CARCASS TRAITS OF WETHER LAMBS PRODUCED BY CROSSBRED DAMS OF FINNSHEEP, DORSET AND RAMBOUILLET BREEDING AND SLAUGHTERED AT TWO LIVE WEIGHTS

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CHAPTER I

INTRODUCTION

In recent years the American sheep industry has become very interested in the Finnish Landrace breed of sheep. This breed in it's native country of Finland has been shown to be very prolific, often producing litters of lambs containing 3 or more individuals. Research at a number of institutions throughout the United States has also shown that the Finnish Landrace breed and its crosses are quite prolific in this country. They have also been shown to be younger at sexual maturity than the domestic breeds with which they have been compared.

Considering the Finnish Landrace's high lambing rate and early sexual maturity, many commercial sheepmen may be tempted to infuse Finnish Landrace germ plasm into their commercial flocks. However, the Finnish Landrace breed seems to have one major fault which should be examined before this breed is used extensively. Upon visual appraisal, they seem to be inferior to our domestic breeds in general conformation and meatiness. This study was initiated to compare the carcass traits of terminal cross lambs produced by crossbred ewes of one-quarter Finnish Landrace breeding with similar lambs produced by crossbred ewes of Dorset and Rambouillet breeding only.

Also, for some time there has been an interest among some members of the sheep industry to increase live lamb slaughter weights above the traditional 100 pounds. In many cases this idea has met strong opposition from lamb buyers and is reflected in lower prices paid for heavy lambs. Members of the sheep industry contend that overall efficiency of lamb meat production can be improved if lambs are slaughtered at heavier than traditional weights while buyers argue that heavier lambs tend to produce carcasses that are more wasteful than those produced by lighter lambs. One-half of the lambs in this study were slaughtered at each of the two live weights of 100 and 125 pounds in order to compare lean yield of light versus heavy lambs.

This study also includes an evaluation of the relationship of radioactive potassium (K^{40}) content of the live animal, as estimated by a whole-body scintillation counter, with subsequent yield of lean and fat trim.

CHAPTER II

REVIEW OF LITERATURE

This literature review will concern itself with previous research done in the general areas of a) indices of carcass composition, b) carcass characteristics of lambs slaughtered at two live weights, and c) carcass characteristics of lambs of Finnish Landrace, Dorset and Rambouillet breeding.

Indices of Carcass Composition

A very good estimate of the amount of bone, lean and fat tissue in a carcass can be obtained through complete dissection of the carcass and several chemical techniques. These methods, although quite accurate, are time consuming, relatively complicated and uneconomical in that the value of the carcass is greatly reduced. For these reasons, and perhaps others, animal scientists have for many years been evaluating the relationship between several single live animal and carcass measurements and carcass composition in order to find measurements that are both easily obtainable and accurate predictors of carcass composition.

Composition of Sample Joints

P'alsson (1939) evaluated the use of sample joints in estimating composition of the entire carcass. He used eleven 4½ month old wether lambs of various British and Icelandic breeds with carcass weights of approximately forty pounds. The carcasses were not separated into the various joints in the normal manner where cuts are made across bones but were instead, separated anatomically with the bones providing the major fixed cutting points. He chose the leg and loin as his sample joints. He reasoned that due to its relatively early development, the use of the leg may cause slight underestimation of total body fat in early maturing over-fat animals. The loin, on the other hand, is a late developing joint in which much fat is acculmulated later in life. Therefore, he concluded that the use of one leg plus one loin is likely to give more satisfactory results than the use of either of these joints alone when working with lambs of different breeds, ages, sex, etc. The correlations between the weight of the various tissues in the leg, loin and leg + loin and the weight of these same tissues in the carcass were found to be 0.95, 0.88 and 0.97 for bone, 0.90, 0.84 and 0.92 for muscle and 0.95, 0.94 and 0.97 for fat, respectively. All correlations were significant at the $P < .01$ level. He concluded that the tissue weights of the carcass can be accurately estimated by the weights of the same tissues from the leg or loin with a combination of leg and loin weights giving the most precise estimate.

Hankins (1947) reported the relationships between the percent separable bone, muscle and fat of all the primal cuts (breast, leg, loin, neck, rib and shoulder) and the percent of these same separable tissues in the dressed carcass. He used 64 lambs raised at a number of research stations throughout the United States ranging in age from 4 to 14 months and ranging in live slaughter weight from 36 to 145 pounds. The lambs were of six different breeds and five crossbred groups and were composed of twelve ewe lambs, twenty-two ram lambs and thirty wethers. The composition of the rib was the best indicator of carcass composition. The correlations between percent fat, muscle and bone of the rib and carcass were 0.98, 0.92 and 0.97, respectively. The relationship between percent fat and bone of each of the primal cuts except the neck and the percent of these same tissues in the carcass was high with all correlations greater than 0.90. Correlations between each cut and the carcass for percent muscle were lower than for either percent fat or bone. The percent rib and leg muscle had the closest relationship with percent carcass muscle.

Barton and Kirton (1958b) further evaluated the use of the leg and loin as indices of carcass composition. They jointed the carcasses as described by P'alsson (1939). Fifty New Zealand mutton and seventy New Zealand lamb carcasses of unknown history, covering the normal range in carcass weight and grade, were used. The respective correlations between the weight of the various tissues in the leg, loin and leg + loin and the weight of these same tissues in Prime Down Cross lamb carcasses were 0.92, 0.97 and 0.98 for fat; 0.94, 0.90 and 0.97 for muscle and 0.94, 0.84 and 0.96 for bone. They concluded that the leg + loin was the best indicator of carcass composition but that the loin is superior to the leg as an indicator of carcass fat and that the leg is superior to the loin as an indicator of carcass muscle and bone.

Field, et al. (1963) also studied the relationship between the composition of cuts and the composition of the carcass using the carcasses of 165 Southdown cross lambs slaughtered at about 85 pounds. They found the relationships between percent separable fat and lean of the leg, loin, rib and shoulder and those same tissues of the carcass to be quite high. The rib and leg were the best indicators of percent fat with correlations of 0.89 and 0.88, respectively. The shoulder and leg were the best indicators of carcass percent lean with correlations of 0.87 and 0.86, respectively. The rib, shoulder and leg were all good indicators of percent carcass bone with correlations of 0.84, 0.82 and 0.81, respectively. The loin was the poorest indicator of percent carcass bone with a correlation of 0.61. This was probably due to errors in splitting.

Timon and Bichard (1965a) felt that since many of these previous studies had been done with experimental material that varied greatly, the correlations produced were somewhat inflated. In an effort to reduce this variation, they selected 83 purebred Clun Forest wether lambs from one established flock. The lambs were slaughtered upon reaching 80 pounds live weight. The respective correlations between the percent separable components of the leg, loin, best-neck (rib) and shoulder and these same tissues of the entire carcass were found to be 0.90, 0.96, 0.94 and 0.91 for fat; 0.87, 0.93, 0.92 and 0.90 for muscle and 0.84, 0.84, 0.75 and 0.86 for bone.

Latham, et al. (1966) found percent separable fat of the leg, shoulder and loin to all be significantly related to percent separable carcass fat (r=0.90, r=0.90 and r=0.89, respectively). Their best indicator of percent separable carcass lean was the percent separable lean of the rib with a correlation coefficient of 0.90 ($P < .01$). The percent separable bone of the leg and shoulder were the best indicators of percent separable carcass bone with correlation coefficients of 0.84 and 0.82 ($P < .01$). They also found that the single cut that was the best indicator of percent separable carcass fat, lean and bone was the leg followed closely by the shoulder. These relationships were determined from the carcasses of 121 crossbred lambs (Southdown or Hampshire rams x western blackfaced ewes) slaughtered at approximately 40 kg. live weight at an average age of 196 days.

Munson (1966) examined the carcasses of 123 lambs produced by mating Hampshire, Suffolk, or Dorset rams to Dorset x Rambouillet or Rambouillet ewes. The lambs had a mean live weight at slaughter of 103.8 pounds. He found the loin to be the best indicator of percent chemical carcass fat with a correlation of 0.75 ($P < .01$) existing between pounds of loin fat trim and percent chemical carcass fat. Edible cut weight of all the major cuts showed low correlations with percent chemical carcass lean. Edible leg weight showed the strongest relationship with a correlation of 0.49 ($P < .01$). Leg bone weight was the best indicator of percent carcass bone with a correlation of 0.69 ($P < .01$).

Carcass Measurements

P'alsson (1939), using the 11 lambs described previously, evaluated the use of single carcass measurements as indicators of carcass bone, muscle or fat. He found a strong relationship between the weight of the left fore cannon bone and weight of the skeleton ($r=0.80$, $P < .01$). The relationship was only slightly improved when the weight of all four cannon bones was used in place of the one left fore cannon. His best single internal indicator of carcass muscle was length of "eye muscle" with a correlation of 0.67, $P < .05$. This correlation was improved by the addition of depth of "eye muscle" in millimeters ($R=0.77$, $P < .01$). He found the thickness of fat over the "eye muscle" to be very highly correlated to weight of carcass fat in older, more mature hoggets but to a lesser extent in lambs ($r=0.80$, vs. $r=0.70$, $P < .02$). His best indicator of weight of carcass fat was the thickness of the thickest layer of fat over the last rib ($r=0.82$, $P < .01$).

Field et al. (1963), working with a set of lambs of the same breeding and weight as described previously, evaluated the use of area of loin eye per 45 pounds of carcass, fat thickness over rib, percent kidney and pelvic fat and percent leg as indicators of percent separable carcass fat and lean. The relationships found were significant but low and the estimating equations developed using these single measurements had little predictive value. When area of loin eye, percent kidney and pelvic fat and fat thickness over the loin eye were combined, the coefficient of multiple correlation with percent carcass fat was 0.79 ($P < .01$). This gave an estimating equation of: percent fat in carcass = 32.51 - 4.47 (area of loin eye/45 pounds of carcass, sq. in.) + 0.69 (fat thickness over eye, mm.) + 1.16 (percent kidney and pelvic fat) with a standard error of estimate of 2.43. When percent leg was added to the above measurements, a multiple correlation coefficient with percent carcass lean of 0.75 ($P < .01$) was obtained. This gave an estimating equation of: percent lean in carcass = 33.27 + 3.90 (area of loin eye/45 pounds of carcass, sq. in.) - 0.46 (fat thickness over eye, mm.) - 0.80 (percent kidney and pelvic fat) + 0.53 (percent leg) with a standard error of estimate of 2.14.

Timon and Bichard (1965c) working with the carcasses of 83 Clun Forest wethers and using the same fat measurements as P'alsson (1939), found a high relationship of fat thickness over the "eye muscle", fat thickness of the thickest layer of fat over the last rib and the sum of these two measurements with carcass fat weight ($r=0.82$, $r=0.88$ and r=0.89, respectively, P < .01). None of their measurements were strongly related to carcass muscle percentage. Eye muscle area and the product of length and depth of eye muscle had similar coefficients of correlation of approximately 0.65 (P < .01). Cannon bone weight was more highly correlated with carcass bone weight than any other measurement (re=.60).

