THE EFFECTS OF CREEP FEEDING LAMBS ON GROWTH, FEED CONSUMPTION, AND CARCASS CHARACTERISTICS

A Thesis

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INTRODUCTION

Recently many breeders throughout the state have indicated a great interest in creep feeding of nursing lambs. Not only is there a high initial outlay of capital for feed and equipment, but this type of feeding requires proper management and care if the creep feeding enterprise is to be successful.

The 1960 creep test, conducted at The Ohio State University, was designed to compare the gains made by creep fed lambs to those made by lambs with no creep feed, and to further evaluate the use of alfalfa pellets as the sole creep feed and in combination with other feeds.

In addition to the growth data obtained from this experiment there seemed to be further possibilities in regard to the final carcass produced. In recent years there has been limited work done in the carcass area of lamb production. It was felt that carcass work on the lambs from this experiment would help us to better evaluate the creep rations, not only from the feeder's viewpoint, but also from the meat processor's.

The carcass work was undertaken for the purpose of comparing the effect of creep rations on the carcass product. Areas of the carcass work which were investigated were: shrinking percentage, dressing percentage, percent of edible portion, carcass grade, and finally a chemical analysis of the carcass for total fat, moisture, and protein.

The first section of this paper will deal with the growth aspect. The various creep rations will be compared as to rate of gain, time on feed, and feed consumption. These comparisons will better enable us to evaluate the rations from an economical as well as from a management standpoint.

The second section will deal with the carcass work. The various procedures followed in determining shrinkage, dressing percentage, percentage edible portion, and chemical analysis are explained in detail. The statistical analysis, results, conclusions, and discussion are presented in various tables and illustrations.

It is the author's firm conviction that by analyzing these data as presented in this paper, we will be able to better evaluate the effect of creep feeding and type of ration on the growth and final carcass produced. It is hoped that the value of creep feeding in regard to the economic production of market lambs will be clearly expressed.

LITERATURE REVIEW

The Effect of Pelleting Creep Rations

In recent years the use of pelleted feeds has increased considerably. However, most studies to date have been with swine and poultry. Neal (18) reported that the feed required to produce a unit of gain on lambs was reduced when alfalfa was fed as pellets. Noble *et al.* (19) reported no detrimental effect from pelleting a ration for lambs of 45% Redlan Kafir, 50% ground alfalfa hay, and 5% molasses. Bell (3) reported greater daily gains on less feed per hundred pounds gain with lambs on a pelleted ration of 45% corn and 55% hay when compared with the same ration fed as whole corn and long hay. Bell (4) reported that lambs fed a pelleted creep ration gained faster and more efficiently than similar lambs fed the same ration unpelleted. Jordan *et al.* (16) in an 86 day trial found that pelleting of good palatable feed such as corn and alfalfa, while it increased its efficiency slightly, was not a profitable procedure at current prices due to the cost of pelleting. Cate (10), in a study undertaken to determine the effect of self-fed pelleted and self-fed meal rations of varied quality on the rate and economy of lamb gains, indicated that pelleting alfalfa meal and corn was of slight value, hardly enough to warrant the cost of pelleting. However, the pelleting of rations containing timothy meal greatly increased economy as well as rate of gain. They concluded that the practical aspect of pelleting is the feasibility of using low quality roughages as a part of self-fed lamb fattening rations.

A Look at the Various Indexes of Carcass Composition

Although there is an abundance of literature available on animal nutrition, most workers have approached the subject mainly from the feeding side, concerning themselves primarily with the digestibility and nutritive value of various food stuffs. When dealing with meat producing animals, the nutritionist usually stops short at either live weight or the carcass weight of the animals. This of course is insufficient for a proper and adequate evaluation of various feeding programs.

However, a notable exception to this was some of the early work by Hammond (11) and many others. Hammond, in his study of growth and mutton qualities in the sheep, deals with the problem of meat production in a different way from previous writers. He studied the ultimate product, meat, and worked backwards to elucidate the conditions or factors which affect its formation. He found that the value of an animal for meat could not be measured from live weight, nor even carcass weight, without consideration of several other factors. Age, breed, sex, and degree of fatness have an effect not only on the proportions of dressed carcass to live animals, but also on the relative development of the different tissues, bone, muscle, and fat in the different joints.

Hammond (11) made a comprehensive study of the development, distribution, and composition of the bone, muscle, and fat of the leg of mutton. In discussing the changes brought about through domestication and improvement by breeding, he considers that the main differences in the composition of the leg between the improved and semi-wild breeds lies in the amount of fat present and in the shape of the muscles; and that in the improvement of the mutton breeds the proportion of muscle to bone has not been increased, but fat has been added, particularly the subcutaneous layer. Bonsma (5) stated that the length of leg in relation to the circumference gives a further measure of the compactness of the joint, and is of particular importance. Spencer (23) considers that in the best type of carcass the circumference is equal to or greater than the length, while in less desirable carcasses the circumference is only about 3/4 as great as the length of leg.

