THE EFFECT OF SLAUGHTER WEIGHT AND FEED RESTRICTION ON PERFORMANCE AND CARCASS CHARACTERISTICS OF SWINE

by

Clarence Melvin Bradley

Bachelor of Science
University of Missouri
1949

Master of Science
University of Missouri
1952

Submitted to the faculty of the Graduate School of
Oklahoma State University in partial fulfillment
of the requirements for the degree of
DOCTOR OF PHILOSOPHY
August, 1963

THE EFFECT OF SLAUGHTER WEIGHT AND FEED RESTRICTION

ON PERFORMANCE AND CARCASS CHARACTERISTICS

OF SWINE

Thesis Approved:

J. C. Hillier
Thesis Adviser

Robert Totusek

James A. Whatley Jr.

Roger E. Koeppe

Lowell E. Walters

Robert MacVicar
Dean of the Graduate School

ACKNOWLEDGMENT

The author wishes to express his appreciation to Dr. J. C. Hillier, Professor of Animal Husbandry, for his guidance during the course of this study and in the preparation of this thesis. Further appreciation is extended to Dr. L. E. Walters, Professor of Animal Husbandry, for his instruction in processing the carcasses, and to Professor G. V. Odell, Department of Biochemistry, for his supervision of processing the samples for chemical analysis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

INTRODUCTION

The continued passive attitude of consumers toward pork suggests that improved production methods are needed if pork products are to realize their potential in a growing population.

The production of pork may be increased or decreased rather quickly by two methods: (a) varying the number of females bred and/or (b) varying slaughter weights. During periods when market prices increase, both methods are widely practiced. Selling hogs at heavy weights tends to produce excessive fat that is not acceptable to the consumer.

Constructive efforts by purebred breeders to produce a meat-type hog through their meat certification programs have been met with enthusiasm. However, recent United States Department of Agriculture figures (1961) show little change in the pounds of fat trim per unit weight of pork carcass during the past twenty years. The average weight of slaughter hogs marketed has remained about the same during this time. On the other hand, processors are trimming pork cuts closer now than formerly, which would tend to mask the improvements made in lean-to-fat ratio.

Recent improved nutritional knowledge has stimulated much interest and application of swine production in confinement in areas of the Corn Belt and the southern half of the United States. These multiple farrowing units tend to equalize market supplies and afford an opportunity of merchandising quality pork at premium prices. Ten years ago almost half of the pigs were farrowed in March, April, and May, compared to a 15 percent difference from highest to lowest quarter in 1961. Nevertheless, during 1961 the percentage of the consumer's dollar spent for pork set a new low.

Logically, an aggressive pork industry depends upon a balance among its major segments, i.e., production, processing, and consumption. The producer must rely on a healthy, efficient-gaining pig that will finish at an early age and yield a high ratio of lean to fat.

The processor is entitled to a quality product with a good dressing percentage and a high yield of lean cuts. Further, before demanding a premium price from the wholesaler, he must be assured that this quality will remain available in sufficient supply to satisfy the demand of the wholesaler at all seasons of the year.

Finally, the consumer demands a high ratio of lean to fat in any meat purchased. The consumer's concern is one of "red meat," or "edible portion," with a minimum of fat, and at a competitive price.

The purpose of this study is (1) to determine the production efficiency, killing qualities, and carcass value of superior-type pigs slaughtered at 150, 175, 200, and 225 pounds live weight; and (2) to determine the effect of limited feeding during the finishing period on the foregoing factors.

REVIEW OF LITERATURE

Attitudes Toward Lightweight Slaughter Hogs

Historically, lightweight slaughter hogs have been viewed with disfavor. The idea that it takes a heavy hog with a lot of fat to have a satisfactory dressing percentage is an old one (Smith, 1920; Morrison, 1936; Vaughan, 1935). Some recent workers have also reported a tendency for dressing percent to decrease with decreasing amounts of backfat (Tribble *et al.*, 1954; Winters *et al.*, 1949; Lasley and Tribble, 1952; and Jordan *et al.*, 1956).

An equal number of workers have considered dressing percent to be influenced less by finish and weight than was formerly thought. These researchers feel that well-muscled, "handy-weight" hogs should logically dress as high as fat ones of comparable weight. More recent work substantiates their contention that well-muscled hogs with minimum amounts of backfat will dress as high as those of higher condition, and that good dressing percentages can be found over a wide range of slaughter weights.

McCampbell and Baird (1961) slaughtered purebred Poland China hogs at 170, 190, 210, and 230 pounds; and found no difference in dressing percent due to slaughter weight. Zobrisky (1958) reported no difference in dressing percent of good pigs slaughtered at 200, 250, and 300 pounds, although those weighing 150 pounds dressed 3 percent less. Pigs weighing 150 pounds also dressed less than 200-pound pigs in an experiment reported by Wagner et al. (1963). Emerson et al. (1961) slaughtered Yorkshires and crossbreds at 120, 150, 180, and 210 pounds; and reported no difference in quality or processing properties. Mullins (1960) found well-muscled slaughter pigs at 220 pounds to dress fully as high as the fatter type.

In an interesting report by Hankins et al. (1953) comparisons were made among seven different strains of hogs. A total of 445 hogs were fed to a weight of 210-213 pounds and were dressed "packer style." Of special interest is the fact that the fattest animals did not dress the highest. Landrace-Chester Whites, which were next to the thinnest in terms of backfat measurements (39.77 mm), dressed 80.93 percent, while the Landrace-Large Blacks, the fattest (backfat 43.6 mm), dressed 80.05 percent. These investigators stated that the greater development of muscle and bone in higher-yielding strains accounted for the difference.

A high-fiber ration may be as important as weight and condition in reducing dressing percent. Bohman et al. (1955) fed pigs a pelleted ration containing 10, 20, and 50 percent alfalfa hay. These workers found a large decrease in dressing percent with each increased level of alfalfa. They attributed part of the observed difference to a significantly increased weight of the stomach and large intestine from pigs fed the higher levels of alfalfa. Stevenson et al. (1960) also reported lower dressing percentages from pigs when alfalfa meal was increased from 4 to 16 percent or 4 to 28 percent of the ration.