Latham *et al.* (1966) found area of loin eye/20 kg. of carcass, fat thickness at 12th rib, percent kidney fat and yield of untrimmed leg, rib and rib plus loin to all be significantly (P < .01) correlated with percent separable carcass lean and fat. No one correlation was, however, large enough to show a strong relationship. Multiple regression equations for predicting fat and lean using loin eye area, fat thickness, percent kidney fat and percent yield of untrimmed leg as independent variables accounted for 63 percent of the variation in carcass fat and 64 percent of the variation in carcass lean.

Specific Gravity

Brown, Hillier and Whatley (1951) determined the relationship between the specific gravity of 32 Duroc hog carcasses and the chemical analyses of the carcasses. They found a strong relationship of carcass percent ether extract and carcass percent protein with carcass specific gravity (r=.75 and r=.65 respectively, P < .01).

Kirton and Barton (1958) used 58 Romney ewe mutton carcasses to evaluate the use of specific gravity in predicting percent chemical carcass fat. The ewes varied greatly in live weight and their carcass weights ranged from 27.6 to 129.7 pounds. The correlation between carcass specific gravity and percent chemical carcass fat was -0.88.

Field et al. (1963), working with a set of rather uniform carcasses, described previously, found carcass specific gravity to have little value in predicting percent separable fat, lean and bone in the carcass. Specific gravity of the rib had a higher relationship with the carcass components than did carcass specific gravity. Correlations between rib specific gravity and percent carcass components were found to be -0.64 for fat, 0.62 for lean and 0.43 for bone ($P < .01$).

An evaluation of the relationship between the specific gravity of the various joints and the percent separable carcass fat and lean was done by Timon and Bichard (1965b). They used the carcasses of 83 Clun Forest wethers slaughtered at about 80 pounds live weight. They found the specific gravity of the loin and best-neck (rib) to be the best indicators of both carcass fat and muscle. The loin showed correlations of -0.89 and 0.82 with carcass fat and muscle, respectively, while the best-neck (rib) had correlations of -0.86 and 0.76 with carcass fat and muscle, respectively. Carcass Weights (in air and under water) were obtained by adding together the individual joint weights. The correlation of carcass specific gravity (using the afore mentioned calculated carcass weights) with percent carcass fat and lean was higher than for any of the individual joints. The correlation coefficients for carcass specific gravity was -0.93 for carcass fat and 0.85 for carcass muscle. All correlations were significant at the $P < .01$ level.

Latham et al. (1966) reported that specific gravity of the carcass, leg, shoulder and rib each had a low correlation with percent fat and lean in the carcass. But specific gravity of the leg and rib was more highly correlated with carcass fat and lean than was the shoulder and the carcass. The carcasses used were of a uniform weight, grade and finish.

Munson (1966) using the carcasses of 123 lambs, described previously, found that the specific gravity of the hind saddle including the kidney knob was the best indicator of percent carcass fat and lean (r=0.70 and r=0.69, respectively) when compared with the specific gravity of the carcass, foresaddle, and individual cuts. Of the individual cuts, the specific gravity of the rack was the best indicator of all three carcass components with correlations of -0.70 ($P < .01$) for fat, 0.64 ($P < .01$) for lean and 0.63 ($P < .01$) for bone.

Adams et al. (1970) investigated the use of specific gravity of the whole carcass, foresaddle, hindsaddle and hindsaddle without kidney and kidney fat for estimating lamb carcass composition. Correlations between measures of carcass composition and the specific gravity of the hindsaddle were higher than those for the whole carcass or any of the other sections studied. Specific gravity values of the hindsaddle were highly associated (0.78 and -0.71) with yield or retail cuts and fat trim. The carcasses used in this study were from 46 ewe and wether lambs produced by matings of Suffolk or Hampshire rams with Rambouillet ewes. The carcasses ranged in weight from 17.6 to 30.9 kg. with a mean of 23.8 kilograms.

Pottasium - 40 Content

Kirton et al. (1961) used a liquid scintillation counter to measure gamma activity of naturally occurring K^{40} in ten recently shorn blackfaced lambs. They had a mean live weight of 88 pounds and a range of 77 to 106 pounds. The K^{40} content of both the live animals and their carcasses were estimated. Measures of carcass composition used were percent separable fat, lean and bone and percent ether extract, protein and water. No significant ($P < .05$) correlations were found between carcass composition and the gamma activity of the carcasses, due in part to less variability among the lambs in comparison to counting precision. Significant correlations were found between the gamma activity of the live animals and their carcass composition but they were not large enough to be of practical importance.

Judge et al. (1963) compared the use of carcass weight, loin eye area, fat thickness and K^{40} count in predicting percent edible portion and percent trim fat of 38 lamb carcasses ranging in weight from 25.8 to 58.5 pounds. K^{40} count was significantly correlated with percent edible portion ($r=0.74$, $P < .01$) and percent fat trim ($r=0.79$, $P < .01$) but loin eye area and fat thickness were more highly correlated with percent edible portion and fat thickness was more highly correlated with percent trim fat than K^{40} count.

In this same study 27 live Southdown cross lambs were counted. They were 5 to 6 months of age and weighed 82 to 108.5 pounds. There was little relationship between K^{40} count and percent edible portion of live weight. The correlations between K^{40} count and percent fat trim of live weight ranged from -0.72 to -0.89 and were generally significant. The correlation of fat thickness and percent trim fat of live weight was 0.78 ($P < .01$).

Effects of Slaughter Weight on Lamb Carcass Traits

Callow (1947) working with cattle and McKeekan (1940) working with pigs found correlations ranging from 0.91 to 0.98 between carcass weight and the weight of dissectable and/or chemical fat. This increase in fat weight as carcass weight increases is not undesirable if it is also accompanied by a similar increase in muscle weight. However, when fat weight increases at a faster rate than muscle weight as carcass weight increases, wasteful carcasses result. Barton and Kirton (1958a) found that as carcass weights increased in a group of 25 mature Romney ewe carcasses, fat weight increased at about twice the rate of muscle weight. In the same study he worked with 33 wether lamb carcasses that ranged in weight from 26 to 50 pounds. In these lamb carcasses, they found that fat weight and muscle weight increased at about the same rate as carcass weight increased. This indicates that if an animal is young and growing, it can be carried to a heavier weight and still maintain a favorable fat to muscle ratio. However, once the animal has matured or nears maturity, an increase in carcass weight will result in fat deposition at an increased rate.

Rouse et al. (1970), conducting a rather comprehensive study on carcass composition at increasing weights, slaughtered 30 western wether lambs at weights of 32, 46 and 50 kilograms. They found that bone deposition occurred at a slower rate from 32 to 50 kg. relative to the other tissues. From 32 to 46 kg. muscle growth nearly doubled but increased very little from 46 to 50 kg. Fat deposition did not show a proportional increase from 32 to 50 kg., but showed a disproportionally greater increase at heavier weights. These data indicated that lean had reached its maximum deposition at 46 kg. and that a large portion of the gain from 46 to 50 kg. was caused by fat deposition. Rouse et al. (1970) also noted that the hindsaddle contained a higher percent separable fat than did the foresaddle in the initial slaughter group. However as the lambs increased in weight, hindsaddle-foresaddle separable fat differences became relatively small. This is an indication that lambs fatten in an anterior to posterior sequence at heavier weights.

Lambuth et al. (1970) slaughtered 72 Hampshire cross wether lambs at weights of 36, 45 and 54 kilograms. They found that the heavier slaughter weight lambs had a higher percent total fat trim, larger loin eye areas and a lower percent total retail yield of carcass weight, edible portion and bone than the lighter slaughter weight groups. Antoniewicz and Pope (1967) and Melton et al. (1968) found similar results when carrying lambs to heavy weights. Lambuth et al. (1970) also noted that the leg and shoulder decreased as a percentage of carcass weight and that the loin and rack increased as a percentage of carcass weight as slaughter weight increased. This indicates that the excess fat is deposited more readily in the loin and rack region than on the shoulder and leg as carcass weight increases.

In order to take advantage of the fact that ram lambs tend to be leaner than either wether or ewe lambs at a given weight, numerous studies have been done which compare the carcasses of ram lambs with the carcasses of wether or ewe lambs at increasing slaughter weights.

Field, Riley and Botkin (1967) reported a study in which carcasses from 36 rams averaging 22 kg. were compared to 49 ram carcasses averaging 32 kg., and both light and heavy rams were compared to 105 ewe and 88 wether carcasses averaging 22 kilograms. All lambs were produced from Western type ewes of Rambouillet, Columbia and Corriedale breeding. Differences in percent retail cuts of carcass weight from heavy and light rams were not significant, but the heavy rams excelled light rams ($P < .01$) in dressing percent, carcass grade, marbling and tenderness. The heavy rams had a lower dressing percent than did the ewes and wethers, but yielded a higher percent of retail cuts of carcass weight possessing more marbling. The heavy rams also had the largest loin eye areas, but Warner-Bratzler shear values indicated that this muscle was tougher in rams ($P < .01$) than it was in ewes and wethers.

Jacobs et al. (1972) slaughtered 43 wether lambs weighing 50 kg., 47 wethers weighing 65 kg. and 50 rams weighing 68 kilograms. All lambs were produced by mating Suffolk rams to whitefaced ewes. The light wethers were trimmer than the heavy wethers and superior in cutability to both the heavy rams and wethers. The heavy rams however were superior to the heavy wethers in measures of fatness and cutability. They also had a smaller 12th rib fat thickness than the light wethers. All differences were significant at the $P < .05$ level.

Taste panel results indicated that both light wethers and rams were significantly ($P < .05$) less tender than heavy wethers. However, rams were comparable to light wethers in all palatability traits studied.

Shelton and Carpenter (1972b) using the carcasses of 196 ewe, wether and ram lambs and Kemp et al. (1970) using 30 ram and 30 wether carcasses, found that as carcass weight increased in each sex group, yields of retail cuts and edible portion decreased and yield of fat trim increased. However the increase in fatness and decrease in retail yield and edible portion was less in the ram carcasses than in the carcasses of the other sex group(s) as carcass weight increased.

Kemp et al. (1972) evaluated the effect of castration and slaughter weight on cooking loss and palatability of lamb. They used the same 30 ram and 30 wether carcasses referred to above. They found that the roasts from the wethers (at all weights) had more drip loss and less evaporative loss during cooking and the meat had higher flavor, tenderness and overall satisfaction scores than meat from rams. As both rams and wethers became heavier, roasts had more drip loss and total cooking loss and were more desirable in juiciness, tenderness and overall satisfaction.

Carcass Traits of Lambs of the Finnish Landrace, Rambouillet and Dorset Breeds of Sheep

The Finnish Landrace, Rambouillet and Dorset represent three potential breeds of sheep that may be used to produce crossbred ewes for fat lamb production in the United States. Each of these breeds excells in one or more of the traits which results in increased reproductive performance or more lambs produced per ewe per year. The Finnish Landrace has been shown in a number of studies to be more prolific and younger at sexual maturity than breeds with which it has been compared. The Rambouillet is noted for its high quality fleeces and both the Rambouillet and Dorset are noted for their long breeding seasons.