Numerous research workers, Hammond (11), Hirzel (14), and Palsson (21), found that the weight of the cannon bone gave a very reliable estimate of the weight of total bone present in the carcass. Palsson (21) obtained a correlation coefficient of + 0.9432 (significant at 1%) between the weight of the left fore cannon and the total weight of bone in the carcass. "The length of the cannon bone of lambs of the same kill weight gives a fairly reliable indication of the relative size of the skeleton and the total weight of bone present in the carcass."

From a commercial point of view, the loin is the most valuable and highest priced joint in a lamb carcass. Hammond (11) has shown that the lumbar and sacral regions are among the latest developing parts of the body. Consequently, the development of the longissimus dorsi muscle in the region of the loin offers a reliable measure of the relative muscular development and variation among carcasses. In addition to being a measure of muscular development, Hankins (13) indicated that the physical and chemical composition of the rib is an excellent index for the entire carcass. Palsson (21) found that the length of eye muscle was correlated with the total muscle content of the carcass. In addition to the length of eye muscle, he also measured the depth and indicated that the greater the depth in proportion to length the better. Hammond (11) and Hirzel (14) have calculated depth as a percent of length and given it the term shape index. However, Palsson (21) found that the shape index was in no way correlated with the total weight of muscle in the carcass. Since length, as well as thickness, contributes to the total weight of muscle in the carcass, he found that the most satisfactory index of total muscle weight was obtained by using the formula $A + B + \frac{L}{10}$; A is the length of the eye muscle, B is the depth of the eye muscle, and L is the length of carcass measurement.

According to Bonsma (5) the thickness of the subcutaneous layer of fat is an indication of the finish and distribution of fat in the carcass. The measurement of the thickness of the layer of fat over the loin, just above the greatest depth of the eye muscle, provides a most satisfactory index of the degree of fatness of the carcass. Lack of sufficient depth of fat at this point is associated with an unfinished appearance and is detrimental to the keeping and cooking qualities of the carcass.

Callow (6), in a series on comparative studies of meat, indicated that as the percentage of fatty tissue in boneless meat, which has been used as a measure of its degree of fatness, increases, the percentage of chemical fat also increases, both in the fatty tissue and in the muscular tissue, and hence in the boneless meat itself. It was also reported that as growth and fattening proceeds, the extra chemical fat which is laid down is partitioned unequally among the tissues. A larger and larger proportion of the fat goes into the fatty tissues, and a smaller and smaller proportion into the muscular tissues. It was further shown that in cattle and sheep the percentage of fat and protein in both fatty and muscular tissue depends primarily on the level of fatness of the animal (as measured by the precentage of fatty tissue in the boneless meat).

Callow (7) further indicated that the level of fatness of a carcass is the major factor in determining the percentages of muscular tissue, of bone and of tendons, etc. in the carcass, and the percentages of chemical fat, protein, and water in the muscular and fatty tissues.

Callow (8) reported that the major changes in the anatomy of carcasses and in the chemical composition of their tissues largely depend on the level of fatness of the carcass. In the production of meat carcasses, however, there is an optimum rate of fattening. With higher rates of fattening the muscular tissue does not develop as rapidly as it should and the carcass is too fat for its weight. McMeekan *(17) demonstrated this with pigs.

Callow (9) reported that the rate of fattening had a pronounced affect on the deposition of fat and protein. Young animals fatten more slowly than old ones and thus deposit less fat and more protein. For lambs fattening slowly, 38.5% of the increase in carcass weight is due to chemical fat and 10.66% to protein, whereas with steers over 2 1/2 years of age 71.5% of the increase in carcass weight is due to chemical fat and only 4.45% to protein. Palsson (22), in a study on the effect of the plane of nutrition on growth and development of carcass quality of lambs, reported that the percentage of marbling fat in the longissimus dorsi muscle appeared to be more dependent on the age of the animal than on the plane of nutrition or the state of fatness of the animal, being lowest in the group on the High-High plane of nutrition and highest in the Low-Low carcasses.

The Approximate Chemical Composition of Lamb

Hankins (12) analyzed the approximate composition of lamb cuts from 42 lambs representing 8 pure breeds and 6 crosses. The study was based on the variation of ether extract (fat) content of edible portion of dressed carcasses, and classified the lambs as follows: 35% or more ether extract as "Fat", 20 % to 34% inclusive as "Intermediate,", and less than 20% as "Thin.". They found that the ether extract content ranged from 5.8% to 45.8% with lambs having a chilled carcass weight, of 33.6 pounds. They concluded that fat and edible portion were inversely proportional to grade and that the rib was significantly higher in ether extract content than the trimmed leg, shoulder, loin, neck, and breast cuts.

The American Meat Institute Foundation as reported in their publication "The Science of Meat and Meat Products." reports the following proximate composition and energy value of a cooked lamb rib chop retaining its total fat content.

Protein	20.3%
Water	41.0%
Fat	37.2%
Ash	0.9%
Calories	420/100gms.

EXPERIMENTAL PROCEDURE

Source of Lambs

The 1960 creep trial conducted at the University utilized Hampshire sired lambs out of a native crossbred ewe flock. The ewes were a combination of Targhee, Columbia, Merino, and Dorset breeding ranging from four to nine years of age. The first lambs were dropped January 11 and the last on March 20, with 90% of the ewes lambing during the first 34 days.