Merkle (1953) found essentially the same thing when high levels of corn cobs were fed. Lasley (1951) compared records of more than a thousand pigs fed in dry lot during the winter to their full sibs fed on pasture the following summer, and reported a 2 percent higher dressing percentage for dry-lot-fed pigs even though they had less backfat. Bell (1958) noted a significant difference in dressing percentage among Canadian testing stations in comparable Yorkshire hogs slaughtered under standard conditions. Saint-Pierre et al. (1934) found that full-fed fall pigs dressed higher than limit-fed pigs, while the reverse was true for full-fed spring pigs. Both groups were fed in dry lot.

A survey of 25 packers from 13 states made by Field et al. (1961) indicated that 83 percent preferred hogs weighing from 200 to 225 pounds. They indicated that an equal live weight of 175-pound hogs would yield less carcass weight and cost 20 percent more to process. They, in turn, paid $1.50 per hundred less for the 175-pound hogs as compared to hogs weighing 200-225 pounds.

Consumer acceptance tests have largely appeared since 1952 and are limited in scope. In general, there is a preference for the leaner cuts from lightweight carcasses as compared to cuts from heavier-weight hogs. Some consumers object to the smaller cuts, especially the chops. Lightweight cuts also appear to be comparable in flavor and tenderness to the cuts from heavier hogs, as measured by consumer tests, taste panels, and Warner-Bratzler shear values (Emerson et al., 1961; Hatesohl, 1959; Mullins, 1960; Zobrisky, 1960).

Some very real objections to lightweight hogs would seem to be (1) increasing processing costs per unit weight to the packer; (2) the relatively high fixed costs for maintenance of the breeding herd; and (3) high per-head vaccination and medication costs.

Effect of Slaughter Weight on Feed Efficiency

For a long time researchers have known that feed efficiency decreases as maturity approaches and declines further with aging. Henry (1902) observed a decreased efficiency of 33 percent for 320-pound pigs as compared to those weighing 78 pounds. A few years later Haecker (1916, 1920) studied changes in body composition of steers at different stages of growth as correlated to feed requirement per hundred pounds of gain from a weight of 100 to 1200 pounds. Feed efficiency was considerably greater with younger cattle. Composition of early gain was primarily water, protein, and minerals as opposed to large deposits of fat in older steers. Since fat is lower in water and higher in energy than protein, the most efficient gains occurred in the younger cattle.

Brody (1945) described the decreased efficiency of animals approaching cessation of growth by the "principle of diminishing increments of food consumption" by saying: "As the animal approaches mature weight, the successive increments of body weight decrease per unit food intake; finally, growth virtually ceases while food consumption continues for maintenance alone."

Hogan et al. (1924) did extensive feed efficiency and carcass analysis studies on a limited number of individually-fed large-type Poland China pigs paired with an equal number of large-type Yorkshires which were slaughtered at live weights of 100, 150, 200, 250, and 300 pounds. The amount of feed required per pound of gain, by stages, was 4.26, 4.20, 4.96, and 6.33 pounds, respectively. In stage one (100-150 pounds), 36.95 pounds of feed were required to produce 1 pound of protein in the carcass (includes skin, tail, etc.) and 60.28 pounds to produce 1 pound of edible protein. Stage two (150-200 pounds) was substantially the most efficient in terms of carcass and edible protein production, requiring 23.78 and 35.62 pounds of feed, respectively. During the period from 200 to 250 pounds live weight, 81.93 and 108.7 pounds of feed were required. Finally, gains from 250 to 300 pounds required 96.15 pounds and 125.72 pounds to produce 1 pound of carcass protein and 1 pound of edible protein, respectively. The protein conversion ratio (ratio of protein in the feed to edible protein in the carcass) for the four stages from lightest to heaviest was 9.0:1, 5.3:1, 16.3:1, and 18.9:1. Fat retention tended to vary inversely with protein production. The author suggested that feed cost of protein gains increased rapidly after 200 pounds.

Loeffel et al. (1943) conducted experiments similar to those of Hogan by self-feeding large-type purebred and crossbred pigs (mostly Durocs) in groups from 71 to 400 pounds. One representative animal was slaughtered in increments of 25 pounds from 150 to 400 pounds. In succeeding trials five pigs were slaughtered at each weight of 150, 175, 200, and 225 pounds; and complete carcass data were collected, including separable fat and lean.

The feed required to produce a pound of live weight gain by increments was 4.19 pounds of feed (125-150 pounds); 4.26 pounds (150-175 pounds); 4.93 pounds (175-200 pounds); and 5.83 pounds (200-225 pounds). The authors pointed out that the latter figure may be biased because of an outbreak of flu that affected more of the heavy pigs. Although Loeffel and Hogan used slightly different increments of live weight, their feed efficiency figures may be interpreted to parallel each other rather closely for a given weight. In each case, no significant difference in feed efficiency was noted with increasing weight until the pigs reached approximately 175 to 200 pounds. From this weight upward, feed efficiency decreased sharply. Loeffel reported a decrease in feed efficiency of 13.3 and 14.8 percent for pigs growing from 175 to 200 pounds and 200 to 225 pounds, respectively. Hogan noted 15.3 and 20.1 percent less efficiency for pigs growing from 200 to 250 pounds and 250 to 300 pounds, respectively. In both cases the pigs were described by the authors as "large-type," and their pictures substantiated the author's description; but they did not appear to have the amount of muscling that is expected of the modern meat-type hog of today. Such being the case, the modern pig should logically continue muscle growth to heavier weights, thus shifting the feed efficiency curve to the right until such time as muscle growth decreases and fat deposition substantially increases.

Bruner (1962) analyzed records from the Ohio Swine Improvement Program with reference to feed efficiency and backfat probe on about one thousand pigs. The average feed efficiency for those pigs failing the test because of having 1.6 or more inches of backfat was 20 pounds poorer than for those that qualified. This observation suggests that the meatier pigs at the Ohio test station were also more efficient in feed conversion.

