grading, it was necessary to shear the lambs to get the most accurate measurements. These measurements, as well as the carcass measurements, were made with standard measuring instruments obtained from the Bureau of Animal Industry, United States Department of Agriculture.

The lambs were weighed again in the morning, just prior to slaughtering. The weight of the shorn wool was added to this to give final slaughter weight. Standard slaughter methods were used. The head was removed at the atlas joint, the front feet at the lower breakjoint, and the hind feet at the round pastern joint. The breast bone was not split at the time of slaughter.

Carcasses were allowed to chill at temperatures of 34 - 38 degrees Fahrenheit for a period of 48 hours. They were weighed at the end of a 24-hour period and again at the end of the 48-hour period to determine the shrinkage.

Carcass grade was also determined by the same grading committee. Measurements of the carcass were then made. A uniform method of cutting

was used to divide the carcass into the so-called wholesale cuts, the weight of each cut being determined. Photographs of the hotel rack were made according to scale, showing a cross-section of the eye muscle between the eleventh and twelfth ribs. Mechanical separation was made of the hotel rack, dividing it into fat, lean and bone. Samples of the fat and the lean obtained in separating the hotel rack were analyzed chemically for percentage of water and ether extract of both the fat and the lean.

It was thought advisable to make more inclusive grading charts for both slaughter and carcass grades in this study, due to the brevity of charts now being more commonly used. For others who might use similar charts, it is suggested that a different system of numbering be used. If the grades were on a basis of 100 for the top of prime, then most correlations with grade would give positive, rather than negative results, which would be more convenient for the worker.

Average grades of the committee were used as the final grades. The grading charts appear as they were used in this study. (Charts 1 and 2). Recording sheets for both live lamb and carcass measurements were mimeographed in detail to eliminate the possibility of error. (Charts 3 and 4). Similar sheets were also used to record slaughter data (Chart 5) for cutting records and chemical analysis (Chart 6). The measuring equipment used and the points at which the measurements were made are shown in Figures I - VI.

A uniform method of cutting was used to eliminate as much as possible the variability that results in making cuts by "chance". The carcass was first divided into the saddle and the rack, leaving one rib on the hind saddle. The leg and loin were separated at the joint between

the last two lumbar vertebrae. In breaking down the rack, the breast and shank were first removed. The guide used was a line from a point one-half the distance from the midpoint of the back at the last rib to the navel, and a point two-thirds of the distance from the midpoint of the back (back of the shoulders) to the sternum, and at right angles to the shoulder arm. A nine-rib hotel rack was desired, so that cut was separated from the shoulder between the third and fourth ribs. This left a three-rib shoulder.

Area readings of the eye muscle were obtained by the use of the planimeter on the photographs taken of the hotel rack, with the surface between the eleventh and twelfth ribs being used. Area of eye was intended to include only the cross-section of the longissimus dorsi muscle and not the entire lean surface of the cut. The measurement for width of eye muscle was obtained by determining the longest distance across the rather eliptical-shaped eye muscle. The depth of eye was considered to be the longest distance obtainable at right angles to the width measurement. Some investigators have referred to "width of eye" as "length of eye" muscle. These terms may be used interchangeably but it is felt that the term "width" is less confusing and is used throughout this study.

Chemical analyses were made by members of the Experiment Station Chemistry Department for ether extract and water content of fat and lean, using the approved method outlined by the Association of Official Agricultural Chemists.

Because of the inter-relationship of certain measurements which are believed to be dependent upon each other, two or more factors were grouped together in some instances to get a more accurate relationship in analyzing the data.

SLAUGHTER LAMB GRADING CHART

Lot No.

Animal No. Date Grader

	2	4	6	8	10	12	14	16	18
FOREQUARTER									
Width Fore-Rib		Very Full			Moderately Full			Narrow	
Depth Fore-Rib		Very Deep			Moderately Deep			Shallow	
Smoothness		Very Smooth			Moderately Smooth			Rough	
MIDDLE									
Length		Very Compact			Moderately Compact			Rangy	
Width Loin		Very Wide			Moderately Wide			Narrow	
Depth		Very Deep			Moderately Deep			Shallow	
QUARTERS									
Length Rump		Very Long			Moderately Long			Short	
Width Dock		Very Wide			Moderately Wide			Narrow	
Depth Leg		Very Deep			Moderately Deep			Deficient	
QUALITY									
Smoothness		Very Smooth			Moderately Smooth			Rough & Uneven	
Refinement (Head & Bone)		Very Refined			Moderately Refined			Coarse	
FINISH									
Back		Very Thick			Moderately Thick			Thin	
Rib		Very Thick			Moderately Thick			Thin	
Dock		Very Thick			Moderately Thick			Thin	
FINAL GRADE	Prime		Choice		Good		Medium		Common

CHART I

LAMB CARCASS GRADING CHART

Lot No.
Animal No.

	2	4	6	8	10	12	14	16	18
CONFORMATION									
Compactness		Very Compact			Moderately Compact			Rangy	
Balance and Thickness of Carcass		Very Thick			Moderately Thick			Shelly	
Rack		Very Thick			Moderately Thick			Shelly	
Lcin		Very Thick			Moderately Thick			Shelly	
Leg		Very Plump			Moderately Full			Deficient	
FINISH									
Thickness of Fat		Very Thick			Moderately Thick			Thin	
Distribution		Very Uniform			Moderately Uniform			Uneven	
QUALITY									
Color of Fat		White			Creamy			Yellow - Fiery	
Firmness of Fat		Flaky			Slightly Soft			Stringy	
FINAL GRADE		Prime	Choice		Good			Medium	Common

CHART 2

CHART 3

Live Lamb Measurements

Length:

(1) Horizontal from pinbones to front of chest at base of throat..... _____

(2) Pinpoints to front edge of hooks..... _____

(3) Front edge of hooks to the last rib..... _____

(4) Pinpoints to base of neck..... _____

Width:

(1) Through the shoulder (widest point)..... _____

(2) Narrowest point just back of shoulder..... _____

(3) Loin back of last rib..... _____

(4) Loin, front of hooks..... _____

(5) Through the thurls (behind the hooks)..... _____

(6) Across the hooks..... _____

Depth:

(1) Top of shoulder to floor of chest between the front legs..... _____

(2) Just back of shoulder to bottom of chest behind the front legs..... _____

(3) Floor of chest to the ground..... _____

(4) Top of hooks to bottom of rear flank..... _____

(5) From the rear flank to the ground..... _____

CHART 4

Lamb Carcass Measurements

Width:

(1) Through shoulder..... _____

(2) Narrowest point just back of shoulder..... _____

(3) Maximum spread of rib..... _____

(4) Narrowest part of loin..... _____

(5) Legs at base of tail (Line drawn through pinbones)..... _____

Depth:

(1) Just back of shoulder to floor of chest..... _____

(2) Over loin through rear flank at narrowest point.... _____

Circumference:

(1) Heart girth..... _____

(2) Legs (Base of tail)..... _____

(3) Forerib (2/3 the distance from midpoint of back to sternum)..... _____

(4) Last rib (½ the distance from midpoint of back to navel)..... _____

(5) Leg at bottom of twist..... _____

(6) Leg (3/4 the distance from breakjoint above hock to patella)..... _____

(7) Foreleg (3/4 distance from breakjoint above pastern to point of elbow)..... _____

Length:

(1) Front leg (Elbow to breakjoint above pastern)..... _____

Length (Continued):

(2) Hind leg:

Patella to breakjoint above hock..... _____

Breakjoint above hock to breakjoint above pastern..... _____

From line perpendicular to breakjoint above hock to bottom of twist..... _____

(3) Point of shoulder to breakjoint above hock..... _____

(4) Point of shoulder to patella..... _____

(5) Articulation between last 2 lumbar vertebrae to articulation between last 2 thoracic vertebrae (1 rib on loin)..... _____

(6) Articulation between last 2 thoracic vertebrae to articulation between 3rd and 4th thoracic vertebrae (9-rib rack)..... _____

(7) Articulation between 3rd, and 4th thoracic vertebrae to anterior of 1st thoracic vertebra (3-rib chuck)..... _____

CHART 5

Slaughter Sheet

Feed-lot weight	
Final slaughter weight	
Content of stomach and intestines	
Empty body weight	
Warm dressed weight	
Chilled weight (24 hours)	
Chilled weight (48 hours)	
Dressing percentage	
Warm Chilled Empty	
Weight of pelt and feet	
Weight of head	
Weight of fleece	
Viscera full	
Viscera empty	
Content of viscera	
Caul fat	
Liver	
Heart	
Trachea	
Miscellaneous	
Lung and trachea	
Gut fat	
Length of small intestine	
Length of large intestine	
Lung capacity	

Chart 6

Cutting Sheet

Cold carcass weight				
Wt. Hind Saddle				
Wt. Rack				
Wt. Leg				
Wt. Loin				
Wt. Hotel Rack				
Wt. Shoulder				
Wt. Breast, Flank				
Shank				
Wt. of bone from rib cut				
Wt. of fat from rib cut				
Wt. of lean from rib cut				
% Ether extract in fat				
% Water in Fat				
% Ether Extract in lean				
% Water in lean				

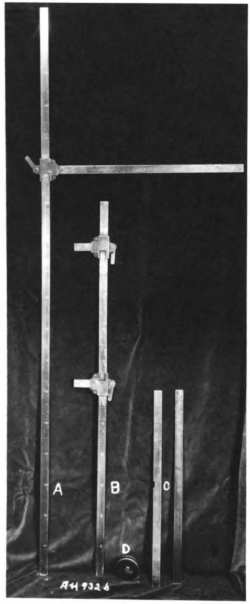

Figure I. Measuring Instruments, Standard Equipment Obtained from the Bureau of Animal Industry, United States Department of Agriculture: (A) Measuring rule for height of animal, (B) caliper for width measurements, (C) arm used to replace short caliper arms for width measurement of shoulder and thurls, (D) centimeter tape.

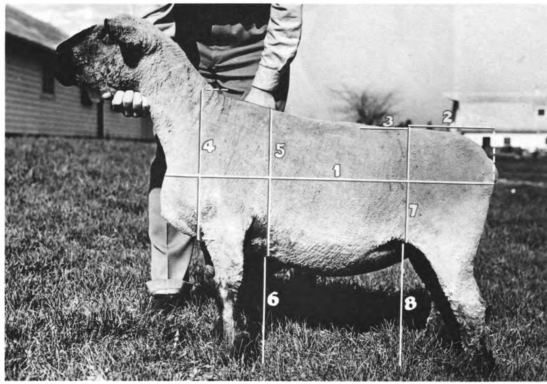

Figure II

Live Lamb Measurements
Showing Length and Depth of Body and Length of Leg.

1. Length from pinpoints to the front of the chest at base of throat.
2. Pinpoints to front edge of hooks.
3. Front edge of hooks to the last rib.
4. Depth from top of shoulder to floor of chest between the front legs.
5. Depth of body just back of the shoulders.
6. Floor of chest to ground.
7. Depth of rear flank.
8. Rear flank to the ground.

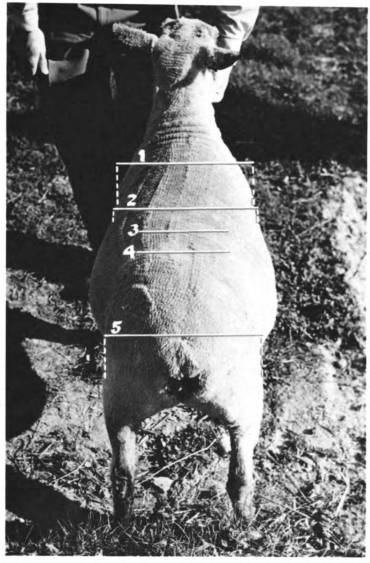

Figure III

Width Measurements of Live Lambs

1. Through the shoulders.
2. Narrowest width just behind the shoulders.
3. The loin just behind the last rib.
4. The loin just in front of the hooks.
5. Through the thurls just behind the hooks.

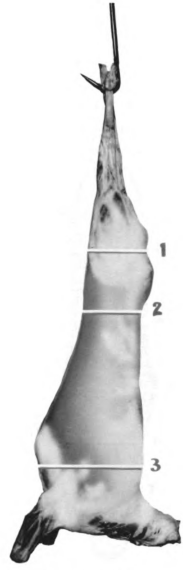

Figure IV

A Side-View of the Lamb Carcass

1. Circumference of both legs at the base of the tail.
2. Depth of carcass at the shallowest part of the flank.
3. Depth of carcass just back of the shoulders to the floor of the chest.