However, since the end product of fat lamb production is the lamb carcass, the carcass traits of these three breeds should also be determined. Few comprehensive studies comparing large numbers of breeds for production and growth traits can be found in the literature. Even fewer studies are available comparing the carcass traits of various breeds.

Dickerson et al. (1972) evaluated the carcass traits of 610 ram lambs representing the Suffolk, Hampshire, Polled Dorset, Rambouillet, Targhee, Corriedale and Coarse Wool breeds. The lambs were randomly allotted to a slaughter age group of 22 or 26 weeks, conventional car-measurements were recorded and percent boneless major cuts was estimated using the U.S.D.A. (1969) prediction equation. At both 22 and 26 weeks of age, Rambouillet carcasses exceeded Dorset carcasses by about 2.0 kg. in chilled carcass weight. Dorsets exceeded Rambouillets in dressing percent, leg conformation scores and quality grade. The two breeds were similar for loin eye area, estimated percent boneless major cuts, and 12th rib fat thickness. The Rambouillet carcasses exceeded the Dorset carcasses in percent kidney fat at 26 weeks of age.

This study shows little difference between the carcasses of Rambouillet and Dorset lambs when slaughtered at the same age. If slaughtered at the same wieght, one would expect the Dorset carcasses to have larger loin eye areas, greater 12th rib fat thickness and a lower estimated percent boneless major cuts than the Rambouillet carcasses.

McClelland and Russell (1972) slaughtered 7 Scottish Blackface and 7 Finnish Landrace wether lambs over a weight range of 26 to 41 kilograms. They found no significant difference between the two breeds in mean percent chemical fat in the carcass or in the regression coefficients of percent chemical fat on carcass weight. They did find, however, that the mean percent chemical fat in the muscular plus associated fatty tissues was significantly greater in the Scottish Blackface carcasses, while the Finnish Landrace carcasses had a significantly greater percent chemical fat in the omental plus mesenteric and perirenal fat depots (percent kidney, heart and pelvic fat). Percent subcutaneous fat was not different between the two breeds. Regression coefficients showed that over the weight range studied the Scottish Blackface and Finnish Landrace deposited subcutaneous fat at a similar rate, that the Black face deposited intra and inter muscular fat at a faster rate than the Finnish Landrace and that the Finnish Landrace deposited kidney, heart and pelvic fat at a faster rate than the Scottish Black face. It was concluded that the Finnish Landrace has a pattern of fat deposition resembling the wild or more primitive breeds of sheep.

Shelton and Carpenter (1972a) evaluated the carcasses of 89 wether lambs produced by mating Blackface, Rambouillet, Finnish Landrace, Karakul, Navajo and Barbado rams to Rambouillet ewes and slaughtered at about 100 pounds. Overall, the lambs sired by the Blackfaced and Rambouillet rams (control groups) produced the trimmest, highest cutability carcasses. The Finnish Landrace sired lambs, however, produced carcasses that were very similar to the control groups except in percent kidney and pelvic fat. The Finnish Landrace sired lambs contained about 1.10 percent more kidney and pelvic fat than the Blackface sired lambs and about 0.20 percent more than the Rambouillet sired lambs. The Karakul, Navajo and Barbado lambs carried more external finish and yielded a lower percent boneless cuts than the other groups.

Dickerson (1974) reported a study in which the carcass traits of 434 Finn cross, 165 Rambouillet cross and 610 purebred ram lambs from seven domestic breeds of dams were evaluated. One of the seven domestic purebreds used was the Dorset. The lambs were slaughtered at 22, 26 or 33 weeks of age. Finn cross lambs weighed less than Rambouillet cross lambs at 26 and 33 weeks but dressed 2 to 3 percent higher, had more kidney fat and slightly lower yield of boneless lean cuts at the later slaughter ages. One-half Dorset lambs were superior in leg and carcass conformation and dressed about 2 percent higher than ½ Rambouillet lambs.

Dickerson et al. (1974) also evaluated the carcass traits of 1,044 terminal cross lambs produced by mating Suffolk, Hampshire and Oxford sires with Finn cross, Rambouillet cross and purebred ewes of seven domestic breeds including the Dorset breed. Lambs were slaughtered at either 22 or 24 weeks of age. Lambs from Finn cross ewes exceeded those from Rambouillet cross and purebred ewes in dressing percent (49.9, 48.9, 49.2 percent) and percent kidney fat (4.1, 3.6, 3.6 percent) but were slightly lower in carcass weight (22.7, 23.5, 23.4 kg.), leg conformation score (11.9, 12.1, 12.3), back fat thickness (7.7, 8.0, 8.7 mm) and kilograms of boneless major lean cuts (9.9, 10.2, 10.1 kg.). Lambs from ½ Dorset dams had higher leg conformation scores and a lower percent kidney fat than lambs from ½ Rambouillet dams.

Research in West Germany (Nitter, 1974) and Ireland (Hanrahan, 1974) has shown that lambs produced from Finnish Landrace x domestic breed ewes have a greater percent kidney and total carcass fat and a lower percent carcass bone and muscle than lambs produced by domestic purebreds and other crossbreds when slaughtered at similar weights.

Summary of Literature Review

Available data tends to indicate that the best method of estimating carcass composition other than through complete carcass separation and chemical analysis is obtained by determining the composition of sample cuts. Although studies have disagreed slightly on which cuts are most indicative of carcass composition, fat content of loin seems to have the highest relationship with carcass fat and lean and bone content of the leg tends to have the highest relationship with these components of the carcass.

Relationships between single carcass measurements and carcass composition have been very variable from one study to another and seem to be of little predictive value. The one exception is the strong relationship between cannon bone weight and carcass bone weight in a number of studies.

The results of specific gravity studies are also varied. Available studies would indicate that carcass specific gravity can detect differences in coposition in highly variable populations. Due in part to relatively large amounts of air being trapped in whole carcasses and thus inaccurate specific gravity readings being obtained, specific gravity of smaller portions of the carcass whose composition has a strong relationship to carcass composition tend to have a higher relationship to carcass composition than the specific gravity of the carcass itself. The relationships of the specific gravities of these carcass portions, especially of the hindsaddle, leg and loin, are generally high enough as to be good indicators of carcass composition.

K^{40} content of carcasses seems to be of little value since more easily obtainable carcass measurements such as loin eye area and fat thickness have been shown to have higher relationships with carcass composition than has K^{40} count. K^{40} content of the live animal has been shown to be as good an indicator of carcass fat as carcass fat thickness.

Research indicates that when lambs from populations that have been selected to finish properly at a given weight are slaughtered at heavier weights, carcass fat yield increases and carcass lean or retail cut yield decreases. However, heavier carcasses have larger loin eye areas and are more desirable in juiciness, tenderness and overall eating satisfaction. Ram lambs can be carried to heavier weights and be comparable in retail cut yield to lighter wether and ewe carcasses.

A valid comparison of the carcass traits of the Finnish Landrace, Rambouillet and Dorset breeds of sheep is difficult since no study has been found that has compared all these breeds at the samt time. Also since the Finnish Landrace breed is relatively new to many countries other than Finland, much of the available carcass data on this breed has been generated by crossbred individuals.

Generally, however, studies have shown that when slaughtered at similar weights of about 100 pounds, lambs of Finnish Landrace breeding tend to have a greater percent kidney fat and dressing percent and a slightly lower yield of major cuts than either Dorset or Rambouileet lambs. Dorset lambs tend to have larger loin eye areas, higher dressing percents, higher conformation scores, lower percent kidney fat and greater 12th rib fat thickness than Rambouillet lambs.

CHAPTER III

MATERIALS AND METHODS

Live Animal Procedure

This study involves the carcasses of 60 wether lambs born in January and February, 1974 at the Ft. Reno Livestock Research Station and slaughtered at approximately 100 or 125 pounds live weight. The lambs were a sample of wether lambs produced by mating Hampshire and Suffolk rams to a flock of crossbred ewes in which five combinations of Rambouillet, Dorset and Finnsheep (Finnish Landrace) breeding were represented. The flock was comprised of approximately 50 ewes of each of the five following breed combinations: ¼ Finnsheep, ½ Dorset, ¼ Rambouillet; ¼ Finnsheep, ¼ Dorset, ½ Rambouillet; ¼ Finnsheep, 3/4 Rambouillet; ½ Dorset, ½ Rambouillet and ¼ Dorset, 3/4 Rambouillet. Twelve lambs were selected from each dam breed combination with six lambs assigned to slaughter at about 100 pounds live, full weight and six assigned to slaughter at about 125 pounds live, full weight. Each of two Hampshire and four Suffolk rams sired 10 of the lambs (one lamb for each of the 10 dam breed combination ÷ slaughter weight classes). Table I shows the number of lambs slaughtered at the two weights from each dam breed combination and sire.

Initially, it was thought that only twin reared wether lambs would be included in the study. However, in some cases a sire did not produce

TABLE I

DISTRIBUTION OF LAMBS AS TO DAM'S BREEDING,
SIRE AND APPROXIMATE SLAUGHTER WEIGHT

Dam's Breeding[a]		¼F,½D,¼R		¼F,¼D,½R		¼F,3/4R		½D,½R		¼D,3/4R		
Slaughter Wt.	(lb.)	100	125	100	125	100	125	100	125	100	125	
	H 1	1	1	1	1	1	1	1	1	1	1	10
Sire's Breed	H 2	1	1	1	1	1	1	1	1	1	1	10
and Number[b]	S 3	1	1	1	1	1	1	1	1	1	1	10
	S 4	1	1	1	1	1	1	1	1	1	1	10
	S 5	1	1	1	1	1	1	1	1	1	1	10
	S 6	1	1	1	1	1	1	1	1	1	1	10
		6	6	6	6	6	6	6	6	6	6	60

[a]F=Finnsheep, D=Dorset, R=Rambouillet

[b]H=Hampshire, S=Suffolk

any twin reared wethers in one of the five dam breed combinations, and a single reared wether was selected instead. A total of 9 single reared wethers are included in the study. Tables II and III summarize some growth traits of the lambs from birth to slaughter. These data have been adjusted for differences due to type of birth and rearing using correction factors reported by Gould and Whiteman (1971).

The lambs were born in a large, enclosed lambing barn. They were weighed, identified with a metal ear tag, and placed in an individual pen along with their dams shortly after birth. Docking and castration was done at approximately three days of age. At about five days of age, the lambs and their dams were released from the individual pens and allowed access to a large paddock with other lambs and dams. When two weeks of age, the lambs were moved with their dams to a feeding barn that allowed access to winter wheat pasture. The lambs were also provided with a creep. The "starter" creep ration was fed in a ground form and was composed of 45 percent milo, 40 percent alfalfa, 10 percent soybean oil meal and 5 percent molasses.