Feed efficiency has been reported in some detail recently on hogs of lighter weights by a number of researchers. Mullins (1960) supervised two tests where meat-type pigs were compared to "average" pigs at two different slaughter weights, i.e., 160 and 220 pounds. A summary of rate-of-gain feed efficiency and feed cost at 60-pound weight intervals is recorded in Table I.

The meatier pigs gained faster and more efficiently during all stages. They also produced considerably more acceptable carcasses. Feed efficiency from weaning to 160 and to 220 pounds favored the meat-type hogs by 9 and 6 percent, respectively. Furthermore, the 160-pound meat-type

TABLE I

A COMPARISON OF AVERAGE DAILY GAIN, FEED EFFICIENCY, AND COST PER HUNDRED POUNDS GAIN BETWEEN MEAT-TYPE AND AVERAGE HOGS

Weight Interval Lbs.	A.D.G.	Feed per 100 Lbs. Gain	Feed Cost 100 Lbs. Gain
	100 Average Hogs		
40-100	1.36	301.6	$ 8.78
100-160	1.62	416.6	11.84
160-220	1.64	426.1	11.89
40-160	1.44	346.3	10.74
40-220	1.48	384.9	11.81
	24 Meat-Type Hogs		
35-100	1.54	266.0	7.71
100-160	1.84	368.0	10.97
160-220	2.04	417.0	11.62
35-160	1.70	315.7	9.06
35-200	1.77	362.8	10.31

pigs were 13 percent more efficient in feed utilization than comparable 220-pound pigs. Among the average hogs, 160-pound pigs were 10 percent more efficient than those weighing 220 pounds.

These data further support the contention that (a) muscular pigs are more efficient than others; and (b) feed efficiency decreases as live weight increases, with almost any type of pig.

An experiment similar to that of Mullins was reported by Field _et al_. (1961). These workers slaughtered large numbers of 160- and 220-pound muscular Hampshire hogs to determine rate of gain, feed efficiency, and carcass merit. The values obtained were 1.52 and 1.55 pounds for average daily gain, and 3.43 and 3.70 pounds for feed efficiency. Although rate of gain was essentially the same, the lighter hogs were about 7 percent more efficient in feed conversion than the heavier hogs. The increased processing cost of the light hogs was more than offset by the additional $1.27 value per hundredweight of their dressed carcasses over the heavier group.

McCampbell and Baird (1961) slaughtered purebred Poland China hogs at 170, 190, 210, and 230 pounds. They observed that average daily gain decreased with increased increments of live weight as follows: 1.56, 1.47, 1.43, and 1.43, respectively. At the same time, the amount of feed required per pound of gain was 3.40, 3.61, 3.64, and 3.74 pounds,

These workers found very little difference in feed efficiency between animals in live weight groups of 190, 210, and 230 pounds. The lighter group (170 pounds) was significantly more efficient. Results reported by Wallace et al. (1959) with pigs slaughtered at 150, 180, 210, and 240 pounds showed a linear decrease in feed efficiency as weight was increased. Dressing percent was in favor of heavier-weight groups.

Effect of Slaughter Weight on Carcass Quality

Some early experiments at Illinois by Bull and Longwell (1929) described the effect of type on carcass quality in great detail. Their experimental material consisted of five distinct types of Poland China swine: very chuffy, chuffy, intermediate, rangy, and very rangy. Representatives of each of these types were slaughtered at 175 and 225 pounds and the carcasses subjected to physical separation. In general the carcasses of the chuffy pigs contained less lean, less skin and bone, and more fat than those from intermediate-type hogs. Carcasses from the rangy type contained more bone and skin and had less fat than those from intermediate-type hogs. However, the differences were small and the authors pointed out that "the animals looked very different, but when separated and sampled they were very much alike." Many of the rangy-type pigs were criticized for being "underfinished."

On the other hand, some carcass differences are evident from the percentages of lean, fat, skin and bone of the 175- and 225-pound slaughter weight groups, as shown in Table II.

TABLE II

PHYSICAL COMPOSITION OF CARCASSES OF HOGS HAND-FED INDIVIDUALLY IN DRY LOT, 175-POUND AND 225-POUND WEIGHTS (EXPRESSED IN PERCENTAGE OF CARCASS WEIGHTS)

	175-Lb. Slaughter Weight	225-Lb. Slaughter Weight
	Very Chuffy Type	
Lean	45.7	41.7
Fat	37.6	42.9
Skin	4.7	4.6
Bone	11.1	9.9
	Intermediate Type	
Lean	44.4	45.2
Fat	35.1	38.0
Skin	6.3	4.7
Bone	13.3	11.2
	Rangy Type	
Lean	45.5	45.9
Fat	33.9	33.3
Skin	6.4	5.2
Bone	13.1	13.4

The very chuffy pigs were comparable to the other two types in percentage separable lean at 175 pounds, but not at 225 pounds. The fat-lean ratio changed significantly from 37.6 percent fat and 45.7 percent lean to 42.9 percent fat and 41.7 percent lean at the heavier weight. At the same time, there was little difference between the intermediate and rangy types in the percent of components at light and heavy slaughter weights. It appears from these data that the chuffy-type pigs were more adversely affected by fat deposition at heavier weights than were either the intermediate or rangy types.

Mitchell and Hamilton (1929) did extensive chemical analyses on the carcasses of the previously-described pigs of Bull and Longwell plus a group of 275-pound rangy pigs. This was done in an effort to determine if the change in fat content with increased weight accounted for the changes noted in the other carcass constituents. They then computed the percentages of dry matter, protein, and ash on the fat-free basis; and concluded that fat content was the only major difference in carcasses of different weight hogs.

Hankins and Ellis (1945) analyzed data on the physical and chemical characteristics of 64 carcasses from hogs of intermediate type. The slaughter weights were 175, 200, 225, and 250 pounds. They found a close correlation between carcass weight and weight of primal cuts. However, with increasing live weight from 175 to 250 pounds the amount of separable fat of the carcass increased from 37 to 45 per cent; separable lean decreased from 41 to 32 percent; and the caloric value per pound of edible lean increased approximately 22 percent, whereas that of bacon increased by one-third. The authors called attention to the low percentage of fat in the ham and loin compared to the bacon. They observed less than 1 percent difference in separable lean between a typical 13.9-pound ham from the 175-pound pigs and a 17.3-pound ham from the 250-pound group. Fat trim and bone accounted for the weight difference.