Figure V

A Back-View of a Lamb Carcass

1. Length of shank from the breakjoint above the hock to the bottom of the twist.
2. Circumference of leg at the bottom of the twist.
3. Width of the legs at the base of the tail.
4. Narrowest part of the loin.
5. Maximum spread of ribs.
6. Narrowest point behind the shoulders.
7. Width through the shoulders.

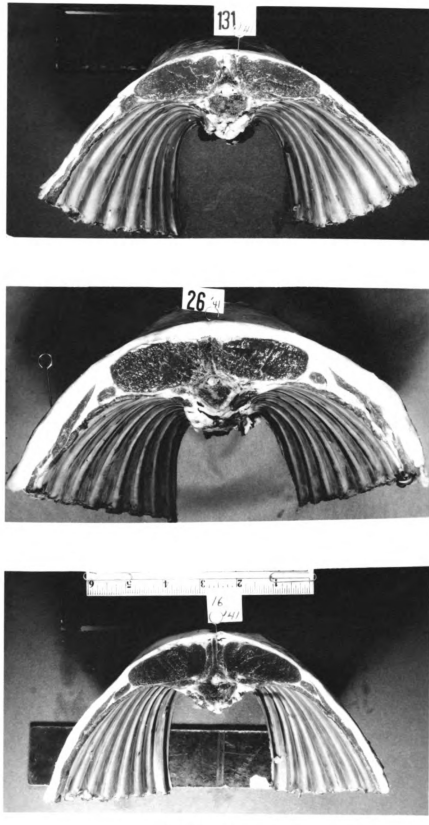

Figure VI

Photographs of Hotel Rack Between the 11th and 12th Ribs.

The measurements for area, width, and depth of eye muscle and depth of fat measurements were obtained from enlargements of similar pictures.

Results

The lambs ranged in carcass grade from top prime to top medium, with the larger proportion being in the higher grades. An average of the grading committee shows that there were 15 prime, 8 choice, 7 good, and 2 medium grade carcasses. None of the lambs were criticized for being excessively fat; however, the lambs which were in the lower grades were lacking in finish.

Before making any study of the size of the eye muscle, it was necessary to determine whether or not there was a significant difference between the averages of the areas of the eye muscle in the right and left sides of the carcasses. The method used was that given in any statistics text book (2) for the test of significance between means of small samples. The "t" value obtained was 0.181 which indicates no significant difference between the means of the areas of the right and left eye muscles.

Table I

Predicting Equations for the Area of the Eye Muscle		
Measurements Used	Predicting Equations	Standard Error of Estimate
(1) Width	$A = a + bW = -0.4861 + 0.98\ (W)$	0.194
(2) Depth	$A = a + bD = 0.4338 + 1.2726\ (D)$	0.191
(3) W + D	$A = a + bW + cD = -1.1762 + 0.81\ (W) + 1.071\ (D)$	0.153
(4) W x D	$A = h\ (WD) = 0.7638\ (WD)$	0.125
(5) W x D	$A = k + h\ (WD) = 0.1757 + 0.6814\ (WD)$	0.122

A = Area W = Width D = Depth

Table I shows the equations used for predicting the area of the eye muscle from width and depth. Equation (1) predicts areas from width and leads to the largest standard error of estimate (0.194 square inches). The second equation (2) predicts area from depth and leads to a slightly smaller error (0.191 square inches). This agrees with Hirzel's (7) work in which he states that depth is of greater importance in determining area of eye than is width. It is probable that a greater difference would have been shown if the lambs in the experiment had been older, as depth of eye is a late-maturing factor, according to Palsson (8). The third equation (3) gives a predicting equation from width and depth measurements. The resulting standard error of estimate, 0.153 square inches, indicates that this is more accurate for predicting eye area than either measurement used singly. Equation (4) is for predicting the area from the product of the width and depth measurements. Its error, 0.125 square inches, is smaller than that obtained by using the first three equations. However, the smallest error found, viz. 0.122 square inches, was obtained by using a constant with the width times depth measurement. This method of predicting is accurate to within 7 per cent of the mean of the area of the eye muscles.

In the following tables (I to XV) correlations of $\pm$ 0.349 are significant at the 5 per cent level, designated *, and correlations of $\pm$ 0.449 are significant at the 1 per cent level, designated **. (Fisher 4).

Table II shows that most of the factors used by the carcass grader give highly significant negative correlations. Attention is called to the fact that the grading charts had small numerical values for the higher grades and large numerical values for the lower grades, which resulted in some negative correlations. Number (1) of Table II

Table II

Correlation Coefficients between Numerical Value of Carcass Grade and:

(1) Thickness of fat over the eye..... - 0.739**

(2) Length of Carcass - Point of shoulder to breakjoint above hock..... + 0.595**

(3) Length from breakjoint above hock to the twist..... + 0.823**

(4) Length of carcass + length of breakjoint to twist..... + 0.731**

(5) Average depth (carcass)..... - 0.083

(6) Circumference of leg at twist (carcass)..... - 0.250

(7) Average width (carcass)..... - 0.779**

(8) Average width + average depth + twist circumference..... - 0.555**

(9) Average width + twist circumference..... - 0.647**

(10) $\frac{L\ (\#4)}{W + D + C\ (\#8)}$ ..... + 0.855**

(11) $\frac{L\ (\#4)}{W + C\ (\#9)}$ ..... + 0.867**

(12) $\frac{L\ (\#4)}{W\ (\#7)}$ ..... + 0.873**

(13) Slaughter grade..... + 0.783**

shows that there is a high correlation between fat covering and carcass grade, an increased amount of fat giving a more desirable carcass. Numbers (2), (3) and (4) show that a long-shanked lamb or one that is not compact is a low grader. This may be due to some other factor which affects the muscular development and fattening ability of these lambs. The average depth measurement (5) of the fore flank and hind flank does not affect carcass grade, nor does the circumference of the twist (6). In carcasses of similar weight, carcass grade is directly affected by average width (7). When (5) and (6) are added (9), they give a higher

correlation than when (5), (6) and (7) are used together (8), although both give highly significant correlations. This indicates that carcasses that are wide, deep and full in the twist are the most desirable from a grade standpoint. To make a study of the effect of type on grade, numbers (10), (11) and (12) were determined. The method shown was used instead of running multiple correlations because the correlations obtained can be compared with the other correlations obtained in this study. The undesirable factor, length, is used as the numerator and the measurements of desirability are used as the denominator. The length of carcass measurement was considered undesirable, since carcasses are selected that are thick and compact. It is desirable that the average width and average depth of carcass, and circumference of the twist be as great as possible. These three measurements were added together.