Allotment of Lambs

The lambs were placed in the creep at approximately 10 days of age and were alloted so as to have random distribution of twins and singles among the four lots. Further allotment was made so that the lambs in each lot were of the same average age. There were a total of 85 lambs on test.

Treatment of Lambs

The lambs were all exposed to a self feeder and waterer throughout the experiment. The following mixtures were fed to the four lots.

Lot 1- Self-fed dehydrated alfalfa meal pellets (17% protein) throughout the trial.

Lot 2- Self-fed alfalfa pellets throughout the trial and shelled corn (also self fed) added at 56 days on feed.

Lot 3- Self-fed alfalfa pellets throughout the trial and a concentrate ration consisting of 80% shelled corn plus 20% soybean oil meal pellets (also self fed) added at 56 days on feed.

Lot 4- No creep feed.

The lambs were not vaccinated for overeating disease, nor were antibiotics used in this trial.

Individual lamb weights were recorded at 14 day intervals and feed consumption figures secured for each lot at the end of each 14 day period. When the lambs reached 90 pounds, they were assigned either to market or to The Ohio State University Meat Laboratory for slaughter and subsequent carcass evaluation. Ten lambs from each of the first 3 lots were slaughtered. No lambs were slaughtered from lot 4.

Carcass Evaluation Procedures:

After 14 day weigh periods, those lambs weighing 90 pounds or over were assigned for slaughter. One half of these lambs were selected for carcass evaluation and the rest were taken to the Producer's Livestock Association. The lambs secured for carcass work were selected without consideration of age, time on feed, or rate of gain, but by weight alone. The lambs, designated for carcass evaluation, were brought to the Meat Laboratory and the entrance weight recorded. They were allowed to shrink for 24 hours. During this interval the lambs had access to water, but no feed. After this period the lambs were weighed and slaughtered. Records were kept on the amount of shrink of the lambs from the time they were taken off feed until they were slaughtered.

Prior to slaughter, a live animal evaluation was conducted with local live lamb graders and buyers, members of the Animal Science Staff, and Extension personnel, participating. The objective of this evaluation was to relate live animal characteristics with the resulting carcass observations.

Once the lambs were evaluated and slaughtered, they were placed in a cooler at a temperature of 35-40 degrees. The carcasses were chilled for 48 hours, at which time they were graded by a committee composed of three men of the Animal Science Meat staff. After the carcasses were graded they were split into the right and left sides.

After the carcasses were split, the following carcass measurements were taken: (1) length of carcass, a tape measurement from the symphysis pubis to the anterior edge of the middle of the first rib; (2) length of leg, measured from the anterior end of the symphysis pubis to the break joint; (3) depth of thorax, maximum depth of chest across the fifth rib; and (4) the thickness of backfat at first and last rib and at the last lumbar.

Following the carcass measurements, the right side of each carcass was completely boned and the percentage edible portion calculated. Edible portion is the percentage of edible meat from an entire carcass. There was one exception in boning the wholesale cuts. The back was only trimmed to approximately one quarter of an inch and the kidney with accompanying fat removed. The bone was not removed. The back was separated between the 12th and 13th rib and the loin eye traced for area computation. In addition to the tracing, a photograph was taken of this area to give a visual indication of muscle development and fat deposition for further analysis. Once the photographs were taken, the 7 rib sample was completely boned and the lean and fat were frozen for future chemical analysis.

Chemical Determinations (2)

Chemical determinations were undertaken to study the effect of the different creep rations on the total fat, moisture, and protein of the lamb carcasses. It would be expected that under these widely different types of rations there would be noticeable differences in this respect. Not only the direct effect of the different rations, but their indirect affect as to rate of gain and time on feed would be expected to exhibit noticeable differences. Since these lambs were all of similar breeding, pronounced differences between lots would theoretically be attributed to either their environment, management, or type of feeding program. With the environment and management being the same in all cases, the most likely explanation for chemical differences may be the type of feed these lambs were consuming.

Lots one, two, and three were the lots from which ten lambs per lot were slaughtered. The three lots were all self fed 17% dehydrated alfalfa pellets from the time the lambs were ten days old to market weight. This indicates that the protein requirements, according to present N.R.C. standards, are more than adequately covered. Any theoretical differences would possibly be a result of an increase in total energy which was supplied in the form of self-fed shelled corn from 56 days of age till marketing. Assuming of course that the increased energy intake would contribute to a faster growth rate and subsequent depositing of body fat, one would expect lots two and three to grade higher, both live grade and carcass grade. By relying on this assumption, a higher percentage of total fat and a lower percentage of water in the lambs from lots 2 and 3 was anticipated.

Preparation of Sample

The sample for chemical analysis was prepared from the rib section of the right side of the carcasses. The rib section was ground three times with a small portable grinder to assure complete mixing. During the third grinding on approximately 50-75 gm. sample was collected in an air tight, 2 ounce sample bottle. Once the grinding and collection of sample was completed, the moisture determinations were immediately undertaken to prevent a minimum of moisture loss. Approximately 8-10 gms. of this ground material was used for the moisture and fat determinations. The remaining ground sample was then refrozen in the sample bottles for subsequent nitrogen determinations and also to run a check on freezer loss over the duration of experiment.