Moisture content of the carcasses declined from 41.8 to 34.7 percent with increasing weight. Scott (1930), Loeffel et al. (1943), Hogan et al. (1925), and others have reported similar results.

Hankins and Ellis (1934) had previously analyzed 60 carcasses from pigs weighing 93 to 250 pounds and found the percentage of fat in the edible portion of the carcass to range from 30 to 57 percent according to chemical analysis.

Loeffel et al. (1943) did not find as much variation by physical separation, but found that fat ranged from 44.33 percent in 225-pound hog carcasses to 32.40 percent in the carcasses from lighter hogs (150 pounds). Conversely, separable lean decreased from 51.52 percent on the light carcasses to 43.48 for the heaviest carcasses.

The authors pointed out that the largest daily gains occurred in pigs from 150-175 pounds with a sharp decline after 300 pounds. They noted continued muscle and bone growth to 400-pound weights, but observed that rate of growth was not nearly as rapid as was fat deposition. They found no difference in organoleptic tests among weight groups.

A great deal of interest has been aroused recently in carcasses from lightweight meat-type hogs. One hypothesis is that modern hogs produce wholesale meat cuts large enough to meet consumer demand at lighter slaughter weights than formerly. Lesser amounts of lard are also expected from lighter carcasses.

Varney et al. (1962) found the following significant differences between 159- and 215-pound slaughter hogs: light hogs were superior ($P < 0.01$) in lean cut yields and in dollar value per pound on both a live and carcass basis. Heavier hogs dressed higher and had a higher yield of bacon and lard.

Similar observations were made by McCampbell and Baird (1961) on Poland China hogs ranging from 170 to 230 pounds (20-pound increments). As live weight increased, fat back, carcass length, and loin area also increased; but lean cuts decreased substantially, as did feed efficiency.

Mullins (1960), Field et al. (1961), and Zobrisky (1960) combined consumer acceptance tests with production and slaughter information on different weight hogs. These workers found that heavier hogs produced larger loin areas. When loin area was calculated on a per hundredweight of carcass basis, Mullins found the lighter carcasses significantly superior in loin lean area as well as in backfat and percent lean cuts. The lightweight carcasses were worth $2 more per hundred pounds than the heavier carcasses.

Eighty families were selected for a consumer survey on acceptability. General acceptability was reported good for cuts from both weight groups (160 and 220 pounds live weight). However, cuts from the heavier carcasses were criticized more often for being too fat. The cuts criticized most for their apparent fat content were the blade roasts, Boston butts, bacons, and picnics. No differences were found in tenderness.

After observing a significant ($P < 0.05$) advantage in lean cuts from 160-pound hogs over those weighing 220 pounds, Field *et al.* calculated carcass value on Chicago prices (*National Provisioner*) to favor the light carcasses by $1.27 per hundred. These carcasses came from purebred Hampshires from the University of Kentucky Herd Improvement Program.

A majority of 561 consumers also preferred cuts from the lighter carcasses. They objected to cuts from heavy hogs ($P < 0.01$) for being too fat. A survey of meat packers in 13 states indicated a preference for the heavier hogs and also for conventional-size wholesale cuts, when they were asked which weights their customers preferred. Their judgment was not substantiated according to a similar questionnaire sent to the retailers, who tended to select lighter-weight cuts than the packers. They listed their reasons as (a) consumer acceptance, (b) balanced movement of retail cuts, (c) profit cutout, (d) more tender and flavorful, (e) consistently leaner, and (f) more attractive unit cost.

Organoleptic tests indicated no differences in palatability or tenderness between cuts from the 160- and 220-pound live weight groups. Warner-Bratzler shear scores were also very similar.

Zobrisky (1960) slaughtered 125-, 165-, and 205-pound meat-type hogs and studied consumer acceptance in co-operation with 240 families in two locations. In addition to noting the advantage of light hogs in reduced backfat and increased lean cuts, he attempted to determine at what stage of growth these advantages occurred. He concluded that the greatest increase in weight of bone and lean cuts was from 125 to 165 pounds and the weight of greatest fat deposition was from 165 to 205 pounds.

Taste panels found no differences among weight groups, and no significant differences were detected in Warner-Bratzler shear values. Fifty-two percent of the consumers found chops from the 125-pound pigs "too small" and 48 percent "just right." These data almost identically duplicated a similar test by Hatesohl (1959) in another town in Central Missouri, where consumer preference for chops, ham, and steaks from 165-pound and 205-pound hogs was very similar. A surprising number of customers rated all of the cuts "too fat," regardless of the size carcass from which the cuts were made.

Mention should be made of a trial in Canada by Bell (1958) with Yorkshires slaughtered at 185 and 200 pounds.

Carcasses were measured for length and backfat. No advantages were found in carcasses from 185-pound live weight pigs over those weighing 200 pounds. Both groups gained slowly, however, because of a restriction of total digestible nutrients in the ration.

It would seem obvious from the reports of the foregoing researchers that reducing slaughter weight from 225 to 200 pounds or less would not only increase feed efficiency but produce less noticeable fat in the retail cuts.

Effect of Limit-Feeding on Carcass Quality and Feed Efficiency

A large amount of research has been directed toward reducing fat deposition and increasing feed efficiency by limiting the energy intake of growing-finishing swine.

Perhaps the most widely referred to experiments are the classical studies of Hammond and McMeekan (1940). They initiated research based on four planes of nutrition designed to produce 200-pound bacon pigs with quality carcasses. An inbred line of pedigreed Large Whites was established by brother-sister mating from which fourth generation gilts were mated to one boar to produce 80 pigs for use in the experiment. Levels of nutrition imposed in the feeding regime were:

(1) High plane throughout (High-High).

(2) High plane to 16 weeks of age, then restricted (High-Low).