Table III

Correlation Coefficients between Numerical Value of Carcass Grade and:

(1)	Percentage of hind saddle	-0.108
(2)	Percentage of rack	+0.108
(3)	Percentage of breast and shank	+0.239
(4)	Percentage of shoulder	+0.160
(5)	Percentage of hotel rack	-0.387*
(6)	Percentage of loin	-0.612**
(7)	Percentage of leg	+0.604**

In Table III the effect of carcass grade upon the percentage yield of wholesale cuts is shown. Grade in this study does not show any significant effect upon the percentage of fore (2) and hind saddle (1). No significance was found in the percentage of shoulder (4) or breast

and shank (3). A significant difference is shown by the hotel rack (5), and the loin (6) shows a highly significant difference. This means that prime lambs have a larger proportion of these two cuts than do lambs grading lower. The percentage of leg (7) is greater in the lower grade carcasses. It is suggested that this may be accounted for by the fact that there is a high proportion of muscle in the leg and also that there is an increase in the length of shank. The greatest increase in thickness of fat covering is over the hotel rack and loin.

Table IV

Correlation Coefficients between Percentage of Shoulder and:

(1) Length of shoulder (Vertebrae)..... - 0.169

(2) Width of shoulder (Carcass)..... + 0.129

(3) Width of shoulder (live)..... + 0.395*

Table V

Correlation Coefficients between Percentage of Hotel Rack and:

(1) Length of hotel rack (Vertebrae)... - 0.071

(2) Width of hotel rack (Carcass)..... + 0.527**

(3) Width of hotel rack (Live)..... - 0.279

(4) Area of eye..... + 0.043

(5) Depth of fat over eye..... + 0.271

Table VI

Correlation Coefficients between Percentage of Loin and:

(1) Length of loin (Vertebrae).... + 0.217

(2) Length of loin (Hooks to ribs) - Live..... - 0.125

(3) Width of loin (Carcass)..... + 0.369*

(4) Average width of loin (Live).. - 0.051

(5) Depth of fat over eye..... + 0.519**

(6) Area of eye..... + 0.193

Table VII

Correlation Coefficients between Percentage of Leg and:

(1) Length upper breakjoint to twist (Carcass)... + 0.687**

(2) Circumference of legs at base of dock (Carcass)..... - 0.273

(3) Circumference of leg at the twist (Carcass).. - 0.073

(4) Length upper breakjoint to lower breakjoint (Carcass)..... + 0.435*

(5) Width of thurls (Live)..... + 0.119

(6) Length of pinpoints to hooks (Live)..... - 0.494**

Tables IV, V, VI, and VII show correlation coefficients between percentage yield of each of the four most valuable wholesale cuts and a number of measurements which it was thought might affect them. The significant correlations here are all positive. In Table IV, only one measurement of the shoulder (3) was found to be significant and that was taken on the live lamb. Neither of the carcass measurements (1) or (2) were of any value in predicting percentage. There is only

one measurement (2) in Table V which affects the percentage of hotel rack; it is the width of the carcass over that cut. A similar width measurement of the loin of the live lamb, Table VI, gives a significant correlation with the percentage of that cut. A higher correlation was obtained, however, by using the depth of fat over the eye muscle.

Substantiating what was suggested in Table III, that long-shanked lambs have a high percentage of leg, it is shown in Table VII, (1), that there is a highly significant positive correlation between length of shank and percentage of leg. The length of the cannon bone (4) also gave a significant correlation, but it was not as high as (1). In (6) a highly significant negative correlation was obtained which is very hard to explain. It may be that increased length and thickness of shank account for this correlation.

Table VIII

Correlation Coefficients between Weight of Shoulder and:

(1) Width of shoulder (Live)..... +0.708**

(2) Width of shoulder (Carcass)..... +0.671**

(3) Length of shoulder (Carcass, vertebrae).. -0.343

Table IX

Correlation Coefficients between Weight of Hotel Rack and:

(1) Width of hotel rack (Live)..... +0.385*

(2) Width of hotel rack (Carcass)..... +0.601**

(3) Length of hotel rack (Carcass, vertebrae) -0.047

(4) Area of eye..... +0.676**

(5) Depth of fat on eye..... +0.551**

Table X

Correlation Coefficients between Weight of Loin and:

(1) Average width of loin (Live)..... + 0.184

(2) Length of hooks to ribs (Live)..... - 0.117

(3) Length of loin (Carcass, vertebrae)..... + 0.146

(4) Width of loin (Carcass)..... + 0.529**

(5) Area of eye..... + 0.531**

(6) Depth of fat on eye muscle..... + 0.501**

Table XI

Correlation Coefficients between Weight of Leg and:

(1) Width of thurls (Live)..... + 0.328

(2) Length of pinpoints to hooks (Live)..... + 0.061

(3) Circumference of legs at base of dock (Carcass)..... + 0.863**

(4) Circumference of leg at twist (Carcass)... + 0.426*

(5) Length of upper breakjoint to twist (Carcass)..... - 0.365*

From an economic standpoint, the weight of the various wholesale cuts is not as important as their relative percentages. It was felt, however, that it would be quite helpful to find the measurements which have the most effect upon the weight of the various cuts. Tables VIII, IX, X, and XI show this. The width of the shoulder (1) and (2) is the best indication of weight of that cut as shown in Table VIII. In Table IX the factor which gave the highest correlation with weight

of hotel rack was the area of the eye muscle. Other factors which are highly significant are the depth of fat over the eye muscle, and the carcass width measurement. The live lamb width measurement correlation is significant, but the length measurement is not. The weight of loin, Table X, also shows that area of eye muscle (5), width of loin in the carcass (4), and depth of fat over the eye muscle (6), are highly significant in predicting its weight. In Table XI a circumference measurement taking in both legs at the base of the tail (3) gave a highly significant correlation with leg weight. A circumference measurement of one leg at the twist, and the length from the upper break-joint to the twist, were both significant correlations, but not highly so.