Moisture Determination (2) (14)

The loss in weight that a substance undergoes at 100-105 degrees centigrade represents moisture that is bound superficially for many inorganic substances.

In order that we might use the moisture free sample for the subsequent fat determination, the temperature at which the samples were dried was held at 98-101 degrees. Higher temperatures will cause some decomposition of fats thus rendering the sample useless for the fat determinations.

A 4-5 gm. sample of freshly prepared meat was carefully weighed into a previously dried and weighed aluminum dish. The uncovered dish, containing the sample, was placed in an air oven at an approximate temperature of 98-101^{o} for 18-20 hours at which time it was cooled in a desiccator and weighed. The loss in weight was recorded as percent moisture. As in the case of fat extraction, duplicates were run on all samples with the variability lying between 0.1 and 1.0 percent.

Fat Determination (2) (14)

The process of extraction of a single constituent, in this case fat, from a complex sample by shaking the sample with several small portions of an immiscible solvent, is a very commonplace operation in organic preparative work. The solvent used in this work was anhydrous ether. Anhydrous ether is basically prepared by washing commercial ether with 2 or 3 successive portions of water and the subsequent addition of solid sodium hydroxide or potassium hydroxide. After the mixture has stood until most of the water has been extracted from the ether, small pieces of carefully cleaned metallic sodium is added. The mixture is then let stand until hydrogen evolution ceases.

The complete extraction of fat may be interfered with by large quantities of soluble carbohydrates. It is possible to alleviate this problem by extracting with water prior to fat extraction. However, soluble carbohydrates were not a problem in this work because a moisture free sample was used in the determination. Thus the soluble carbohydrates had been driven off in the moisture determination.

The official A.O.A.C. method of fat extraction was used in this study. A moisture free 1-2 gm. sample was placed into a porous thimble which permitted the rapid passage of ether. The thimble containing the moisture free sample was then placed into a Soxhlet apparatus for extraction purposes. Duplicates were run on each sample. As stated under the official methods, the extraction period may vary from 4 hours at condensation rate of 5-6 drops per second to 16 hours at 2-3 drops per second. The rate at which the fat was extracted in this study was 3-4 drops per second. Prior to undertaking this portion of the study, 6 samples were extracted at the varying time intervals of 8, 12, and 16 hours.

Table one will show the results of this time test.

TABLE 1

PERCENT FAT

SAMPLE / Time	8 hr.	12 hr.	16 hr.
41a	40.13		
41b		40.5	
41c			39.91

There were no significant differences in the extraction accuracy at the times indicated. Relying on this information, the time schedule for the Soxhlet was set for 8 hours. Once the 8 hours had elapsed, the samples and thimble were dried for 30 minutes at 100 degrees centigrade, cooled in desiccator and weighed. Fat percentage was computed on the original fresh meat sample.

Nitrogen Determination

The method devised by Kjeldahl (2,14) was used in the nitrogen determination. Fresh samples of 1-2 grams weighed on 4 inch filter paper and dropped into a 800 ml. Kjeldahl flask. The filter paper wrapper prevents any of the material from clinging to the neck of the flask and thereby escaping digestion. After the addition of copper sulfate, sodium sulfate, and sulfuric acid the mixture was allowed to digest. Once the sample had digested and cooled, water, sodium hydroxide and zinc were added thus liberating the ammonia, which was distilled into a measured volume of standard acid (50 ml. of 4% boric acid). The acid contained methyl red and brome cresol green as an indicator. Approximately

350-400 ml. of distillate was collected and this was titrated with 1/14 N. hydrochloric acid to slate gray.

RESULTS

In analyzing the results of this experiment, it should be recognized that the carcass work was only part of the overall project. An attempt will be made to present briefly the results from the management and growing aspect of the feeding trial. In this way it will be possible to make a more appropriate and comprehensive analysis of the carcass work.

Creep Feeding Summary:

The creep feeding of alfalfa pellets from 10 days of age until market weight resulted in a uniform growth rate among the lambs in these lots. However, at 56 days of age, when shelled corn was added to lot 2, and shelled corn and soybean oil meal to lot 3, the lambs in these lots went "off-feed". In the case of lot 2, scours developed. This digestive disturbance resulted in an average daily gain of 0.1 pound per day. This was a drastic drop when we realize that prior to adding the corn, the lambs were averaging 0.6 - 0.7 pounds per day. It should be emphasized that the corn was not added gradually, but added all at one time. In other words, the lambs in lots 2 and 3 were given all they could eat the 56th day. One interesting observation was that with the sudden full feed of corn for these two lots, there were no cases of enterotoxemia. Over-eating has long been one of a sheep feeder's biggest problem when feeding market lambs. Standard practice has been to increase the feeding of shelled corn gradually over a period of 10 days to two weeks. But in spite of this gradual increase to a full feed of corn, many market lambs succumbed to enterotoxemia.

A possible explanation of experiencing no trouble along this line was because these lambs were getting all of the alfalfa pellets they wanted from the time they were 10 days of age. In addition, they were nursing the ewe during the duration of this experiment. It was mutually agreed that had these lambs not been on a full feed of alfalfa pellets when corn was added, there may have been cases of "overeating".