Prior to the oldest lambs reaching 66 days of age, all lambs were placed on a bi-weekly weighing schedule. Lambs were weighed full. Any lamb 66 days of age or older at the time of weighing was weaned regardless of his weight or condition. As a result of this arrangement, age at weaning ranged from 66 to 79 days of age. The lambs were weaned by removing the dams to a distant pasture and leaving the lambs in the feeding barn. This is a common management practice with the experimental flock at the Ft. Reno Experiment Station and places minimum stress on the newly weaned lambs by leaving them in familiar surroundings. When all lambs were weaned, they were placed in drylot and finished on a

TABLE II

GROWTH TRAIT MEANS AND STANDARD DEVIATIONS OF THE LAMBS SLAUGHTERED AT APPROXIMATELY 100 POUNDS LIVE WEIGHT[a]

Growth Trait	Dam's Breeding[b]					Pooled S.D.
	¼F,½D,¼R	¼F,¼D,½R	¼F,3/4R	½D,½R	¼D,3/4R	
Birth Wt. (lb.)	8.7	10.1	8.5	8.1	10.3	1.54
70 Day Wt. (lb.)	55.2	62.0	49.3	55.0	59.0	7.40
A. D. G. (lb.)[c]	0.546	0.599	0.610	0.591	0.638	0.108
Slaughter Age (da.)	153.3	136.8	154.7	151.0	136.3	21.05
Slaughter Wt. (lb.)	100.7	102.0	101.0	102.8	101.3	1.85

[a]n=6 lambs per Dam's Breeding group

[b]F=Finnsheep, D=Dorset, R=Rambouillet

[c]Average daily gain is measured from 70 days of age to slaughter

TABLE III

GROWTH TRAIT MEANS AND STANDARD DEVIATIONS OF THE LAMBS SLAUGHTERED AT APPROXIMATELY 125 POUNDS LIVE WEIGHT[a]

Growth Trait	Dam's Breeding[b]					Pooled S.D.
	¼F,½D,¼R	¼F,¼D,½R	¼F,3/4R	½D,½R	¼D,3/4R	
Birth Wt. (lb.)	9.5	8.4	9.2	7.3	10.0	1.90
70 Day Wt. (lb.)	55.3	52.2	53.5	52.7	62.8	8.69
A. D. G. (lb.)[c]	0.612	0.595	0.540	0.546	0.549	0.098
Slaughter Age (da.)	189.0	194.2	200.8	203.3	185.0	30.44
Slaughter Wt. (lb.)	128.2	126.0	124.2	125.5	126.0	1.76

[a]n=6 lambs per Dam's Breeding group

[b]F=Finnsheep, D=Dorset, R=Rambouillet

[c]Average daily gain is measured from 70 days of age to slaughter

ration similar to the creep ration but with the soybean oil meal deleted and the alfalfa and milo each increased by 5 percent.

When the heaviest lamb designated for the study approached 100 pounds, the test lambs were weighed weekly. Upon reaching 100 pounds, all test lambs were shorn and their fleeces weighed. The lambs were shorn for three reasons: (1) a more hygenic job of slaughter could be accomplished with the shorn lambs, (2) it was thought that the lambs going to 125 pounds would tend to gain better during the hot weather of summer if they were shorn and (3) it was felt that more reliable K^{40} counts would be obtained from shorn lambs. Lambs previously designated for slaughter at 100 pounds were taken out of the feedlot when their full weight reached a minimum of 100 pounds. Lambs designated for slaughter at 125 pounds were taken out of the feedlot when their full weight reached a minimum of 125 pounds minus the pounds of wool that the individual produced when shorn at 100 pounds. When a lamb was "weighed off", a visual appraisal of its body type was made by the author with one of the following descriptive terms assigned to the lamb: rangy, typical or compact. These terms were intended to classify the lambs according to skeletal frame with a "rangy" lamb being longer legged and longer bodied and with a "compact" lamb being shorter legged and shorter bodied than a "typical" lamb.

On the same day that a lamb was "weighed off", it was trucked to the Meat Animal Evaluation Center at Stillwater (a distance of about 97 miles) and held overnight without feed or water. The next morning, after approximately a 24 hour shrink period, the amount of radioactive potassium (K^{40}) was estimated in each lamb with the use of the O.S.U. K^{40} whole-body scintillation counter. The lambs were counted in a chamber designed for market weight swine. The counting procedure for each lamb was as follows:

1. Five one-minute background counts were taken with the whole-body counter empty
2. Five one-minute counts were taken with the lamb in the whole-body counter
3. Another set of five one minute background counts were taken with the whole-body counter empty
4. A second set of five one-minute counts was taken with the lamb in the whole-body counter
5. Another set of five one-minute background counts were taken with the whole-body counter empty

Net K^{40} count I was calculated by averaging the first set of five one-minute counts on the lamb and subtracting the average of the ten one-minute background counts taken before and after the lamb had been in the counter. Net K^{40} count II was calculated in a similar manner using the second set of five one-minute counts on the lamb. Overall net K^{40} count was the mean value of the net K^{40} count I and net K^{40} count II and was simply called net K^{40} count.

Slaughter and Carcass Procedure

All lambs were slaughtered according to accepted procedures at the O.S.U. Meats laboratory approximately 30 hours after being "weighed off" at the Ft. Reno Livestock Research Station. Slaughter and carcass procedures were very similar to those described by Munson (1966). At the time of slaughter the thymus glands, right and left crura of the diaphragm (hanging tenderloin) and the spleen were removed. The sternum was split and pork carcass flank spreaders were inserted to hold the ventral midline cut open. A 1 x 1 x 10 inch wooden plug was placed in the pelvic cavity and slightly into the abdominal cavity after the bung was dropped in order to smooth the pelvic fat. The flank spreaders and the wooden plug were used to reduce the chance of trapping air in the hindsaddle during the determination of specific gravity. In order to insure that all kidney fat remained with the hindsaddle, it was pinned posterior to the 13th rib using beef shroud pins. Pelt and hot carcass weights were recorded and the carcass was shrouded.

The carcass was allowed to chill for 24 hours in a 34 to 38 degree Fahrenheit cooler before grading. Maturity, conformation, rib feathering, flank streaking and flank fullness and firmness were visually estimated and a final quality grade determined to the nearest one-third of a USDA grade. Leg conformation scores were also determined to the nearest one-third of a USDA grade. The grades were expressed on the following numerical scale to facilitate statistical analysis:

high prime	15	average choice	11
average prime	14	low choice	10
low prime	13	high good	9
high choice	12	average good	8

The depth of fat over the second sacral vertebra (rump fat depth) was estimated by probing directly over the dorsal vertebral process, approximately three inches anterior to the base of the tail. This probing was done with a steel swine backfat probe on the intact carcass.

The chilled carcasses were weighed to the nearest one hundredth of a pound. A slight knife cut (scoring) was made on both sides from the point of the patella to the junction of the humerus and radius. This scoring facilitated the removal of the flank, breast and shank at a later time. The carcasses were divided into fore- and hind-saddles between the 12th and 13th ribs by making a cut perpendicular to the line of the back and therefore across the ventral tips of the 11th and 12th ribs. Depth of fat over the body wall was measured at the cut surface of the 11th rib.

The area of the longissimus dorsi muscle and fat cover over the l. dorsi was traced onto transparent acetate paper. Fat thickness over the l. dorsi was the average of three fat measurements taken over each l. dorsi muscle. The area of the l. dorsi was measured by using a compensating polar planimeter and averaging the values obtained for the left and right sides of the carcasses.

The fore- and hindsaddles were weighed to the nearest hundredth pound, and hydrostatic weighing was used to determine the specific gravity of the hindsaddle. The weights in air and water were taken as precisely as possible. The tank and water used to weigh the submerged hindsaddles were maintained at the same temperature as the carcasses, i.e. 34 to 38 degrees Fahrenheit. Weights in water were determined in grams and the air weights were converted to grams. The following formula was used to calculate the specific gravity of the hindsaddles:

$$\text{specific gravity} = \frac{\text{weight of hindsaddle in air}}{\text{weight of hindsaddle in air} - \text{weight of hindsaddle in water}}$$

One additional precaution was taken prior to weighing the hindsaddle in water to insure a minimum amount of trapped air. The muscular periphery of the diaphragm was cut loose from its attachment except at the most dorsal and most ventral attachments.

The neck was removed from the shoulder by cutting along a line parallel to the angle of the scapula. All kidney, heart and pelvic fat including the kidneys was removed and weighed. Both the fore- and hindsaddle were split into right and left sides with a rotating band saw. The fore (metacarpals) and rear (metatarsals) cannon bones of both right and left side were removed, trimmed of soft tissue and weighed on a gram balance.

The flanks were removed from the hindsaddle by a cut which started in the crotch and proceeded out to and along the scored line previously mentioned. The leg was removed from the loin between the second and third sacral vertebrae with the cut being made perpendicular to the line of the back. As a result, the sirloin area was included with the loin.

The breast and shank were cut from the foresaddle along the scored lines. Separation of the shank from the breast was at the natural seam. The rack and shoulder were separated by cutting between the 5th and 6th ribs perpendicular to the line of the back. This procedure yielded a seven rib rack.

The flanks, shanks and breasts of both the right and left sides were handled similarly. The flanks were dissected into separable lean and fat, and the shanks were dissected into separable lean, fat and bone. The breasts were divided in half with a cut perpendicular to the previously scored line. The anterior half which contained the major portion of the sternum was dissected into separable lean, fat and bone. The subcutaneous fat of the remaining half was removed. Breast bone was the bone removed from the anterior half, breast fat was separable fat from the anterior half plus subcutaneous fat of the posterior half and breast lean was the remainder.

All subcutaneous fat was trimmed from the major cuts of the right side (shoulder, rack, loin and leg). The shoulder and leg were also completely boned. Intermuscular fat in close proximity of the bones was also removed. The weight of the trimmed rack and loin plus the weight of the trimmed and boned shoulder and leg was denoted as pounds of trimmed major cuts of right side.

The major cuts of the left side were trimmed in such a manner that an average of approximately 0.2 inches of subcutaneous fat remained on each cut. The tibia was removed from the leg producing an "American cut" leg. The weight of these four trimmed cuts was denoted as pounds of trimmed major cuts of left side.

Statistical Analysis

The data were arranged in a randomized complete block design with a 2 x 5 factorial arrangement of treatments (2 slaughter weights and 5 dam breed combinations). There were six blocks with each block containing 10 lambs, all sired by the same sire. (See Table I). The data were analyzed using the computer program entitled Statistical Analysis System (SAS) developed by Barr and Goodnight (1972) at North Carolina State University.

The linear model used in the analysis for each carcass trait was:

$$Y_{ijkl} = \mu + W_i + D_j + s_k + (WD)_{ij} + e_{ijkl}$$

where:

Y_{ijkl} = the observed carcass trait of the lth lamb from the kth sire, jth dam's breeding group and ith slaughter weight group.

μ = population mean.

W_i = fixed effect of the ith slaughter weight group; i = 1,2.