Table XII

Correlation Coefficients between Thickness of Fat over the Eye Muscle and:

(1) Carcass grade..... - 0.739**

(2) Percentage of hotel rack..... + 0.271

(3) Percentage of loin..... + 0.519**

(4) Weight of hotel rack..... + 0.551**

(5) Weight of loin..... + 0.501**

Table XIII

Correlation Coefficients between Area of Eye Muscle and:

(1)	Growth rate	+0.646**
(2)	Narrowest width back of shoulders (Carcass)	+0.268
(3)	Average width of rack (Live)	+0.625**
(4)	Average width of loin (Live)	+0.504**
(5)	Maximum spread of ribs (Carcass)	+0.416*
(6)	Average width of loin (Carcass)	+0.327
(7)	Circumference of leg at twist (Carcass)	+0.367*
(8)	Percentage of hotel rack	+0.043
(9)	Percentage of loin	+0.193
(10)	Weight of hotel rack	+0.676**
(11)	Weight of loin	+0.531**

Table XIV

Correlation Coefficients of Factors Related to Width or Depth of Eye:

(1)	Width of eye, and width of loin (Carcass)	+0.265
(2)	Depth of eye, and circumference of leg at twist (Carcass)	+0.506**

All of the correlations in Table XII have been mentioned in the tables preceding this one. They are grouped together here to show the importance of an adequate covering of fat over the eye muscle. Attention is again called to the fact that a negative correlation of fat covering with carcass grade is a desirable characteristic.

Table XIII is a similar grouping of the factors correlated with

area of eye muscle. One correlation is mentioned here that has not been mentioned previously in this study: the growth rate (1), which is highly significant. This is of practical interest to the livestock producer, because it points out a distinct advantage for rapid growing lambs. The other correlations are explained in the discussion of the preceding tables.

Table XV

Correlation Coefficients between Dressing Percentage and:

(1) Area of eye muscle..... + 0.574**

(2) Length from base of throat to pinpoints, plus average length of leg..... - 0.156

(3) Average width (shoulder, rack, loin and thurls)..... + 0.404*

Table XV shows a highly significant correlation between dressing percentage and area of eye muscle. The correlation between dressing percentage and length of body plus length of leg was not significant, while average width showed a correlation significant at the 5 per cent level.

A correlation of + 0.786 was found between the ether extract of the fat and of the lean from the hotel rack. The correlation between the percentage of water in the fat and of the lean from the same cut was + 0.683. From these two correlations, and the statement that the firmness grade of fat on the lamb carcass shows a high negative correlation with the amount of moisture in the tissue, (Report of Review Committee) some conclusions are drawn. It would seem that carcasses that are criticized for being "washy" or "watery" have a high water content in both fat and lean and should be discriminated against. From the correla-

tion obtained on ether extract, it is assumed that the lean from those carcasses with high ether extract is the most desirable as fat is considered one of the palatability factors. Therefore, carcasses that have a good covering of fat are higher in ether extract and correspondingly lower in moisture content than lambs lacking finish and firmness.

Summary

The experimental material used in this study was a group of thirty-two lambs, dropped during the spring of 1941, representing the Hampshire, Oxford, Shropshire, Rambouillet, Cotswold X Rambouillet, and Hampshire X (Cotswold X Rambouillet) breeds. The lambs were all handled similarly prior to slaughter. Weight of the lambs determined the time of slaughter, the plan being to slaughter the lambs at approximately 85 pounds. Final slaughter weights averaged 82½ pounds. Standard methods of slaughter and cutting were followed.

Analysis of the data on size of the eye muscle showed no significant difference in the area of the eye muscle in the right and left side of the carcass. Predicting equations were set up for finding the area of the eye by the use of the measurements of width and depth. It was found that the predicting equation giving the smallest standard error of estimate was the use of a constant (0.1757) plus the width times depth measurements. The error of this measurement is within 7 per cent of the mean of the areas of the eye muscles. These predicting equations also showed that depth of eye is more important than width of eye in predicting its area.

Depth of fat over the eye muscle varied directly with carcass grade, and no lambs in this study were wasty in their fat covering. The factors associated with type, namely: compactness, width, low-setness and thickness, showed a direct effect on grade. Depth of body was not important. Slaughter grade showed a high correlation with carcass grade.

In studying the relationship of carcass grades upon the percentage of wholesale cuts, no relationship was found with yield of shoulder

or breast and shank. The percentages of loin and hotel rack were significantly greater in the higher grades while the percentage of leg was greater in the lower grades. Carcass grade did not affect the percentages of fore and hind saddle.

Various body measurements showed a high correlation with the percentages of the different wholesale cuts. The only measurement showing any relation to the percentage of shoulder was the width of shoulder in the live lamb. The same was true of the hotel rack, with the exception of the fact that it was the width of the carcass over that cut. Depth of fat over the eye was the best index of the percentage of loin, although live width of loin was also significant. Lambs that were long in their shanks and cannon bones had the largest percentage of leg.

Width of shoulder of either the live lamb or the carcass was a good indicator for the weight of that cut. Area of eye muscle, depth of fat over the eye and carcass width all varied directly with weight of hotel rack and loin. The best indication of the weight of the leg is the circumference of both legs at the base of the dock. Length of shank and circumference of twist were also significant. The length of the vertebrae in the shoulder, hotel rack and loin cuts has no relationship to the weight of those cuts.

A highly significant correlation was found between area of eye muscle and the growth rate of lambs.

The ether extract of the lean varied directly with the ether extract of the fat. The percentage of water in the fat varied directly with that of the lean. It also emphasized the difference in composition of the edible portion of the carcass as finish increased. The change was largely a reduced percentage of moisture and an increase in ether

extract in both the fat and the lean. This showed that a carcass grader may be justified in putting lambs in the lower grades when they lack firmness of fat and lean in the flanks.

Conclusions

Data indicate that there are three main factors closely associated with the carcass grade: namely, slaughter grade, covering of fat over the eye muscle, and type. The most desirable carcass type, as shown by grade and yield, was found to be compact, wide-bodied, deep-twisted, and short-shanked. Percentage of the shoulder and of the breast and shank are not affected by carcass grade. The proportion of loin and hotel rack increases with carcass grade, while leg decreases when carcass grade increases.

Carcass grade had no effect upon the percentages of fore and hind saddle in the carcass. The percentage of loin and hotel rack was the largest in the higher grade lambs. The percentage of leg varied inversely with grade. The yields of shoulder, breast and shank were not affected by grade. Width of loin in the carcass and width of shoulder in live lambs show positive relationship to the percentage of those cuts. Width of hotel rack in the carcass was the best indicator of yield of that cut. Long shanks and cannon bones indicated a larger proportion of leg in the carcass.