The average daily gain (on test) varied from 0.418 pounds in lot 4 to 0.668 pounds in lot 3, with the lowest variation being between lots 1 and 2. (Table 2.) Although lot 2 ate more feed per lamb than did the lambs in lot 3, (160.8 pounds to 153.0 pounds) the average daily gain in lot 2 was slightly less than those in lot 3.

Feed consumption records were stopped on May 13, which was the date on which the first lambs were removed for slaughter. Table 2 shows the creep feeding summary in regard to average daily gain and feed consumption.

TABLE 2

1960 CREEP FEEDING SUMMARY

(Test Period - February 5 to May 13)

	LOT 1	LOT 11	LOT 111	LOT 1V
Number of lambs started on test				
Single	11	10	10	10
Twin	12	12	10	10
All lambs	23	22	20	20
Average daily gain (on test)				
Single	.658 lb	.667	.733	.464
Twin	.588 lb	.601	.605	.374
All lambs	.621 lb	.631	.668	.418
Average weight May 13				
Single	78.18	82.20	88.90	62.90
Twin	67.33	73.58	75.10	53.10
All lambs	72.52	77.50	82.00	58.00
Feed consumption per lamb to May 13				
Alfalfa pellets	146.9 lbs.	131.8 lbs.	94.7 lbs.	---
Shelled corn		29.0 lbs.	46.6 lbs.	---
SBOM pellets			11.7 lbs.	---
TOTAL Feed	146.9 lbs.	160.8 lbs.	153.0 lbs.	---
120 Day weights				
Single	89.35 lbs.	87.92 lbs.	97.62 lbs.	64.42 lbs.
Twin	77.38 lbs.	79.48 lbs.	79.47 lbs.	53.63 lbs.
All lambs	83.10 lbs.	83.32 lbs.	88.55 lbs.	59.03 lbs.
Lamb sales by July 8				
No. & % of total	17 (74%)	21 (95%0)	19 (95%0)	4 (20%)
Average weight	93.29 lbs.	93.71 lbs.	94.63 lbs.	92.00 lbs.
Average age	132 days	145 days	134 days	164 days

Carcass Results:

The carcasses were analyzed both subjectively and objectively (Table 3) to determine the affect the type of ration would have on various carcass traits.

TABLE 3

WEIGHT, YIELD, GRADE, SHRINK, AND CUT-OUT VALUE OF LAMB CARCASSES

Lot Number	1	2	3
No. of Lambs/lot	10	10	10
Ave. weight of lambs, lb.			
Feed lot wt., lb.	93.1	92.9	95.1
Selling wt., lb.	90.6	9.13	93.2
Killing Wt., lb.	84.8	87.4	88.7
Ave. weight of carcass, lb., (hot)	47.14	48.16	50.27
Ave. weight of carcass, lb., (chilled)	45.87	46.82	48.90
*Dressing Percentage			
Feed lot wt., lb.	49.2	50.38	51.39
Selling wt., lb.	50.36	51.26	52.45
Killing wt., lb.	54.05	53.58	55.07
**Ave. grade factor	7.6H.C.	8.2L.P.	7.9L.P.
Shrinkage - Feed lot to kill			
Pounds	8.3	5.5	6.4
Percent	8.92	5.92	6.73
Carcass Cut-Out Values:			
Ave. wt. of Leg, lbs.	7.23	7.44	7.68
E.P. in leg, lbs.	5.16	5.29	5.52
Percentage E.P.	71.36	71.10	71.87
Ave. wt. of Back, lbs.	5.3	5.21	5.22
E.P. in Back, lbs.	4.3	4.19	4.13
Percentage E.P.	81.13	80.42	79.11

TABLE 3 (Continued)

Ave. Wt. of Shoulder, lbs.	5.51	5.82	5.62
E.P. in Shoulder, lbs.	4.1	4.3	4.29
Percentage E.P.	74.41	73.88	76.33
Ave. Wt. of Breast & Shank, lbs.	4.8	4.78	5.18
Edible portion, lbs.	3.33	3.3	3.65
Percentage E.P.	69.37	69.03	70.46
PERCENTAGE EDIBLE PORTION IN TOTAL CARCASS:	73.59	73.38	73.86
POUNDS OF EDIBLE MEAT IN 100LBS. OF LAMB PRODUCED IN FEED LOT:	36.24	36.97	37.96

*Dressing percentage was computed by dividing chilled carcass weight by kill weight, selling weight, and feed lot weight.

**Carcasses were scored by using the following numbers: 10-8, prime; 7-5, choice.

Seven variables were measured on the lambs of lots 1, 2, and 3. The number of animals in each ration were constant (10); however, the birth conditions (single, twin) and the sex varied. Accordingly an analysis using a method of fitting constants (Snedecor, 5th ed., p. 388), was employed to compute ration and birth-sex* effects. Only in the case of shrinkage was the ration effect significant. Birth-sex was significant in shrinkage and rate of gain. In no case was there a differential ration effect in the birth-sex combinations (ration-birth-sex interaction). The mean squares from the analysis are shown. (Table 4). The complete analysis for shrink and the adjusted means are given. (Table 5.)

*"Birth-sex" refers to the birth conditions of singles, twin, and male-female.