D_j = fixed effect of the jth dam's breeding group; j = 1,2,3,4,5.

s_k = random effect of the kth sire; k = 1,2,3,4,5,6.

$(WD)_{ij}$ = interaction effect of ith slaughter weight group and the jth dam's breeding group.

e_{ijkl} = random error associated with the ijklth observation

One of the 60 designated lambs foundered and was not slaughtered. In order for the data to be balanced and complete, all slaughter data was estimated for the missing cell using a procedure described by Snedecor and Cochran (1967) pp. 317-320. The missing values were estimated using the following formula:

$$X = \frac{aT + bB - S}{(a-1)\ (b-1)}$$

where:

a = number of treatments

b = number of blocks

T = sum of items with same treatment as missing item

B = sum of items in same block as missing item

S = sum of all observed items

The estimated values were treated like normal data points and sums of squares in the analysis of variance were computed as usual. However, the degrees of freedom in the "Total" and "Error Sums of Squares" were both reduced by one. This method gave the correct least squares estimates of the treatment means and of the Error mean square, but the Treatment mean square was slightly inflated. It was decided, however, that this latter point generally be ignored and be considered only if the probability of obtaining an F value as large or larger than the calculated F was approximately equal to the predesignated significance level. This situation did not arise.

The general Analysis of Variance table used for each trait studied along with the associated degrees of freedom and expected mean squares is given in Table IV. In deciding which line entry or entries should be used as error, the two-way interactions "Sire x Dam's Breeding" and "Sire x Slaughter Weight" were tested with the three-way interaction "Sire x Dam's Breeding x Slaughter Weight". For most traits neither of the calculated F values were significant at the $P < .05$ level. This indicated that all three interaction mean squares were probably estimating the same variance. As a result, the Error Mean Square used was the pooled value of the mean squares of these three interactions.

Since the "Dam's Breeding x Slaughter Weight" interaction's F value was not significant at the $P < .05$ level and generally less than the value one for the majority of the traits studied, the effect of dam's breeding group and slaughter weight group are presented averaged over slaughter weight group and dam's breeding group, respectively.

Simple correlations (product - moment) of K^{40} count, 12th rib fat thickness, loin eye area and hindsaddle specific gravity with yield of lean and fat trim were calculated within slaughter weight group using the CORR procedure of SAS. Spearman's rank correlations were calculated for live score with yield of lean and fat trim since live score is not normally distributed. The Spearman's rank correlations were also calculated within slaughter weight group. The Spearman procedure of SAS was used.

TABLE IV

ANALYSIS OF VARIANCE

Source	d.f.	Expected M.S.
Total	58	
Sires	5	$\sigma^2 + 10\sigma^2_S$
Dam's Breeding	4	$\sigma^2 + 12K^2_{DB}$
Slaughter Weight	1	$\sigma^2 + 30K^2_{SW}$
Dam's Brdng x Sl. Wt.	4	$\sigma^2 + 6K^2_{DB \times SW}$
Error[a]	44	σ^2

[a]Error was calculated by pooling the sums of squares of the following interactions: Sire x Dam's Brdng, Sire x Sl. Wt. and Sire x Dam's Brdng x Sl. Wt.

In order to test the hypothesis that the correlations obtained in the two slaughter weight groups were estimating the same population rho and then to pool them into an estimate of rho, z transformations were used as described by Snedecor and Cochran (1967) pp. 186-188.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter will be divided into three main sections: 1) Carcass traits of wether lambs produced by crossbred ewes of five combinations of Finnsheep, Dorset and Rambouillet breeding, 2) Carcass traits of wether lambs slaughtered at two live weights and 3) relationship of K^{40} content of the live lamb with yield of lean and fat trim.

Carcass Traits of Wether Lambs Produced by Crossbred Ewes of Five Combinations of Finnsheep, Dorset and Rambouillet Breeding

Table V presents the mean values of some carcass traits of lambs produced by the five crossbred dam groups. Differences among lambs produced by the five crossbred dam groups were small and nonsignificant at the $P < .05$ level for most traits studied. This might be expected since the lambs were all sired by blackfaced rams of Suffolk or Hampshire breeding. There are, however, some tendencies in these data that deserve elaboration.

Quality grades were quite similar and acceptable with all five groups averaging high choice. Dressing percents were likewise quite similar among lambs produced by the five crossbred dam groups ranging from 48.74 percent to 49.72 percent; a difference of only about 1.0 percent.

TABLE V

MEANS AND STANDARD ERRORS FOR SOME CARCASS TRAITS OF LAMBS PRODUCED BY THE FIVE CROSSBRED DAM GROUPS[d]

Carcass Trait	Dam's Breeding[e]					S.E.M.
	¼F,½D,¼R	¼F,¼D,½R	¼F,3/4R	½D,½R	¼D,3/4R	
Quality Grade[f]	12.00	12.50	12.00	12.33	12.67	0.240
Dressing %	49.72	48.74	49.18	49.42	49.32	0.590
Leg Conf. Score[f]	11.92	11.67	11.42	11.75	11.50	0.332
% Kidney & Pelvic Fat	4.42^{l,m}	4.32^{l,m}	4.48^{l}	3.65^{n}	3.83^{m,n}	0.269
12th Rib Fat Th. (in.)	0.27	0.25	0.30	0.30	0.27	0.022
USDA Yield Grade	3.99	3.85	4.21	4.00	3.84	0.172
Loin Eye Area (in.^{2})	2.27^{l,m}	2.21^{m,n}	2.09^{n}	2.36^{l}	2.29^{l,m}	0.067
Rump Fat Probe (in.)	0.55^{b}	0.59^{b}	0.57^{b}	0.78^{a}	0.59^{b}	0.050
Hindsaddle Sp. Gravity	1.040	1.044	1.042	1.041	1.042	0.0021
% Fat Trim from Major Cuts of Car. Wt.	13.52	13.20	14.26	14.99	13.30	0.611
% Trimmed Major Cuts of Car. Wt.	56.07	56.34	55.02	55.86	56.67	0.607

[a,b,c]Means denoted by different superscripts in the same row are significantly different at the $P < .05$ level.

[l,m,n]Means denoted by different superscripts in the same row are significantly different at the $P < .10$ level.

[d]n=12 lambs per crossbred dam group; averaged over slaughter weight group

[e]F=Finnsheep, D=Dorset, R=Rambouillet

[f]11=average choice, 12-high choice

Since the Finnish Landrace breed is thought to be inferior in muscling to our domestic breeds, one might expect the carcasses of lambs from one-quarter Finnsheep dams to have lower leg conformation scores. However, scores among the five groups were not significantly different. If there is any dam's breeding effect on leg conformation score, these data indicate that it might possibly be dependent upon the proportion of Dorset breeding present since lambs from dams of ½ Dorset breeding had the highest mean leg conformation scores and lambs from dams containing no Dorset breeding had the lowest mean scores.

Lambs produced by dams containing ¼ Finnsheep breeding tended to produce carcasses with a greater ($P < .10$) percent kidney and pelvic fat than did lambs produced by dams of ½ Dorset, ½ Rambouillet breeding. The tendency of lambs of Finnsheep breeding to deposit larger amounts of internal fat than other breeds has been documented by several other researchers. McClelland and Russell (1972) working with pure Finnsheep wethers, Shelton and Carpenter (1972) working with ½ Finnsheep wethers and Dickerson _et al_. (1974) working with ¼ Finnsheep wethers all reported that lambs containing some Finnsheep breeding deposited larger amounts of fat internally than lambs of domestic breeding. The lambs in this study were only 1/8 Finnsheep breeding and this tendency was still evident. The Finnsheep breed is evidently very prepotent for this trait.

Dickerson (1972) also observed that purebred ram lambs of Rambouillet breeding exceeded ram lambs of Dorset breeding in percent kidney and pelvic fat when slaughtered at 26 weeks of age. A slight tendency toward a similar relationship is evident in these data. Of the lambs produced from dams containing only Dorset and Rambouillet breeding, the lambs from dams containing the greatest proportion of

Rambouillet breeding (¼ Dorset, 3/4 Rambouillet) had the greatest mean value for percent kidney and pelvic fat. Likewise, of the lambs produced by dams of one-quarter Finnsheep breeding, the lambs from dams containing the greatest proportion of Rambouillet breeding (¼ Finnsheep, 3/4 Rambouillet) again had the greatest mean values for percent kidney and pelvic fat. Lambs from dams of ¼ Finnsheep, ½ Dorset, ¼ Rambouillet and ¼ Finnsheep, ¼ Dorset, ½ Rambouillet breeding did not follow this pattern.

USDA yield grades were not significantly different among the lambs produced by the five crossbred dam groups. However, lambs produced by dams of ¼ Finnsheep, 3/4 Rambouillet breeding were inferior to the other lambs in the mean values of the three traits which determine yield grade (leg conformation score, percent kidney and pelvic fat and 12th rib fat thickness) and as a result had the highest mean yield grade.

Mean loin eye areas of lambs produced by dams containing ¼ Finnsheep breeding were smaller than mean loin eye areas of lambs produced by dams of Dorset and Rambouillet breeding only. However these data indicate that acceptable loin eye areas can be obtained from lambs produced by dams of ¼ Finnsheep breeding if at least ¼ Dorset is also present. Lambs produced by dams of ¼ Finnsheep, 3/4 Rambouillet breeding had loin eye areas that were significantly less ($P < .07$) than the loin eye areas of lambs produced by the ½ Dorset, ½ Rambouillet dams.

Lambs produced by ½ Dorset, ½ Rambouillet dams had a significantly greater rump fat probe than did the lambs produced by the other four groups. This is an indication that lambs of this breeding tend to deposit fat over the rump at a faster rate than lambs of the other groups.

Pounds of fat trim from the major cuts of the right side (shoulder, rack, loin and leg) expressed as a percentage of right side carcass weight was not significantly different among the five groups. However lambs produced by ½ Dorset, ½ Rambouillet dams which had a tendency toward greater subcutaneous fat deposition as indicated by fat thickness at the 12th rib and rump fat probe and lambs produced by ¼ Finnsheep, 3/4 Rambouillet dams which were the lightest muscled group as indicated by loin eye area, had the largest mean values for percent fat trim from the major cuts. Similarly, percent trimmed major cuts was not significantly different among the five groups, but lambs produced by the ¼ Finnsheep, 3/4 Rambouillet and ½ Dorset, ½ Rambouillet dams had the lowest mean values.

Table VI presents the mean values for the proportion of carcass weight in foresaddle, hindsaddle and untrimmed and trimmed major cuts of lambs produced by the five crossbred dam groups. The only major cut that differed significantly among the five groups in its proportion of carcass weight was untrimmed loin weight. Lambs produced by ¼ Dorset, 3/4 Rambouillet and ½ Dorset, ½ Rambouillet dams had a significantly greater percent untrimmed loin than did lambs produced by ¼ Finnsheep, ¼ Dorset, ½ Rambouillet dams. Percent untrimmed loin is influenced greatly by both subcutaneous fat deposition and the amount of <u>longissiums dorsi</u> muscle present. Table V, presented previously, indicates that lambs from ¼ Finnsheep, ¼ Dorset, ½ Rambouillet dams tended to have less subcutaneous fat trim and smaller loin eye areas than lambs from dams of Dorset and Rambouillet breeding only which would tend to explain these differences in percent of untrimmed loin weight.