There is no statistically significant difference in the size of the right and the left eye muscle. Depth of eye muscle had a greater effect upon size of eye than width. The best predicting equation for area of eye is a constant (0.1757) plus the width times the depth of eye.

Factors showing a direct relationship with size of eye muscle are: growth rate, average width over the hotel rack, and loin in the live lambs. Circumference of leg at the twist and maximum spread of the ribs were the best carcass measurements for indicating area. There

is no relationship between the area of the eye and the yield of the various wholesale cuts.

The thickness of fat over the eye muscle affected carcass grade more than it did the yield in weight or percentage of loin and hotel rack.

Ether extract of the lean varied directly with that of the fat. The same was true of the percentage of water in the lean and the fat. This indicated that with an increase in covering there is an increase in the amount of ether extract in both the fat and the lean and a decrease in the water content of both. Lambs that lack finish and firmness, therefore, should be graded correspondingly lower.

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APPENDIX

Table 1

Individual Data of Lambs Slaughtered

Lamb Number	Slaughter Age in Days	Slaughter Weight	Average Daily Gain	Slaughter Grade	Carcass Grade	Chilled Carcass Weight	Dressing Percentage
26	122	90.7	0.64	4.0	3.2	50.6	55.8
31	136	80.0	0.51	4.8	4.8	41.8	52.3
40	131	82.0	0.52	6.0	2.3	42.4	51.7
37	150	76.7	0.45	9.0	7.5	34.6	45.1
33	178	81.7	0.41	6.7	4.0	39.8	48.7
103	115	94.0	0.73	5.5	3.5	48.5	51.6
90	121	87.0	0.65	7.0	5.8	42.9	49.3
94	164	76.0	0.41	6.0	4.7	38.4	50.5
95	161	82.6	0.45	6.0	4.7	42.6	51.6
82	129	86.0	0.58	4.4	3.2	46.5	54.1
84	161	82.5	0.47	4.0	4.5	39.5	47.9
83	157	77.5	0.44	8.5	5.0	37.2	48.0
89	126	75.3	0.51	4.8	3.0	39.0	51.8
146	179	87.2	0.42	8.0	6.0	42.6	48.9
87	212	81.0	0.34	3.3	2.0	40.5	50.0
17	129	77.8	0.53	9.0	11.2	37.6	48.3
18	136	84.0	0.52	10.0	10.3	39.0	46.4
13	140	81.0	0.49	10.0	14.5	36.5	45.1
5	169	86.9	0.44	7.0	12.7	39.5	45.5
15	187	81.2	0.39	8.7	8.7	37.4	46.1
8	196	79.5	0.35	13.5	10.0	34.7	43.6
16	180	77.7	0.37	10.0	12.3	34.5	44.4
54	226	77.0	0.30	2.7	2.0	40.5	52.6
62	219	87.0	0.35	2.7	4.0	42.5	48.9
707	239	87.0	0.33	5.3	4.7	42.1	48.4
723	236	80.0	0.31	6.7	6.7	37.2	46.5
131	147	83.4	0.50	10.0	12.5	35.8	42.9
133	171	78.3	0.42	8.0	8.7	37.6	48.0
143	174	89.5	0.45	6.7	10.0	41.5	46.4
140	187	77.3	0.36	10.0	13.3	34.2	44.2
128	214	87.5	0.36	8.7	8.0	39.5	45.1
134	216	85.0	0.35	8.0	12.0	40.5	47.6

Table 2

Live Lamb Measurements
(In Centimeters)

Width of Shoulder	Width of Rack	Width of Loin	Width of Thurls	Length - Pinpoints to Hooks	Length - Hooks to Ribs
23.0	23.0	17.0	25.0	21.0	17.0
24.0	22.5	15.5	24.5	21.0	14.5
22.0	20.5	15.5	26.0	20.0	13.0
21.0	19.5	14.5	26.0	20.5	15.5
21.5	19.0	14.0	26.0	20.0	16.5
24.0	23.0	15.5	27.0	21.5	17.5
23.5	22.0	14.5	26.5	21.0	16.0
21.5	20.5	13.0	25.5	20.5	13.0
21.0	20.5	14.0	25.0	20.5	15.0
23.5	23.0	15.5	23.5	20.5	14.5
23.0	22.0	16.0	26.0	21.5	15.0
22.0	21.0	14.5	25.0	19.0	15.5
22.5	22.5	15.0	23.5	20.5	15.0
21.5	21.0	15.0	26.0	17.0	20.5
19.5	20.0	13.0	22.5	20.0	16.5
20.5	20.0	15.0	24.0	20.0	17.0
22.0	21.5	14.0	24.5	21.0	13.0
21.0	19.5	14.0	24.0	19.5	16.5
21.5	22.0	14.0	22.5	17.0	22.5
21.5	21.0	14.5	23.5	22.0	15.5
20.0	19.0	13.0	24.0	21.0	16.5
20.0	19.0	13.0	22.5	15.5	20.5
20.5	19.5	13.0	22.0	19.5	14.5
20.5	19.5	12.5	21.5	21.0	13.5
22.0	21.5	13.0	23.0	21.5	15.0
20.0	20.0	12.5	23.0	21.0	15.5
21.0	21.0	14.5	25.0	20.0	16.0
21.0	22.0	15.0	25.0	17.0	18.5
22.0	23.0	14.5	26.5	19.0	15.5
20.5	20.0	13.0	24.5	19.0	16.0
18.5	18.0	13.0	21.5	15.0	20.5
20.5	20.0	12.5	22.0	19.0	18.0