TABLE 4

MEAN SQUARES FOR SEVERAL CARCASS TRAITS

Source of Variation	df	Dress	Area L.D.	Total E.P.	Moisture	Fat	Rate Gain
Total	29						
Ration	2	617	241	62	413	0	20
Birth-sex	3	144	222	216	3898	3598	328
Interaction	4	548	573	507	1729	1860	24
Error	20	348	561	496	4319	3700	82

TABLE 5

SHRINKAGE AND ADJUSTED MEANS

Source of Variation		Sum of Squares	M.S.	P.
Total	29			
Ration	2	4798	2399.00	7.116**
Birth-sex	3	3931	1310.33	3.887*
Interaction	4	1502	375.50	1.114n.s.
Error	20	6703	337.15	

Adjusted Ration Means		Adjusted Birth-Sex Means	
1	78.23	11	68.99

Adjusted Ration Means - Continued		Adjusted Birth Sex Means - Continued	
2	53.61	12	85.67
3	61.69	21	34.79
		22	68.61

*Significant at 5%
**Significant at 1%

The shrinkage in lot 1 was 8.77%; lot 2, 5,86%; and lot 3, 6.68%. The difference in shrinkage between lots 1 and 2 was significant at the 1% level. The difference between lot 1 and lot 3 was significant at the 5% level.

In addition to the ration effects, several correlations were computed on other carcass variables. These are presented in the following tables. The ration and birth-sex effects have been removed so that the correlation is computed on the "within ration-birth-sex" figures.

The age of the lambs, slaughtered, varied from 175 to 102 days. The effect of age on the area of the longissimus dorsi, percentage moisture, and percentage fat was significant at the 5% level. (Table 6). There was little effect of age upon percentage edible portion of the carcass.

TABLE 6

CORRELATIONS BETWEEN AGE (1) AND SEVERAL CARCASS VARIABLES

Area of longissimus dorsi	-0.428*
Percentage total edible portion	-0.2855
Percentage moisture	-0.5027*
Percentage fat	-0.4376*
Percentage protein	-0.4803*

1 Refer to table 1.
*Significant at 5%

TABLE 7

CORRELATION OF MOISTURE AND FAT ON SHRINK

Percentage moisture	-0.5596**
Percentage fat	0.5537**

**Significant at the 1% level

The percentage moisture and percentage fat of the carcass had an effect on the percentage of shrink, (Table 7). The percentage moisture with a negative correlation of -0.5596 and percentage fat with a positive correlation of + 0.5537, both significant at the 1% level, show vividly the relation of moisture to lean meat and the relation of "leaner" carcasses to the amount of shrink one might expect to observe. In other words, it would appear that the leaner the carcasses, the more shrinkage we might expect.

TABLE 8

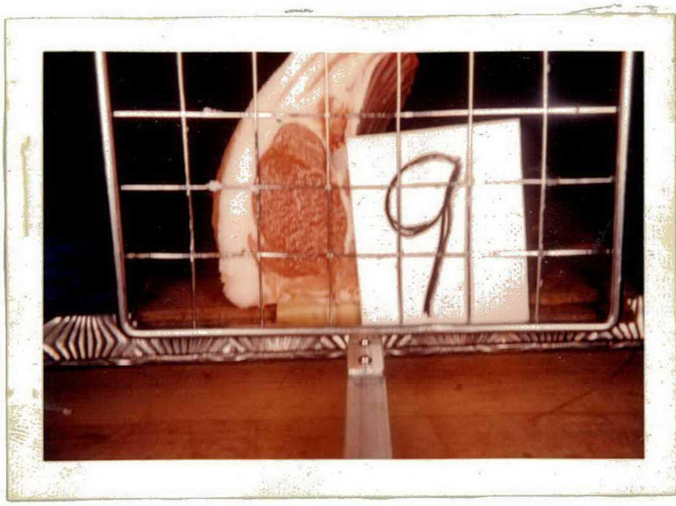
CORRELATION OF THE AREA OF THE LONGISSIMUS DORSI WITH PERCENTAGE EDIBLE PORTION, PERCENTAGE OF PROTEIN AND RATE OF GAIN

Percentage total edible portion	0.2453
Percentage protein	0.4273*
Rate of gain	0.5352*

*Significant at the 5% level

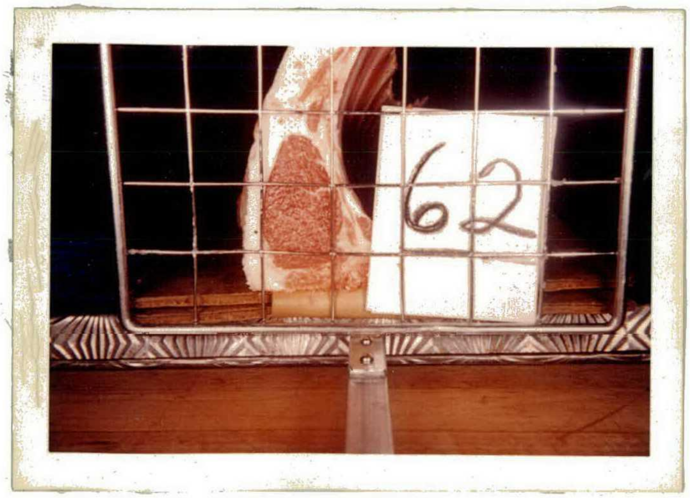
The percentage of protein and rate of gain were correlated with the area of the longissimus dorsi at the 5% level. (Table 8). It was interesting to note that as the rate of gain increased, the area of the longissimus dorsi did likewise. Furthermore, as our rate of gain increased, so did the percentage of protein, indicating to a certain extent at least, that the lambs were putting on this increased gain in the form of lean meat. The following illustrations (1, 2, 3, 4, 5, and 6) will show this quite vividly, as well as showing a few of the wide differences within lots of carcass measurements.