TABLE VI

MEANS AND STANDARD ERRORS FOR PERCENT FORESADDLE, HINDSADDLE AND MAJOR CUTS[c] OF CARCASS WEIGHT OF LAMBS PRODUCED BY THE FIVE CROSSBRED DAM GROUPS.[d]

	Dam's Breeding[e]					
Carcass Cut	¼F,½D,¼R	¼F,¼D,½R	¼F,3/4R	½D,½R	¼D,3/4R	S.E.M.
%Foresaddle	48.78	48.56	48.18	48.65	48.73	0.277
% Hindsaddle	50.62	50.90	51.23	50.70	50.79	0.287
% Shoulder	24.29	24.55	24.32	24.47	24.52	0.244
% Trimmed & Boned Shoulder	17.61	17.79	17.06	17.38	17.80	0.250
% Rack	10.24	10.19	10.12	10.66	10.41	0.184
% Trimmed Rack	7.30	7.50	7.11	7.55	7.50	0.118
% Loin	17.44[a,b]	16.87[b]	17.54[a,b]	17.95[a]	18.02[a]	0.297
% Trimmed Loin	12.88	12.46	12.64	12.97	13.37	0.259
% Leg	24.59	25.12	24.91	24.70	24.60	0.314
% Trimmed & Boned Leg	18.29	18.59	18.21	17.96	18.01	0.295

[a,b]Means denoted by different superscripts in the same row are significantly different at the $p < .05$ level

[c]$\% \text{ Major Cut} = \frac{\text{Weight of the Major Cut of Right Side}}{\text{Weight of Right Side}}$

[d]n=12 lambs per crossbred dam group; averaged over slaughter weight group

[e]F=Finnsheep, D=Dorset, R=Rambouillet

Table VII indicates that the five groups of lambs were quite similar for the percent of each major cut made up of subcutaneous fat trim and trimmed (and boned for the shoulder and leg) major cut. However, lambs from ½ Dorset, ½ Rambouillet and ¼ Finnsheep, 3/4 Rambouillet dams had the largest mean values for percent fat trim and the lowest mean values for percent trimmed cut from the shoulder, rack and loin. For the shoulder, these differences were significant at $P < .10$. Similar results existed for the leg except that the mean values for percent fat trim of the leg was slightly greater for lambs from ¼ Finnsheep, ¼ Dorset, ½ Rambouillet dams than it was for lambs from ¼ Finnsheep, 3/4 Rambouillet dams. These findings again point out the fact that lambs from ½ Dorset, ½ Rambouillet dams carried excessive amounts of external finish and that lambs from ¼ Finnsheep, 3/4 Rambouillet dams were light muscled and carried large amounts of external finish when compared with lambs of the other three groups.

Percent bone of the shoulder was significantly greater for lambs from ¼ Finnsheep, 3/4 Rambouillet and ¼ Dorset, 3/4 Rambouillet dams when compared with lambs from ¼ Finnsheep, ½ Dorset, ¼ Rambouillet and ½ Dorset, ½ Rambouillet dams. Percent bone of the leg tended to be greatest ($P < .10$) for lambs from ¼ Dorset, 3/4 Rambouillet and ¼ Finnsheep, 3/4 Rambouillet dams when compared with lambs from ½ Dorset, ½ Rambouillet dams. Many workers including P'alsson (1939), Hankins (1947), Barton and Kirton (1958b), Field <u>et al.</u> (1963), Timon and Bichard (1965a) and Latham <u>et al.</u> (1966) have found that the weight or percent bone of the shoulder or leg are good indicators of total carcass bone with correlations ranging from 0.81 to 0.95. These data would then indicate that the lambs produced by the ½ Dorset, ½ Rambouillet dams

TABLE VII

MEANS AND STANDARD ERRORS FOR WEIGHT OF THE MAJOR CUTS OF RIGHT SIDE AND THEIR PERCENT SEPARABLE COMPONENTS FROM CARCASSES OF LAMBS PRODUCED BY THE FIVE CROSSBRED DAM GROUPS.[d]

Carcass Cut	Dam's Breeding[e]					S.E.M
	¼F,½D,¼R	¼F,¼D,½R	¼F,3/4R	½D,½R	¼D,3/4R	
Shoulder Wt.	6.82	6.78	6.68	6.80	6.82	0.105
% Fat Trim	13.54^{l,m,n}	12.71^{m,n}	14.47^{l,m}	15.20^{l}	12.12^{n}	0.899
% Bone	13.72^{b}	14.63^{a,b}	14.97^{a}	13.68^{b}	14.71^{a}	0.342
% Trimmed & Boned Shoulder	72.47	72.49^{l}	70.13^{m}	70.95^{l,m}	72.59^{l}	0.807
Rack Wt.	2.88	2.83	2.80	2.99	2.92	0.065
% Fat Trim	27.03	25.33	28.00	26.57	26.57	1.150
% Trimmed Rack	71.58	73.69	70.46	71.04	72.23	1.132
Loin Wt.	4.91	4.66	4.82	5.01	5.02	0.099
% Fat Trim	26.16	25.89	27.82	27.61	25.26	1.103
% Trimmed Loin	73.87	73.99	72.03	72.25	74.28	1.132
Leg Wt.	6.89	6.89	6.81	6.84	6.81	0.112
% Fat Trim	11.75	12.43	12.19	13.51	12.13	0.631
% Bone	13.72^{m,n}	13.80^{m,n}	14.26^{l,m}	13.56^{n}	14.38^{l}	0.238
% Trimmed & Boned Leg	74.35	73.90	73.12	72.65	73.13	0.556

[a,b,c]Means denoted by different superscripts in the same row are significantly different at the P < .05 level.

[l,m,n]Means denoted by different superscripts in the same row are significantly different at the P < .10 level.

[d]n=12 lambs per crossbred dam group; averaged over slaughter weight group

[e]F=Finnsheep, D=Dorset, R=Rambouillet

tend to have the least percent carcass bone and that lambs from ¼ Finnsheep, 3/4 Rambouillet and ¼ Dorset, 3/4 Rambouillet dams tend to have the greatest percent carcass bone.

Carcass Traits of Lambs Slaughtered at Two Live Weights

The purpose of this section is to compare the carcass traits of the 30 light lambs slaughtered at approximately 100 pounds live weight with the 30 heavy lambs slaughtered at approximately 125 pounds live weight. The literature review has cited a number of studies that have shown that as slaughter weight increases above 100 pounds; carcass fat deposition increases, loin eye areas increase, percent carcass bone decreases and yield of trimmed major cuts (edible portion) of the carcass decreases.

Table VIII presents the means and standard errors of some carcass traits of the light and heavy lambs. The mean values for all traits listed in Table VIII were significantly different between the two slaughter weight groups at the $P < .01$ level.

The heavy lambs produced carcasses which had a higher mean quality grade, dressing percent, leg conformation score, yield grade, percent kidney and pelvic fat, fat thickness at the 12th rib and rump fat probe and a lower mean hindsaddle specific gravity than did the carcasses from the light lambs. All of these traits indicate that the carcasses produced by the heavy lambs were fatter and more wasteful than carcasses produced by the light lambs. Mean loin eye areas were however significantly larger when from the carcasses produced by the heavy lambs. Increasing loin eye areas in lambs is of economic importance to the sheep

TABLE VIII

MEANS AND STANDARD ERRORS FOR SOME CARCASS TRAITS OF LAMBS SLAUGHTERED AT TWO LIVE WEIGHTS[a]

Carcass Trait	Approx. Live Weight[b] 100 lbs.	125 lbs.	S.E.M.
Actual Slaughter Wt. (lb.)	101.57	125.90	0.321
Quality Grade[c]	11.63	12.97	0.152
Dressing Percent	47.67	50.88	0.373
Leg Conf. Score	11.27	12.03	0.210
Percent Kidney and Pelvic Fat	3.28	5.00	0.170
Fat Thickness, 12th Rib. (in.)	0.22	0.34	0.014
U.S.D.A. Yield Grade[c]	3.35	4.60	0.109
Loin Eye Area (in.^{2})	2.07	2.42	0.043
Rump Fat Probe (in.)	0.46	0.78	0.031
Hindsaddle Sp. Gravity	1.047	1.036	0.0013

[a]n=30 lambs per slaughter group.

[b]All differences between means in the same row are significant at the $P < .01$ level.

[c]11=average choice, 12-high choice.

industry in order to gain increased consumer acceptance of the higher priced loin cuts. These data indicate that a significant and rather large (+ .35 $in.^2$) increase can be obtained in lamb carcass loin eye areas by merely increasing live slaughter weight from 100 to 125 pounds. However this increase in weight also causes increased deposition of fatty tissues which will tend to lower yield of trimmed major cuts and edible portion as a percent of carcass weight as is shown in Table IX.

Table IX also presents the percent of the carcass which is composed of each of the four major cuts, foresaddle and hindsaddle for the two slaughter weight groups. Percent foresaddle and hindsaddle were not significantly different between the two slaughter weight groups, but as slaughter weight increased, percent foresaddle decreased and percent hindsaddle increased. This slight increase in percent hindsaddle is due to increased deposition of kidney and pelvic fat by the heavier weight lambs. If the pounds of kidney and pelvic fat is subtracted from the hindsaddle and cold carcass weights, percent hindsaddle is greater (not significnatly, $P > .25$) for the light slaughter weight group.

Percent shoulder and leg of carcass weight decreased ($P < .10$ and $P < .01$, respectively) and percent rack and loin of carcass weight increased ($P < .01$ and $P > .25$, respectively) as slaughter weight increased from 100 to 125 pounds live weight. These findings are similar to those of Lambuth et al. (1970) and indicate that as lambs increase in live weight, fat is deposited at a greater rate on the rack and loin than on the shoulder and leg. Percent trimmed and boned shoulder and leg of carcass weight were significantly greater for the lighter weight carcasses. Percent trimmed loin was also significantly greater for the

TABLE IX

MEANS AND STANDARD ERRORS FOR PERCENT FORESADDLE, HINDSADDLE AND MAJOR CUTS[a] OF CARCASS WEIGHT OF LAMBS SLAUGHTERED AT TWO LIVE WEIGHTS[b]

% Carcass Cut	Approx. Live Weight 100 lbs.	Approx. Live Weight 125 lbs.	S.E.M.	Significance Level
% Foresaddle	48.79	48.36	0.175	<0.10
% Hindsaddle	50.66	51.03	0.181	<0.25
% Shoulder	24.64	24.28	0.154	<0.10
% Trimmed and Boned Shoulder	18.22	16.83	0.158	<0.01
% Rack	10.03	10.62	0.116	<0.01
% Trimmed Rack	7.39	7.39	0.075	>0.25
% Loin	17.51	17.62	0.188	>0.25
% Trimmed Loin	13.23	12.50	0.164	<0.01
% Leg	25.81	23.76	0.199	<0.01
% Trimmed and Boned Leg	19.23	17.20	0.186	<0.01
% Major Cuts	77.98	76.28	0.205	<0.01
% Trimmed Major Cuts	58.07	53.92	0.384	<0.01

[a]Percent Major Cut = $\frac{\text{Weight of the Major Cut of the Right Side}}{\text{Weight of Right Side}}$.