(3) Restricted to 16 weeks, then full-fed (Low-High).

(4) Restricted throughout (Low-Low).

Feed allowances were regulated so that the pigs developed according to a predetermined growth curve. Results of the experiment indicated that High-High pigs were least efficient in feed utilization, and High-Low most efficient; i.e., 5.05 vs. 4.28 pounds. The Low-High lot had the lowest efficiency (5.61 pounds) followed by the Low-Low (5.19 pounds).

These data supported the hypothesis of Hammond and McMeekan that different tissues (muscle, bone, fat) tend to grow at different rates during the pig's life. Early feeding on a high plane of nutrition tended to promote growth of bone and muscle, while late-developing tissues (fat) were inhibited by limiting the feed during the latter part of the finishing period.

Hammond (1940) further stated: "Growth gradients run from the cranium backwards and the tail forward and meet in the lumbar region. Thus, after birth the loin makes most growth, followed by the pelvis and thorax, while the head makes the least. In early life bone makes most growth, followed by muscle, while fat attains its maximum rate of growth much later in life." The authors felt that stunting pigs in early life tended to produce a lighter-muscled, fatter carcass than would otherwise result from normal feeding.

McMeekan (1939) slaughtered pigs at monthly intervals from birth to seven months of age; and found body shape to change from "short and shallow with a high percent of head, neck, and legs to a more favorable ratio of loin to these cheap cuts." He observed "waves of growth," starting at the extremities and meeting at the loin.

After leaving England, McMeekan (1940, 1943) duplicated his earlier work with Hammond and further substantiated their results. High-Low-fed pigs had 20 percent more muscle than Low-High pigs and 3 percent more than High-High groups. The Low-Low group excelled in muscling but took 315 days to reach 200 pounds, and was considered impractical.

Callow (1935) found growth gradients with pigs to agree with the work of Hammond and McMeekan. Brody (1945) suggested that body weight and surface growth did not proceed at the same rate, nor did linear size. This is in agreement with results from tests conducted by Comstock et al. (1944).

Finally, McMeekan (1939) analyzed large numbers of carcasses from Danish Landrace pigs. He attempted to determine what variation remained in carcasses from pigs where standardization of carcass had been attempted by years of selection. They were found to vary considerably, especially in loin-eyes and belly streaks.

Many workers in this and other countries have duplicated Hammond and McMeekan's experimental design, but have not always been able to duplicate their results.

Crampton (1940) was interested in whether early rates of gain in pigs are associated with heavier-muscled carcasses under practical feeding regimens in Canada. He analyzed data from 247 individually full-fed pigs for early rate of gain and carcass meatiness and found little correlation between gain and meatiness. Crampton, Ashton, and Lloyd (1954) restricted 110-pound pigs in two seasons to 2 pounds less feed than full-fed controls and increased the percentage of Grade A carcasses from 58 to 70 percent. The restricted animals reached market weight two weeks later on about the same amount of feed, and appeared to have a higher percentage of muscle than the controls, according to the authors. The winter-fed limited pigs gained significantly slower than the summer-fed limited pigs. Two pounds daily less than a full feed decreased gains 0.45 pound in winter and 0.25 pound in summer, compared to full-fed controls.

Ellis and Zeller (1934) compared full-feeding with 70 and 50 percent full-feeding, using Poland China, Chester White, Duroc, and Tamworth pigs from weaning to market weight. The limited lots were more efficient and the 50-percent restricted group produced 16 percent more lean meat than the others. However, their gains of 0.77 pound daily were considered unsatisfactory.

Saint-Pierre <u>et al</u>. (1934) in a similar trial considered 50 percent of a full-feed to be a severe restriction and observed that it took 102 days longer for the pigs to reach market than full-fed controls. Those fed at 75 percent of a full-feed were more efficient than full-fed animals.

Lasley and Tribble (1951) attempted to determine production costs and carcass quality of pigs limit-fed in various amounts and at different weights. They suggested that pigs limited to 75 percent of a full feed after reaching 125 pounds produced meatier carcasses than full-fed controls, but required nine days longer to reach market weight. Pigs limited from weaning were criticized for producing soft carcasses and requiring 33 extra days to reach market weight.

Later work by these experimenters (1952) with the Hammond-McMeekan system where meat-type pigs were restricted to 85 percent of a full feed beginning at 150 pounds live weight, resulted in meaty carcasses in all four groups. The Low-Low group tended to have more muscling, less backfat, and a lower dressing percent than the others. They also required 19 days longer to finish. The four groups ranked as follows on net return (sale price less cost of feed and value of feeder pig): Low-Low, $10.43; High-Low, $9.21; Low-High, $8.93; and High-High, $7.45.

The authors noted that Low-High pigs gained 22 percent faster during the full-fed period than High-High pigs during the same period, and required 79.5 pounds of feed to deposit an additional 4.6 pounds of lard in the carcass. They summarized by suggesting that restricting the feed intake from weaning was most profitable to the producer and most acceptable to the consumer, but least profitable to the processor because of a lower dressing percent.

Tribble _et al_. (1954) fed seven lots of purebred pigs at different levels of restriction and found 85 percent of a full-feed to be most efficient. Carcass fat varied proportionately to feed level, and lean content varied inversely.

In later trials (1956) Tribble et al. found that limited feeding (85 percent) had no effect on feed efficiency until pigs reached 100 pounds. Backfat probes indicated no difference in fat deposition until after 150 pounds.

Cummings and Winters (1951) divided 80 pigs into four lots and fed as follows: (1) full-fed; (2) full-fed to 120 days, then fed at the rate of 3 percent of their body weight; (3) restricted to 3 percent of their body weight until 120 pounds, then full-fed; and (4) restricted to 3 percent of their body weight throughout the test. The total digestible nutrients consumed per pound of gain was essentially the same for the first three lots (3.14 pounds). Pigs in lot four required 2.98 pounds of total digestible nutrients per pound of gain. These figures are higher than the 2 pounds reported by Brody (1945) and the 2.19 pounds reported by Bell (1953). Carcass information revealed a 2.4 percent advantage in lean cuts for the Low-Low lot, with the High-Low lot producing good carcasses, and lots 1 (High-Low) and 3 (Low-High) yielding carcasses "of somewhat less desirability." The slaughter ages were 206, 219, 230, and 266 days, respectively.