ILLUSTRATION I



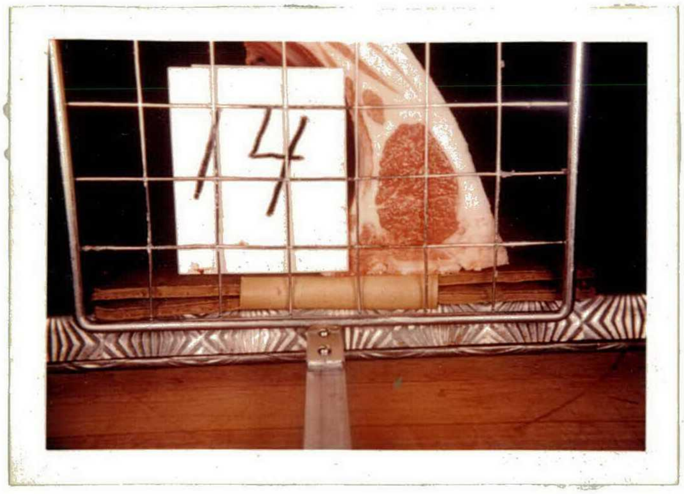
Lot 1	% E.P. 74.4%	% moisture 51
Age 124 days	% Protein 13.41	% fat 35.2
	Loin eye area 2.48 sq. in.	

ILLUSTRATION II



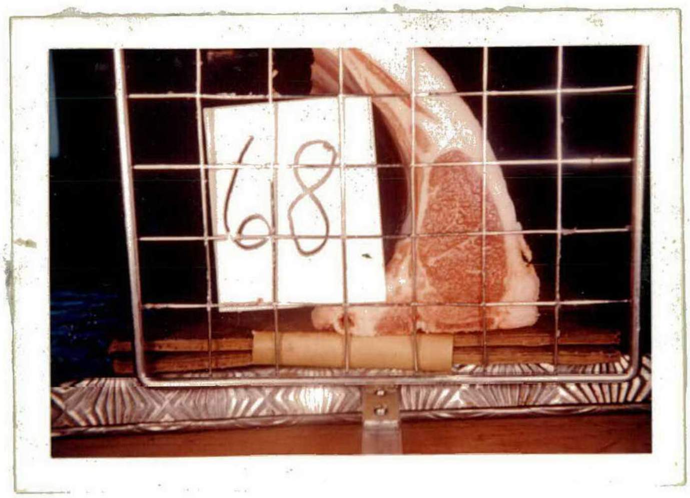
Lot 1	% E.P. 74.9	% moisture 52
Age 107 days	% Protein 13.2	% fat 34.8
	Loin eye area 1.7 sq. in.	

ILLUSTRATION III



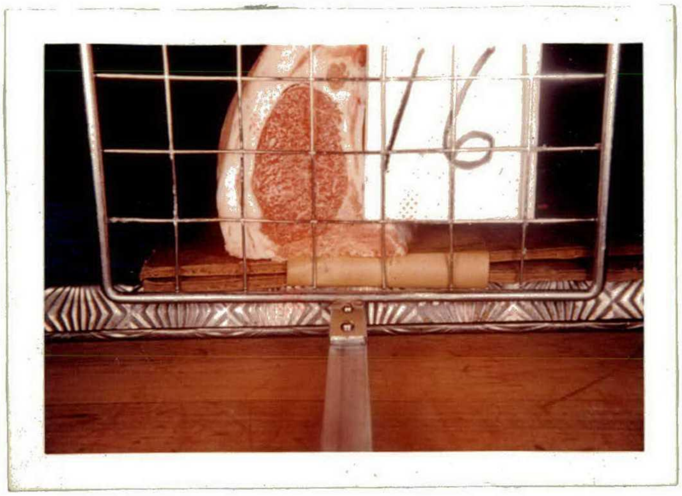
Lot 2	% E.P. 75.7	% moisture 38.9
Age 123 days	% Protein 10.8	% fat 48.9
	Loin eye area 1.74 sq. in.	

ILLUSTRATION IV



Lot 2	% E.P. 69.3	% moisture 54.69
Age 104 days	% Protein 13.36	% fat 31.42
	Loin eye area 2.23 sq. in.	