[b]n=30 lambs per slaughter group.

lighter group but percent trimmed rack was similar for both weight groups. The higher than expected value for percent trimmed rack of the heavy weight group is probably due to the fact that a large depot of intermuscular fat was present under the latissimus dorsi muscle of the heavy carcasses. This seam fat was not removed during trimming. Percent major cuts of carcass weight was significantly less for the carcasses produced by the heavy slaughter weight group indicating that the rough cuts (neck, breast, shank and flank) plus kidney and pelvic fat increased in weight at a faster rate from 100 to 125 pounds live weight than did the weight of the four major cuts.

Table X presents means and standard errors for weight of the major cuts of the right side and their percent separable components from carcasses of the two slaughter weight groups. The major cuts from the carcasses of the heavy lambs were significantly heavier, had a significantly greater percent fat trim and a significantly lower percent bone (for shoulder and leg) and percent trimmed (and boned for shoulder and leg) cut weight than did the major cuts from the carcasses of the light lambs.

Table VIII showed that dressing percent was significantly greater for the heavy slaughter weight group. This indicates that as slaughter weight increased from 100 to 125 pounds live weight, carcass weight increased at a faster rate than did the combined weight of the viscera, blood, pelt, head, hoofs, etc. It has been indirectly indicated previously that a greater portion of this increased carcass weight is probably fatty tissue rather than muscular tissue or bone. As a result, heavy lambs have a lower yield of trimmed cuts from their carcasses than do the light lambs. However, there are some segments of the sheep

TABLE X

MEANS AND STANDARD ERRORS FOR WEIGHT OF THE MAJOR CUTS OF THE RIGHT SIDE AND THEIR PERCENT SEPARABLE COMPONENTS FROM CARCASSES OF LAMBS SLAUGHTERED AT TWO LIVE WEIGHTS[a]

	Approx. Live Weight[b]		
Carcass Cut	100 lbs.	125 lbs.	S.E.M.
Shoulder Wt. (lb.)	5.89	7.67	0.067
% Fat Trim	10.32	16.90	0.333
% Bone	15.22	13.47	0.216
% Trimmed and Boned Shoulder	73.99	69.46	0.511
Rack Wt. (lb.)	2.40	3.36	0.041
% Fat Trim	24.32	29.61	0.727
% Trimmed Rack	73.97	69.64	0.716
Loin Wt. (lb.)	4.19	5.58	0.062
% Fat Trim	24.32	28.78	0.697
% Trimmed Loin	75.56	71.00	0.701
Leg Wt. (lb.)	6.17	7.52	0.071
% Fat Trim	10.72	14.09	0.399
% Bone	14.58	13.30	0.150
% Trimmed and Boned Leg	74.49	72.37	0.352

[a]n=30 lambs per slaughter group

[b]All differences between means in the same row are significant at the $P < .01$ level.

industry (primarily the packer) that should be concerned with the yield of trimmed cuts as a percent of live weight. Table XI presents this information.

Percent fore- and hindsaddle of live weight was significantly greater for the heavy lambs. The heavy lambs also had a significantly greater percent shoulder, rack, loin and major cuts of their live weight than did the light lambs. These findings are all reflections of the greater dressing percents of the heavy lambs. Since the heavy lambs have a greater proportion of their live weight as carcass, we would also expect their major cuts (which are parts of the whole) to make up a larger proportion of their live weight when compared with the light lambs. There was no significant difference between the two weight groups in percent leg. This again shows that as carcass weight increases, subcutaneous fat is deposited at a slower rate on the leg than on the other cuts.

The heavy lambs had a similar yield of trimmed and boned shoulder, significantly greater yield of trimmed loin, significantly lower yield of trimmed and boned leg and overall, a similar yield of trimmed (and boned for shoulder and leg) major cuts when compared with the light lambs. These data indicate that blackface sired lambs slaughtered at approximately 100 and 125 pounds live weight will yield similar proportions of their respective live weights in trimmed major cuts.

This finding should be of economic interest to some of the nation's larger lamb packers who have begun to break lamb carcasses and trim and vacuum package the major cuts in their own plants. It should be possible to produce more pounds of trimmed product per unit of labor or time from heavy lambs than from light lambs. Also, the trimmed loins from the heavy lambs should be more acceptable to consumers and retailers because

TABLE XI

MEANS AND STANDARD ERRORS FOR PERCENT FORESADDLE, HINDSADDLE AND MAJOR CUTS[a] OF LIVE WEIGHT OF LAMBS SLAUGHTERED AT TWO LIVE WEIGHTS[b]

% Carcass Cut	Approx. Live Weight 100 lbs.	125 lbs.	S.E.M.	Significance Level
% Foresaddle	23.26	24.61	0.204	<0.01
% Hindsaddle	24.14	25.97	0.201	<0.01
% Shoulder	11.61	12.18	0.120	<0.01
% Trimmed and Boned Shoulder	8.58	8.46	0.088	>0.25
% Rack	4.73	5.34	0.075	<0.01
% Trimmed Rack	3.48	3.72	0.045	<0.01
% Loin	8.25	8.86	0.107	<0.01
% Trimmed Loin	6.22	6.28	0.080	>0.25
% Leg	12.15	11.95	0.118	<0.25
% Trimmed and Boned Leg	9.05	8.65	0.098	<0.01
% Major Cuts	36.74	38.33	0.285	<0.01
% Trimmed Major Cuts	27.34	27.11	0.222	>0.25

[a]$\% \text{ Major Cut} = \frac{\text{Weight of the Major Cut of Right Side} \times 2}{\text{Slaughter Weight}}$.

[b]n=30 lambs per slaughter group.

of their larger loin eye areas. And this study shows that heavy (125 pound) and light (100 pound) lambs sired by blackfaced sires will yield similar proportions of their live weights in trimmed major cuts. It would seem that heavy lambs similar to the ones used in this study would be preferred by packers who break lamb carcasses in their own plants. Also it would seem that payment of lower prices by those packers for lambs in excess of 100 pounds live weight is not always warranted.

Relationship of K^{40} Content of the Live Lamb With Yield of Lean and Fat Trim

Radioactive potassium (K^{40}) content of each lamb was estimated as outlined previously using the Oklahoma State University whole-body scintillation counter. Two net counts were obtained on each lamb with these being averaged and used as net K^{40} count.

Table XII gives the correlations between K^{40} count I and K^{40} count II for lambs of the slaughter weight groups. Correlations of 0.67 and 0.93 existed between the two counts for the light and heavy slaughter weight groups, respectively. These correlations were significantly different from each other at the $P < .0005$ level. The coefficients of determination (r^2) for the light and heavy slaughter weight groups were 0.45 and 0.86, respectively indicating that the proportion of the variation in Count II accounted for by Count I was greater in the heavy slaughter weight group than in the light slaughter weight group (86 percent vs. 45 percent). If K^{40} count I and K^{40} count II were the same on each individual lamb and thus completely repeatable, the correlation (r) between count I and II and the coefficient of determination would be equal to 1.0. These data indicate that K^{40} count is not

TABLE XII

CORRELATION OF K^{40} COUNT I WITH K^{40} COUNT II FOR THE TWO SLAUGHTER WEIGHT GROUPS

	Approx. Slaughter Wt. (lb.)	
	100	125
r	.67[a]	.93[a]

[a]P < .0001 that rho = 0.

completely repeatable for either slaughter weight group, but that it is more repeatable for the heavy group than the light group.

A possible explanation for the differences in the repeatability of K^{40} count between the two slaughter weight groups may lie in the type of counting chamber used. The chamber was specifically designed for market weight swine, and the light lambs being smaller than the heavy lambs did not fill the chamber as well and as a result were further away from the surrounding panels which detect the gamma radiation given off by K^{40}. This increased distance between the light lamb and the detecting panels would perhaps allow for a greater chance of radiation given off by the animal of not being detected and a greater chance of radiation from other sources of being detected. This would explain the more erratic readings with the lighter lambs.

Table XIII gives the pooled within slaughter weight group correlations of K^{40} count with trimmed major cuts (trimmed and boned shoulder + trimmed rack + trimmed loin + trimmed and boned leg) and subcutaneous fat trim from these major cuts expressed as pounds, percent of carcass weight and percent of live weight. Also included are the correlations of 12th rib fat thickness, loin eye area, hindsaddle specific gravity and subjective live body type score with the same compositional measures mentioned above. These measurements are relatively easy to obtain and are given in order to compare their relationships with trimmed major cuts and fat trim with those of K^{40} count.

It is evident from Table XIII that the relationship between K^{40} count of the live lamb and trimmed major cuts and fat trim expressed in the three different manners is very low. All correlations were less than 0.14 and not significantly different ($P < .05$) from zero. The only

TABLE XIII

CORRELATIONS OF K^{40} COUNT AND OTHER INDICATORS OF COMPOSITION WITH MAJOR CUT AND FAT TRIM YIELD POOLED WITHIN SLAUGHTER WEIGHT GROUP[a]

Correlated Traits	K^{40} Count	12th Rib Fat Th.	L.E.A.	Hindsaddle Sp. Gr.	Live Score
Tr. Major Cuts (lb.)	.14	-.38	.57	.20	-.20
Fat Tr. from Major Cuts (lb.)	.11	.69	-.15	-.68	.22
Carcass Wt.					
% Tr. Major Cuts	-.02	-.69	.39	.66	-.16
% Fat Tr. From Major Cuts	.06	.71	-.22	-.64	.27
Live Wt.					
% Tr. Major Cuts	.14	-.40	.57	.22	-.22
% Fat Tr. from Major Cuts	.10	.70	-.15	-.67	.23

[a]If $|r| > .25$ then $P < .05$ that rho = 0.

other live animal measure on the lambs was a subjective live body type score described in Chapter III: 1 = rangy, 2 = typical and 3 = compact. The correlations of this score with trimmed major cuts and fat trim were also small and thus of little predictive value, but they were in all cases greater than those of K^{40} count. The live score correlations were also consistently in the same direction with "rangy" lambs tending to exceed "compact" lambs in trimmed major cuts and with "compact" lambs tending to exceed "rangy" lambs in fat trim.

The carcass measurement correlations of 12th rib fat, loin eye area and hindsaddle specific gravity with trimmed major cuts and fat trim were moderate in size, generally significantly different from zero, and in all cases greater in absolute value than the correlations of K^{40} count with trimmed major cuts and fat trim.