Winters, Sierk, and Cummings (1949) did not agree with Dickerson (1947), Donald (1940), and Blunn and Baker (1947), who found that the fastest-gaining pigs also were the fattest. These workers, reporting on the Hammond-McMeekan system, found less nutrients required to produce a pound of muscle than a pound of fat.

Braude and Townsend (1958) noted soft carcasses but good feed conversion on Low-Low-fed pigs. The best dressing percentage and most profit were obtained on High-High pigs.

Attempts have been made to reduce the labor required to restrict the feed intake of pigs by self-feeding a high-fiber ration (Bell, 1958; Bohman et al., 1955; Lucus and Calder, 1956; and Merkle et al., 1953). In each case success was obtained in reducing backfat, but dressing percentages were significantly decreased. Merkle noted that dressing percent decreased 5.5 percent when the ration contained 50 percent alfalfa. Size of the stomach and large intestine was significantly increased in pigs eating high-fiber rations. Jordan et al. (1956) found comparable results with pigs on good pasture when they received 80, 70, 60, 50, and 40 percent of a full-feed of grain.

Recent research with limit-feeding a high-energy ration in dry lot at 85 percent of a full-feed from 135 to 200 pounds was reported by Tribble et al. (1956). These pigs gained more efficiently ($P < 0.05$) than full-fed controls. They also excelled in percent lean cuts, and had less backfat than the controls.

Becker et al. (1962) full-fed one group of pigs, fed a second group 70 percent as much from a weight of 114 pounds to market, and a third group 5 pounds per head per day after weaning. The latter two groups took ten days longer to reach market weight, but were 11.0 and 8.4 percent more efficient, respectively. Although not significantly so, their carcasses consistently appeared to be leaner than those full-fed. The authors suggest a full-feed to 100 pounds, them limit-feed at the rate of 70 percent of a full-feed thereafter for improved feed efficiency and carcass quality.

It would appear from the foregoing discussion that limiting the energy intake after 100 pounds to growing-finishing pigs to about 75 to 85 percent of a full-feed increases feed efficiency and improves carcass quality, according to current carcass standards. Severe restriction (40 to 60 percent) appears to result in decreased gains and advanced age to a point of undesirability from a practical point of view.

More uniform farrowing throughout the year has largely removed seasonal "price breaks." Therefore, the disadvantage of 10 to 20 days of additional age voiced by researchers a decade ago for limited-fed hogs is no longer valid.

Further, refined feeding equipment has been developed that will meter out desired amounts of feed on time schedules, eliminating the expense and inconvenience of hand-feeding. Thus, when feed intake is adjusted so that the cost of maintenance for 10 to 20 additional days is less than the inefficiency of fat deposition of full-fed pigs, limit-feeding would seem to be indicated, not only for the sake of economy but for the long-range good of the swine industry.

MATERIALS AND METHODS

Sixty-four weanling pigs were used in two separate experiments during the spring and summer of 1959 and fall and winter of 1960. The criteria tested were: (1) feed efficiency at different weights and under different feeding regimes; and (2) carcass quality as measured by lean-fat ratio, chemical analysis, and physical measurements. Since the experimental procedures were substantially different, each trial will be described separately.

Trial I

The purpose of this trial was to study (1) the efficiency of feed utilization, (2) dressing percentage, and (3) carcass merit of hogs slaughtered at four different live weights.

Thirty-two purebred Hampshire gilts were assigned to individual pens in a randomized block experiment to be slaughtered at weights of 150, 175, 200, and 225 pounds for detailed carcass analysis.

The gilts were from the Oklahoma State University Hampshire herd. Weekly weights of the group were made, and as four pigs (or eight) reached 60 pounds they were taken to the University Nutrition Barn and randomly allotted to a block until eight replications were complete.

One pen of each block was along an alley that accommodated substantial amounts of foot and/or animal traffic. Some pigs appeared to be nervous upon assignment to pens until becoming accustomed to the new surroundings. Otherwise, comfort of the animals was maintained because of natural breeze and coolness of the barn, and fly control by use of lethal bait. Pens were cleaned and washed daily and stationary watering troughs were filled three times daily, or as needed.

All pigs were self-fed a 16 percent protein ration throughout the test. Milo was the base grain. Appendix Table I lists its composition. Every effort was expended to keep the feeders adjusted to prevent waste, but no attempt was made to weigh wasted feed, because of its contamination with feces and from having absorbed moisture from the floor. Bedding was not used. A convenient scale in the barn was used to weigh feed to each animal and to weigh each pig (by use of a crate) every two weeks. As each individual approached market weight, weighings were made as needed to determine the desired slaughter weight more closely.

Pictures were made of the animal the afternoon prior to slaughter, and feed was removed from the pen and weighed back. Water remained available.

About 6 a.m. the morning of slaughter, the animals to be slaughtered were hauled in a small automobile trailer about one-fourth mile to the University Meat Laboratory, where they were weighed and slaughtered.

When slaughtered, weights were taken of the head, leaf fat, caul fat, digestive tract (full and empty), pluck, heart, and the hot carcass.

The digestive tract was removed, weighed, and split to remove its contents, then washed and allowed to drain before reweighing. The head was removed and the lean from the cheeks was removed later to be used in analysis of the carcass. Otherwise, the head was given no consideration in calculating percentage components in the carcass. Leaf fat was removed, but hams were not faced. The dressed carcass was then split, weighed, and allowed to remain in the cooler 48 hours before processing.

The length of the chilled carcass was measured to the nearest one-tenth of an inch from the front of the first rib near the backbone to the front of the aitchbone on both carcass halves. Both sides were also used to determine backfat thickness by an average of three measurements from each side. The first was taken opposite the first rib at the junction of the last cervical and the first thoracic vertebrae; the second opposite the last rib at the junction of the seventh and eighth vertebrae below the last lumbar; and the third opposite the last lumbar vertebra.