ILLUSTRATION V

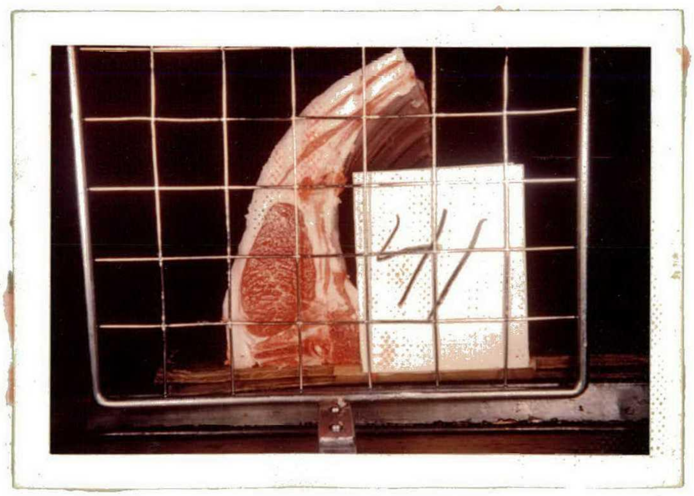


Lot 3
Age 122 days

% E.P. 76.8
% Protein 12.07
Loin eye area 2.53

% moisture 52.5
% fat 34.36

ILLUSTRATION VI



Lot 3
Age 124

% E.P. 72.8
% Protein 11.81
Loin eye area 1.74

% Moisture 47.4
% fat 40.1

Several wholesale cuts were boned and a correlation of the percentage of edible portion in these cuts compared with the entire carcass. (Table 9). There was no correlation between the percentage edible portion in the leg with the percentage edible portion in the entire carcass. However, in the case of the percentage edible portion in the shoulder, it was found that there was a highly significant correlation with the entire carcass. This result is supported by work of Palsson (22) and Hankins (12).

TABLE 9

CORRELATION BETWEEN EDIBLE PORTION OF LEG AND SHOULDER WITH THAT OF TOTAL CARCASS

Percentage E.P. of leg	0.1910
Percentage E.P. of shoulder	0.7279**

**Significant at the 1% level

The average carcass grades were varied by lots, with lot 2 showing a 1/2 grade higher than lots 1 and 3. Although carcass grades differed, the final cut-out (edible portion) did not differ appreciably. This would infer that the higher grading lambs were not overly fat, as this would have decreased the percentage of edible portion. In addition, there was no significant correlation between the percentage of fat and the grade. (Table 10).

TABLE 10

CORRELATION OF PERCENTAGE FAT ON GRADE AND RATE OF GAIN

Grade	-0.2324
Rate of gain	0.2927

SUMMARY AND CONCLUSION

In comparing the average daily gains, there was a pronounced difference between lambs on creep (lots 1, 2, 3) and lambs not on creep, lot 4. However, there were only slight differences between the creep fed lots, (0.62 pounds in lot 1, to 0.66 pounds in lot 3.) This supports the importance and practicality of alfalfa pellets in the creep feeding of lambs. Total feed consumption varied between the 3 lots on creep feed from 160.8 pounds in lot 2 to 146.9 pounds in lot 1. From the standpoint of rate of gain and feed consumption, it would appear that the creep ration of alfalfa pellets, shelled corn, and soybean oil meal was the most effective.

Ration effect on carcass traits was significant only in the case of shrink. Lot 1, which was on alfalfa pellets alone, shrank significantly more than did lots 2 and 3.

There was no significant effect of ration on dressing percentage, percentage total edible portion, or muscle development as indicated by the area of the longissimus dorsi. The greater differences of these traits, within lots, would more likely be a result of differences in carcass type and conformation, rather than feed or nutritional differences.

The physical separation of a carcass to determine edible portion is time consuming and laborious. From this standpoint alone, the high correlation between the percentage edible portion in the shoulder to the total edible portion, becomes even more important. Working only with the shoulder in determining percentage edible portion, not only eliminates a laborious and time consuming operation, but also leaves the more desirable wholesale cuts (ie, leg, loin) virtually untouched and facilitates further, more economical processing of these cuts. The importance of this correlation would be very beneficial to further experiments of this nature.

Determination of the chemical analysis of the lamb carcass in respect to protein, fat, and moisture, showed that the ration had no effect on these traits. Here again larger differences were noticed between individuals within lots than between lots. The average chemical composition determined in this experiment is in full agreement with the results published by Hankins (12) and the A.M.I.F. (1).

In summation, it should be pointed out that this investigation was designed to illustrate the tremendous possibilities in the creep feeding of suckling lambs in Ohio. The results have emphasized the importance of a mixture of roughage, grain, and protein supplement in the ration. Not only will the rate of gain be important to the lamb producer, but also the fact that by obtaining these faster gains, the lambs are ready for market sooner than if no creep had been used. Earlier marketing may result in higher market prices and more income for the producer, which, of course, is the ultimate in any livestock operation.

It would appear from the limited numbers of animals used in this experiment, that there was little effect of creep ration on the carcasses. Perhaps ration effect on the carcasses would have been more pronounced if breeding, sex, and multiple birth influences were considered.

If the lamb market is to compete favorably with the beef and pork market of tomorrow, the production of a meat type lamb carcass must be one of the foremost objectives. Perhaps the results of this experiment will stimulate further investigation. As was stated previously, breeding, sex, and multiple births, in addition to type of ration, should be considered in future research of this nature. In all probability these traits will have an important bearing on the production of a meat type lamb carcass.

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