Table 3

PART I

Lamb Carcass Measurements

Width of Shoulder	Width of Hotel Rack	Maximum Spread of Ribs	Width of Loin	Circumference of Legs at Dock	Circumference of Leg at Twist
20.0	17.8	23.8	18.8	64.5	33.5
18.8	16.3	21.8	19.0	60.5	33.0
20.0	17.8	23.5	19.0	61.0	32.0
17.0	16.5	22.5	18.5	59.0	30.0
17.0	15.0	22.5	18.0	59.5	34.5
20.0	17.3	25.8	20.3	63.5	32.5
20.0	18.0	23.3	19.0	60.5	32.0
17.5	16.0	23.0	17.0	61.0	34.0
18.0	16.5	23.3	18.5	63.0	30.0
19.3	17.5	23.8	18.5	62.0	33.0
19.0	17.5	25.5	20.5	60.5	32.0
17.8	17.5	24.0	18.5	59.0	30.5
19.5	18.3	24.0	18.8	58.5	32.0
17.5	16.0	23.0	17.0	64.0	35.0
19.0	18.3	25.5	21.3	60.5	33.5
16.5	15.0	21.5	16.5	59.0	30.0
18.5	16.3	22.3	17.5	59.5	31.5
15.5	14.3	19.8	16.0	58.0	32.0
17.5	16.0	22.0	16.5	58.5	32.0
16.5	15.5	22.0	17.0	57.5	30.0
15.5	15.0	21.0	14.5	57.0	32.0
15.5	14.5	21.0	14.5	58.0	32.0
21.0	19.0	23.0	19.0	58.0	31.0
20.5	17.5	23.8	19.0	59.5	32.0
18.3	15.5	22.5	17.0	59.0	33.0
16.3	15.3	21.5	15.8	57.5	31.0
17.5	15.5	23.5	18.5	57.5	32.0
18.0	14.5	23.5	17.5	57.5	36.0
17.5	14.5	22.5	17.5	59.0	34.5
16.0	14.5	20.5	15.0	56.0	29.0
18.0	16.0	23.5	17.5	59.0	32.5
18.0	16.0	22.5	18.3	58.5	31.5

Table 3

PART II

Lamb Carcass Measurements

Length of Vertebrae in Shoulder	Length of Vertebrae in Hotel Rack	Length of Vertebrae in Loin	Point of Shoulder to Breakjoint above Hock	Upper Break-joint to Twist	Upper Break-joint to Lower Breakjoint
6.0	18.0	21.0	94.5	15.5	15.3
6.5	15.5	21.5	91.5	17.0	14.0
6.3	19.3	18.5	91.0	16.5	15.3
7.0	18.5	20.5	90.0	17.5	15.0
8.0	19.0	24.0	94.5	18.5	15.0
6.5	20.5	24.5	101.0	17.0	15.5
7.0	19.0	22.0	96.5	18.0	16.5
8.0	19.0	20.0	93.0	17.5	15.0
7.0	19.0	22.0	96.0	17.0	15.5
6.0	19.5	20.5	97.0	16.0	15.0
7.0	18.0	21.0	94.7	17.5	15.5
7.0	18.5	21.5	93.5	18.5	15.0
6.5	20.5	21.0	92.5	18.0	15.5
7.5	19.5	24.0	99.0	20.0	15.5
6.5	18.5	21.0	96.0	18.5	15.5
6.5	19.5	21.5	99.0	20.3	17.3
6.5	20.5	22.0	101.5	21.0	17.5
7.5	19.5	24.5	98.0	21.0	17.0
6.5	20.5	22.0	104.5	20.5	17.0
7.0	18.5	23.5	99.0	19.5	16.0
6.5	19.0	23.5	100.0	21.5	17.0
7.5	19.5	21.0	96.5	21.0	17.3
8.0	18.5	22.0	92.5	16.3	13.8
7.0	19.5	23.0	94.5	16.5	15.0
7.5	19.5	24.0	95.0	16.5	14.5
6.5	18.0	22.5	94.0	16.5	15.5
7.5	20.5	22.0	98.8	21.5	17.0
6.5	18.5	21.0	95.5	19.0	15.0
8.0	20.0	22.5	101.0	19.5	20.3
7.0	19.5	21.5	96.0	19.5	15.8
7.0	20.5	26.0	99.5	21.0	16.3
7.0	20.0	26.0	102.5	20.5	16.0

Table 3

PART III

Lamb Carcass Measurements

Average Width	Average Depth	$\frac{L}{W+D+C}$	$\frac{L}{W+C}$	$\frac{L}{W}$
19.5	19.6	1.52	2.07	5.64
18.6	19.1	1.53	2.10	5.83
19.7	21.0	1.48	2.08	5.46
18.1	19.0	1.60	2.23	5.94
17.5	19.8	1.57	2.17	6.46
19.9	19.0	1.65	2.25	5.93
19.6	19.6	1.61	2.22	5.84
17.7	18.2	1.58	2.14	6.24
18.4	19.0	1.68	2.33	6.14
19.0	18.8	1.60	2.17	5.95
19.7	20.2	1.56	2.17	5.70
18.7	20.5	1.61	2.28	5.99
19.3	19.5	1.56	2.15	5.73
17.6	22.2	1.59	2.26	6.76
20.2	20.5	1.54	2.13	5.67
16.9	18.2	1.83	2.54	7.06
18.4	20.8	1.73	2.45	6.66
16.2	19.8	1.75	2.47	7.35
17.2	19.8	1.81	2.54	7.27
17.0	19.0	1.80	2.52	6.97
16.1	19.1	1.81	2.53	7.55
15.7	19.2	1.76	2.46	7.48
20.2	20.0	1.53	2.12	5.38
19.7	21.2	1.52	2.15	5.63
17.5	18.1	1.63	2.21	6.37
17.7	18.0	1.66	2.27	6.24
18.0	20.5	1.71	2.41	6.68
17.6	18.5	1.59	2.14	6.51
17.5	18.8	1.70	2.32	6.89
16.0	18.5	1.82	2.57	7.22
18.1	21.0	1.68	2.38	6.66
18.4	21.2	1.73	2.46	6.68

Table 4

Percentage of Wholesale Cuts

% Hind Saddle	% Fore Saddle	% Leg	% Loin	% Hotel Rack	% Shoulder	% Breast and Shank
49.2	50.8	33.0	16.0	12.8	23.3	14.4
49.3	50.7	34.7	14.6	12.0	25.3	13.4
47.9	52.1	33.5	14.2	12.5	25.7	13.2
48.3	51.7	35.5	12.4	13.9	24.3	13.9
49.5	50.5	34.9	15.8	12.3	22.1	14.8
49.3	50.7	33.0	16.1	13.0	23.9	13.6
47.3	52.7	34.0	13.5	12.1	25.2	15.2
50.0	50.0	36.2	13.5	13.3	21.9	14.3
50.7	49.3	34.5	16.2	13.1	21.8	13.6
50.3	49.7	32.5	17.4	12.7	22.8	13.8
51.9	48.1	35.9	15.7	12.9	22.0	12.9
51.6	48.4	35.7	15.9	12.6	21.8	13.4
50.8	49.2	32.8	17.7	12.6	22.8	13.6
51.4	48.6	35.2	16.0	12.2	21.6	13.8
51.3	48.7	35.1	16.0	12.3	22.2	14.1
49.5	50.5	35.4	14.4	12.8	23.4	14.1
48.2	51.8	34.9	13.3	11.8	24.9	14.6
49.9	50.1	36.2	13.7	12.3	22.5	14.8
50.6	49.4	35.7	14.7	12.4	22.8	14.7
49.2	50.8	34.5	14.7	11.8	24.1	13.9
49.9	50.1	35.2	14.7	12.7	23.9	13.5
50.4	49.6	38.3	11.9	11.9	22.3	15.1
48.9	51.1	32.6	16.5	13.6	23.2	14.3
50.6	49.4	33.2	17.2	12.5	21.6	15.3
48.7	51.3	30.9	17.3	12.8	23.5	14.7
50.5	49.5	33.3	17.5	12.9	21.2	15.3
49.4	50.6	36.3	13.4	12.0	24.9	13.4
49.7	50.3	34.8	14.9	12.5	23.9	13.3
48.7	51.3	34.9	13.5	11.6	25.1	14.2
48.2	51.8	35.7	12.9	12.3	24.3	14.9
50.6	49.4	35.4	14.7	13.4	21.5	14.1
50.6	49.4	34.3	16.3	12.3	22.5	14.1