The carcass was then weighed and broken into wholesale cuts. The shoulder was removed between the second and third rib at the attachment of the thoracic vertebra and at right angles to the general line of the body. The jowl was removed and squared and the neck bone removed. The ham was removed between the second and third sacral vertebrae perpendicular to the axis of the hind leg. The rough loin was cut from the belly along a line dorsal to the tenderloin muscle at the posterior end and by just missing the dorsal portion of the backbone at the anterior end. An attempt was made to keep the flat side of the blade bone parallel to the table top. The spareribs were then removed from the belly. A ham firmness score was determined by comparing the face of the ham to picture standards numbered from one to five with decreasing firmness corresponding to higher numbers. The right loin was cut between the tenth and eleventh rib to accommodate tracing the longissimus dorsi muscle. The hams, shoulders, loins, and bellies were trimmed, skinned, and boned in accordance with the method described in "Proceedings of the Reciprocal Meats Conference," (1952) except as noted below.

It should be emphasized that every effort was made to remove all of the fat in the trimmed and skinned cuts. For example, the trimmed loin would not have the conventional one-half inch fat layer remaining, but rather all of the fat was removed. It was felt that considerably more experimental precision could be obtained by this technique because of the difficulty of obtaining a uniform one-half inch layer of fat on the trimmed cut. Weights to the nearest tenth of a pound were taken of each cut between each trimming operation.

Each wholesale cut, including the jowl, belly, fat, and lean trim, was hand-separated into fat and lean portions. The bones were for the most part separated from each other (except for the head and feet) and scraped to a uniform degree of thoroughness. Weight of the skin was taken after removal of subcutaneous fat.

After obtaining weights of the separable lean, separable fat, and skin and bone, the fat and lean were cut into approximately one-half inch cubes and blended together. After cubing, the mass was ground three times through a commercial sausage mill, first with a 1 1/8-inch plate, then a 5/16-inch plate, and finally with a 3/16-inch plate. Hand-blending was applied to the mass between each grinding. About 1 to 2 pounds of the product was selected as it came from the mill to be wrapped and quick-frozen. After freezing, the product was again cubed and ground through a small hand mill from which a uniform sample was tamped into a glass bottle for chemical analysis by the Department of Biochemistry.

There was probably some loss of water by evaporation, especially from the lean, during the preparation of the product as described in the foregoing paragraph. Two men worked together and were able to process one carcass in four to five hours. By this short period of exposure and by keeping the product covered with a shroud whenever practical, it was felt that evaporation would be uniform and minimal.

Trial II

During the late fall of 1960 a second trial was conducted to (1) compare feed efficiency and carcass quality of pigs slaughtered at 200 and 225 pounds and (2) compare limit-feeding with full-feeding. The same kind of pigs as described for Trial I was used, with the exception that eight of the 32 head were barrows instead of all gilts as in Trial I.

During the interim from the previous trial, the experimental barn had been changed from individual pens to pens for two pigs each, thus pigs were fed in pairs in a randomized block design instead of singularly. Each block of eight pigs (four pairs) was randomly allotted as to slaughter weight and limit- or full-feeding. The original intent was to start limit-feeding at 150 pounds; however, at this weight the condition of the pigs did not indicate limit-feeding was needed. Consequently, limit-feeding was not initiated until they reached 175 pounds. Starting at that weight the pigs were fed the following amounts of feed by increments which are approximately 80 percent of the National Research Council recommended allowances:

Live Weight (Lbs.)	Daily Feed (Lbs.)
175	5.9
185	6.1
195	6.2
205	6.3
215	6.4
225	6.5

Since both pigs in a pen did not reach 175 pounds at the same time, it was necessary to divide the pen with a gate panel so the light pig could remain on full-feed. This posed a problem of not being able to bed together and may have adversely affected gains during ensuing cold weather, even though all pigs were well-bedded in straw.

The ration fed, pre-slaughter and slaughter treatment remained the same as described in Trial I.

The chilled carcasses of Experiment II animals were weighed in air to the nearest half pound and then weighed in water to the nearest gram to determine specific gravity. A large water tank approximately 7 feet high and 2½ feet in diameter was filled with water at a predetermined level under a rail supporting an electric hoist which raised and lowered the carcass into the tank. A platform 4 feet square on casters supported a Toledo gram scale, and the operator above the tank. Water temperature remained almost constant at 56 to 60° F.

To get an accurate weight it was necessary to sever the diaphragm in a number of places to prevent the formation of air pockets. Prompt weighing was also essential to prevent the carcass from absorbing water.

Specific gravity was taken of the right ham. It was then processed along with the rest of the carcass as described for Trial I with the exception that (1) only the right ham was sampled for chemical analysis, instead of the entire carcass; and (2) cross-sectional tracings on transparent acetate sheets were made of the carcass in four places. A tracing of lean, fat, and bone was made from both the joint side and the second rib side of the untrimmed shoulder. A third tracing was made at the tenth rib perpendicular to the axis of the body, and a fourth from the face of the ham.

RESULTS AND DISCUSSION

The results and discussion for Trials I and II will be made separately. Trial I is concerned with pigs individually self-fed a 16 percent protein ration in the summer of 1959 (Appendix Table I) to weights of 150, 175, 200, and 225 pounds.