These data would indicate that K^{40} count of the live lambs (using the O.S.U. swine counting chamber) has very little if any relationship with trimmed major cut and fat trim yield and that subjective live body scores and the three easily obtainable carcass measurements show stronger relationships than do K^{40} counts.

CHAPTER V

SUMMARY

This study involves the carcasses of 60 wether lambs born in January and February, 1974 at the Ft. Reno Livestock Research Station and slaughtered at approximately 100 or 125 pounds live weight. The lambs were a sample of wether lambs produced by mating Hampshire and Suffolk rams to a flock of crossbred ewes in which five various combinations of Rambouillet, Dorset and Finnsheep (Finnish Landrace) breeding were represented. The flock was comprised of approximately 50 ewes of each of the five following breed combinations: ¼ Finnsheep, ½ Dorset, ¼ Rambouillet; ¼ Finnsheep, ¼ Dorset, ½ Rambouillet; ¼ Finnsheep, 3/4 Rambouillet; ½ Dorset, ½ Rambouillet and ¼ Dorset, 3/4 Rambouillet. Twelve lambs were selected from each dam breed combination with six lambs assigned to slaughter at about 100 pounds live weight and six assigned to slaughter at about 125 pounds live weight. Prior to slaughter, radioactive potassium (K^{40}) content of the live lamb was estimated using the Oklahoma State University whole-body scintillation counter.

Lambs produced by the five dam breed combinations were similar for most carcass traits studied. Lambs produced by dams of ¼ Finnsheep breeding tended to have a greater ($P < .10$) percent kidney and pelvic fat than lambs produced by dams of ½ Dorset, ½ Rambouillet breeding. Lambs from ¼ Finnsheep, 3/4 Rambouillet dams tended to have smaller ($P < .10$) loin eye areas than did lambs from dams of Dorset and

Rambouillet breeding only. One-half Dorset, ½ Rambouillet dams produced lambs that exceeded ($P < .05$) all other groups in rump fat probe indicating a tendency of these lambs to deposit fat subcutaneously at a faster rate than lambs of the other four groups.

Percent trimmed major cuts was not significantly different among the five groups, but lambs from ¼ Finnsheep, 3/4 Rambouillet and ½ Dorset, ½ Rambouillet dams had the lowest mean values. The lambs from the ¼ Dorset, 3/4 Rambouillet dams had the highest mean value followed closely by the two ¼ Finnsheep groups that contained both Dorset and Rambouillet breeding.

The data indicated that lambs produced by the two ¼ Finnsheep dam groups that contained both Dorset and Rambouillet breeding produced carcasses quite acceptable in both quality and lean yield.

The heavy lambs exceeded ($P < .01$) the light lambs in loin eye area and all indicators of fatness, i.e. dressing percent, percent kidney and pelvic fat, 12th rib fat thickness, USDA yield grade, and rump fat probe, and subsequently yielded a lower ($P < .01$) percent of their carcass weight in trimmed major cuts. However, when trimmed major cuts was expressed as a percent of live weight, it was found that the heavy and light lambs did not differ appreciably in this trait.

The heavy lambs had a lower percent shoulder and leg of carcass weight ($P < .10$ and $P < .01$, respectively) and a higher percent rack and loin of carcass weight ($P < .01$ and $P > .25$) than did the light lambs. This indicates that subcutaneous fat is deposited at a faster rate on the rack and loin than on the shoulder and leg as live weight increases.

K^{40} count of the live lamb showed poor relationships with yield of trimmed major cuts and fat trim. Pooled within slaughter weight group correlations ranged from -0.02 to 0.14 and were not significantly different from zero.

Subjective live body type score of the live lamb did not have a strong relationship with yield of trimmed major cuts and fat trim but was superior to K^{40} count. Absolute values of the correlations of 12th rib fat thickness, loin eye area and hindsaddle specific gravity with yield of trimmed major cuts and fat trim were generally moderate in size, significantly different from zero, and always greater than those of K^{40} count.

LITERATURE CITED

Adams, Nelson J., Z. L. Carpenter and C. W. Spaeth. 1970. Estimation of lamb carcass composition by use of specific gravity measurements. J. Anim. Sci. 31:1081.

Antoniewicz, R. J. and A. L. Pope. 1967. Effects of age and weight on feed efficiency and carcass composition of lambs. J. Anim. Sci. 26:1487. (Abstr.)

Barr, A. J. and J. H. Goodnight. 1972. A Users Guide to the Statistical Analysis System. Student Supply Stores. North Carolina State University, Raleigh.

Barton, R. A. and A. H. Kirton. 1958a. Carcass weight as an index of carcass components with particular references to fat. J. Agr. Sci. 50:331.

Barton, R. A. and A. H. Kirton. 1958b. The leg and loin as indices of the composition of New Zealand lamb and mutton carcasses. New Zealand J. Agric. Res. 1:783.

Brown, C. J., J. C. Hillier, J. A. Whatley. 1951. Specific gravity as a measure of the fat content of the pork carcass. J. Anim. Sci. 10:97.

Callow, E. H. 1947. Comparative studies of meat. I. The chemical composition of fatty and muscular tissue in relation to growth and fattening. J. Agr. Sci. 37:113.

Dickerson, G. E. 1974. Crossbreeding performance of Finn and domestic (U.S.) breeds of sheep. (mimeo). International Symposium on Breed Evaluation and Crossbreeding Experiments with Farm Animals. The Netherlands.

Dickerson, G. E., J. Crouse, H. A. Glimp and K. E. Gregory. 1974. Carcass traits of market lambs from Finn - cross ewes. J. Anim. Sci. 39:143. (Abstr.).

Dickerson, G. E., H. A. Glimp, H. J. Tuma and K. E. Gregory. 1972. Genetic resources for efficient meat production in sheep. Growth and carcass characteristics of ram lambs of seven breeds. J. Anim. Sci. 34:940.

Field, R. A., J. D. Kemp and W. Y. Varney. 1963. Indices of lamb carcass composition. J. Anim. Sci. 22:218.

Field, R. A., M. L. Riley and M. P. Botkin. 1967. Effect of sex and ram weight on composition of lambs. J. Anim. Sci. 26:984. (Abstr.)

Gould, M. B. and J. V. Whiteman. 1971. Association of certain variables with the performance of spring vs. fall-born lambs. J. Anim. Sci. 33:531.

Hankins, O. G. 1947. Estimation of the composition of lamb carcasses and cuts. U.S.D.A. Tech. Bul. 944.

Hanrahan, J. P. 1974. Crossbreeding studies involving Finnish Landrace and Galway sheep. (mimeo). International Symposium on Breed Evaluation and Crossbreeding Experiments with Farm Animals. The Netherlands.

Jacobs, John A., Ray A. Field, M. P. Botkin, M. L. Riley and G. P. Roehrkasse. 1972. Effects of weight and castration of lamb carcass composition and quality. J. Anim. Sci. 35:926.

Judge, M. D., M. Stob, M. V. Kessler and J. E. Christian. 1963. Lamb carcass and live lamb evaluations by potassium - 40 and carcass measurements. J. Anim. Sci. 22:418.

Kemp, J. D. and J. D. Crouse, W. Deweese and W. G. Moody. 1970. Effect of slaughter weight and castration on carcass characteristics of lambs. J. Anim. Sci. 30:348.

Kemp, James D., J. M. Shelley, Jr., D. G.Ely and W. G. Moody. 1972. Effects of castration and slaughter weight on fatness, cooking loss and palatability of lamb. J. Anim. Sci. 34:560.

Kirton, A.H. and R. A. Barton. 1958. Specific gravity as an index of the fat content of mutton carcasses and various joints. New Zealand J. Agr. Res. 1:633.

Kirton, A. H. and A. M. Pearson, R. H. Nelson, E. C. Anderson and R. L. Schuch. 1961. Use of naturally occurring potassium - 40 to determine the carcass composition of live sheep. J. Anim. Sci. 20:635.

Lambuth, T. R., J. D. Kemp and H. A. Glimp. 1970. Effect of rate of gain and slaughter weight on lamb carcass composition. J. Anim. Sci. 30:27.

Latham, S. Duane, W. G. Moody and James D. Kemp. 1966. Techniques for estimating lamb carcass composition. J. Anim. Sci. 25:492.

McClelland, T. H. and A. J. F. Russell. 1972. The distribution of body fat in Scottish Blackface and Finnish Landrace lambs. An. Prod. 15:301.

McMeekan, C. P. 1940. Growth and development in the pig, with special reference to carcass quality characters. I. J. Agr. Sci. 30:276.

Melton, C. C., H. J. Tuma, D.H. Kropf, C. E. Menzies and A. D. Dayton. 1968. Effects of weight and finish on lamb carcass composition. J. Anim. Sci. 27:1144. (Abstr.).

Munson, A. W. 1966. Association of various measurements with lamb carcass composition and preliminary estimates of some genetic parameters. Ph.D. Thesis. Oklahoma State University, Stillwater.

Nitter, G. 1974. Results of a crossbreeding experiment with sheep for intensive fat lamb production. (mimeo). International Symposium on Breed Evaluation and Crossbreeding Experiments with Farm Animals. The Netherlands.

P'alsson, H. 1939. Meat crosses in the sheep with special reference to Scottish breeds and crosses. I. J. Agric. Sci. 29:544.

Rouse, G. H., D. G. Topel, R. L. Vetter, R. E. Rust and T. W. Wickersham. 1970. Carcass composition of lambs at different stages of development. J. Anim. Sci. 31:846.

Shelton, Maurice and Z. L. Carpenter. 1972a. Feedlot performance and carcass characteristics of slaughter lambs sired by exotic breeds of rams. Tex. Agr. Exp. Sta. Pro. Rep. 3024:23.

Shelton, Maurice and Z. L. Carpenter. 1972b. Influence of sex, stilbestrol treatment and slaughter weight on performance and carcass traits of slaughter lambs. J. Anim. Sci. 34:203.

Snedecor, G. W. and W. G. Cochran. 1967. <u>Statistical Methods</u> (6th Ed.). Iowa State College Press, Ames.

Timon, V. M. and Maurice Bichard. 1965a. Quantitative estimates of lamb carcass composition. 1. Sample joints. An. Prod. 7:173.

Timon, V. M. and Maurice Bichard. 1965b. Quantitative estimates of lamb carcass composition. 2. Specific gravity determination. An. Prod. 7:183.

Timon, V. M. and Maurice Bichard. 1965c. Quantitative estimates of lamb carcass composition. 3. Carcass measurements and a comparison of the predictive efficiency of sample joint composition, carcass specific gravity determinations and carcass measurements. An. Prod. 7:189.

U.S.D.A. 1969. Official United States standards for grades of lamb, yearling mutton and mutton carcasses. Title 7, Part 53B. Jan. 8. U.S.C. & M.S.

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Master of Science

Thesis: CARCASS TRAITS OF WETHER LAMBS PRODUCED BY CROSSBRED DAMS OF FINNSHEEP, DORSET AND RAMBOUILLET BREEDING AND SLAUGHTERED AT TWO LIVE WEIGHTS

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