Table 5

Weight of Wholesale Cuts
(In Pounds)

Hind Saddle	Fore Saddle	Leg	Loin	Hotel Rack	Shoulder	Breast and Shank
29.4	25.7	16.7	8.1	6.5	11.8	7.3
20.6	21.2	14.5	6.1	5.0	10.6	5.6
20.3	22.1	14.2	6.0	5.3	10.9	5.6
16.7	17.9	12.3	4.3	4.8	8.4	4.8
19.7	20.1	13.9	6.3	4.9	8.8	5.9
23.9	24.6	16.0	7.8	6.3	11.6	6.6
20.3	22.6	14.6	5.8	5.2	10.8	6.5
19.2	19.2	13.9	5.2	5.1	8.4	5.5
21.6	21.0	14.7	6.9	5.6	9.3	5.8
23.4	23.1	15.1	8.1	5.9	10.6	6.4
20.5	19.0	14.2	6.2	5.1	8.7	5.1
19.2	18.0	13.3	5.9	4.7	8.1	5.0
19.8	19.2	12.8	6.9	4.9	8.9	5.3
21.9	20.7	15.0	6.8	5.2	9.2	5.9
20.8	19.7	14.2	6.5	5.0	9.0	5.7
18.6	19.0	13.3	5.4	4.8	8.8	5.3
18.8	20.2	13.6	5.2	4.6	9.7	5.7
18.2	18.3	13.2	5.0	4.5	8.2	5.4
20.0	19.5	14.1	5.8	4.9	9.0	5.8
18.4	19.0	12.9	5.5	4.4	9.0	5.2
17.3	17.4	12.2	5.1	4.4	8.3	4.7
17.4	17.1	13.2	4.1	4.1	7.7	5.2
19.8	20.7	13.2	6.7	5.5	9.4	5.8
21.5	21.0	14.1	7.3	5.3	9.2	6.5
20.5	21.6	13.0	7.3	5.4	9.9	6.2
18.8	18.4	12.4	6.5	4.8	7.9	5.7
17.7	18.1	13.0	4.8	4.3	8.9	4.8
18.7	18.9	13.1	5.6	4.7	9.0	5.0
20.2	21.3	14.5	5.6	4.8	10.4	5.9
16.5	17.7	12.2	4.4	4.2	8.3	5.1
20.0	19.5	14.0	5.8	5.3	8.5	5.6
20.5	20.0	13.9	6.6	5.0	9.1	5.7

Table 6

Measurements of Thickness of Fat of the Eye Muscle

Thickness of Fat	Area of the Eye Muscle	Width of Eye Muscle	Depth of Eye Muscle
0.35	2.31	2.33	1.18
0.44	1.76	2.55	0.97
0.31	1.81	2.31	0.97
0.19	1.49	2.25	0.94
0.25	1.52	2.44	0.81
0.28	2.14	2.38	1.13
0.25	1.90	2.35	1.10
0.30	1.61	2.03	1.06
0.35	1.86	2.25	1.03
0.44	2.07	2.25	1.16
0.28	1.56	2.25	0.90
0.28	1.33	2.15	0.81
0.31	1.66	2.32	0.94
0.28	1.75	2.22	1.10
0.44	1.71	2.16	1.16
0.16	1.90	2.32	1.00
0.06	1.89	2.38	0.97
0.13	1.60	2.28	0.88
0.22	1.93	2.38	1.08
0.24	1.40	2.08	0.97
0.16	1.57	2.25	0.97
0.16	1.54	2.19	0.97
0.31	1.50	2.00	0.96
0.19	1.53	2.06	0.88
0.19	1.79	2.06	1.19
0.35	1.46	1.99	0.94
0.09	1.67	2.31	0.93
0.19	1.82	2.28	1.10
0.16	1.69	2.32	0.96
0.21	1.18	1.97	0.78
0.25	1.51	2.19	0.88
0.19	1.72	2.22	1.00

Table 7

Chemical Analyses

% Ether Extract in Lean	% Ether Extract in Fat	% Water in Lean	% Water in Fat
13.62	85.16	67.36	11.03
11.00	83.29	69.87	12.09
10.92	80.35	69.26	14.44
9.25	73.46	71.48	18.79
8.59	73.33	72.09	18.65
10.19	79.45	69.98	15.07
10.08	81.70	70.26	13.21
12.48	76.10	67.77	17.09
10.63	78.43	69.53	15.23
13.55	84.80	67.27	11.15
12.44	83.05	68.28	12.32
15.21	85.71	55.98	9.94
9.44	86.74	70.34	9.81
8.19	78.37	72.38	16.31
13.86	86.72	66.71	9.16
8.58	76.64	70.63	16.35
8.22	71.15	71.25	20.32
8.54	65.22	71.84	26.02
8.27	72.53	71.20	19.35
10.60	76.99	69.89	16.30
7.14	76.71	72.54	16.44
5.49	66.07	73.95	23.73
14.50	86.03	66.26	9.88
13.97	81.30	67.04	12.66
10.90	77.59	69.52	17.05
10.89	78.47	69.40	16.05
7.63	67.72	72.42	23.29
6.31	66.35	73.03	23.36
6.88	71.28	72.39	21.67
7.90	70.81	72.96	22.69
9.04	72.20	71.24	19.68
8.82	79.10	70.99	14.52