TRIAL I

<u>Performance Phase</u>

Table III presents summaries of growth and feed utilization data of the pigs in Trial I. Average daily gain, daily feed intake, and feed efficiency show these pigs were performing at about an average level. It is not readily apparent why the pigs slaughtered at 150 pounds outgained the other groups nor why those killed at 175 pounds were slowest in rate of gain. Significant differences were not attained among any of the groups in rate of gain or feed efficiency as determined by analysis of variance. Feed efficiency did favor lighter-weight pigs, however. On the other hand, wide differences ($P < .01$) were noted in the performance of the four different weight groups in feed required to produce 1 pound of separable lean and/or 1 pound of edible product (lean plus fat). It should be pointed out that the

TABLE III

PERFORMANCE OF SELF-FED PIGS SLAUGHTERED AT
150, 175, 200, AND 225 POUNDS

	Slaughter Weight, Lbs.			
	150	175	200	225
Number	8	8	8	8
Initial Weight, Lbs.	61.8	60.5	60.4	60.0
Final Weight, Lbs.[a]	152.8	177.4	202.0	227.1
Average Daily Gain, Lbs.	1.51	1.37	1.42	1.43
Daily Feed Intake, Lbs.	5.60	5.30	5.58	6.09
Feed per Pound Gain[b]	3.70	3.92	3.96	4.28
Age at Slaughter, Days	137.6	164.1	179.3	202.3
Feed per Pound of Product[c]	40.8	45.4	47.7	53.6
Feed per Pound of Separable Lean	52.7	62.4	66.7	79.0

[a]Shrunk live weight (twelve hours).

[b]Feed records for seven pigs at each weight. One record was destroyed.

[c]Separable lean plus separable fat.

initial starting weight of approximately 60 pounds tended to favor the groups slaughtered at lighter weights. Nevertheless, as weight increased, efficiency of feed utilization decreased rapidly, particularly at the 225-pound weight. Nearly 28 percent more feed was required to produce 1 pound of separable lean with pigs growing from 200 to 225 pounds than with those growing from 175 to 200 pounds.

While correlation coefficients must be interpreted with reservations with such small numbers, the correlations between the amount of feed required per pound of gain and separable lean were found to be negative for each of the weight groups. Those at 150 and 200 pounds were -0.58 and -0.51, respectively.

Under the conditions of this test a ton of feed would be expected to produce the following amounts of live gain, separable fat, and separable lean:

Slaughter Weight (lbs.)	Live Gain[a] (lbs.)	Separable Fat[b] (lbs.)	Separable Lean[b] (lbs.)
150	543.4	71.5	258.0
175	509.0	77.7	238.1
200	505.0	86.8	231.0
225	467.2	70.7	164.9

[a]Starting with 60-pound pigs.

[b]Charging 170 pounds of feed to 60-pound pigs (calculated from National Research Council recommendations, 1959).

Slaughter Phase

Data obtained from slaughtering the pigs are shown in Table IV. Unlike some reports (Hogan et al., 1925; Zobrisky, 1958), light-weight pigs did not undergo greater live or cooler shrink than those of heavier weights. Perhaps the twelve-hour shrink and short haul (one-fourth mile) to the slaughter point were not representative of conditions under which most shrink is reported.

Dressing percentages from the four weight groups were quite satisfactory and were not significantly different from each other. The 200-pound group was observed to be the heaviest-muscled group (possibly because of chance in random allotment). These pigs also had the highest dressing percent, supporting the contention by other workers previously cited that a hog need not be fat nor heavy to dress well.

Full appreciation of the meatiness of the four groups of pigs may be obtained from average length, backfat, loin area, and percent lean cuts listed in Table IV. The heavier hogs were longer and fatter ($P < .01$) and had larger loin-eyes than the 150- and 175-pound pigs. The 200-pound group had the largest loin areas of all. Orthogonal comparisons indicated a linear increase for length but a tendency toward a quadratic curve for backfat.

The exceptionally high percentages of lean cuts, both on carcass and live basis, are reflected by low amounts of measured backfat and large loin areas.

In general, these data are in agreement with other

TABLE IV

SLAUGHTER YIELDS AND CARCASS MEASUREMENTS OF PIGS SLAUGHTERED AT 150, 175, 200, AND 225 POUNDS

	Slaughter Weight, Lbs.			
	150	175	200	225
Number	8	8	8	8
Shrink[a]	3.75	6.47	6.69	6.25
Shrunk live weight, lbs.	152.8	177.4	202.0	227.1
Chilled carcass weight, lbs.	106.3	125.2	144.7	160.6
Dressing percentage	70.0	70.6	71.3	70.7
Cooler shrink, %	4.89	4.30	4.19	5.14
Carcass information:				
Length, in.	28.9	30.1	30.6	32.1
Backfat, in.	0.99	1.02	1.15	1.24
Loin area, sq. in.	3.36	3.98	4.41	4.24
Lean cuts, %[b]				
Live basis	39.8	40.6	41.3	40.0
Carcass basis	57.0	57.5	57.1	56.7
Weight of trimmed cuts, lbs.				
Ham	11.8	14.1	16.2	17.6
Loin	9.5	11.3	13.1	14.4
Shoulder	9.2	10.5	12.4	13.4
Belly	7.0	8.2	9.1	10.7
Ham firmness score[c]	2.88	2.50	2.13	1.75

[a]Twelve hours off feed.

[b]Closely trimmed ham, loin, and shoulder as a percentage of shrunk live weight or chilled carcass weight.

[c]Range was one to five, with one being the firmest.

researchers with similar types of hogs (Field _et al_., 1961; Mullins, 1960; Varney _et al_., 1962) except in degree; i.e., the former were longer, leaner, and larger in loin lean area than most hogs on which carcass data are available. The fact that they were gilts and were relatively old at a given weight may have enhanced muscular development and minimized backfat deposition. On the other hand, these data clearly show that superior carcasses can be produced from self-fed pigs of various weights by a selective breeding program.

It seems a paradox that 15 of the 32 pigs met swine certification requirements on length, loin area, and backfat; but 30 did not produce U. S. No. 1 carcasses because they were not fat enough, while 26 failed to produce hams that would command a top wholesale price in Chicago because they were too heavy.

Ham firmness scores indicated a significant difference ($P < .01$) between groups. Those from heavier-weight carcasses were the firmest. An attempt to identify soft carcasses with a particular sire or dam by checking the breeding of the pigs was unsuccessful.

Carcass Composition--Physical Separation

Table V contains data on physical separation of carcasses from the four weight groups. It is of interest to note the difference in amount of fat deposition and separable lean production from one stage to another. The amount of separable lean, fat, and product (lean plus fat) is given in pounds as follows:

Stage	Lean	Fat	Product
150-175	9.3	6.2	15.5
175-200	9.8	7.3	17.1
200-225	7.5	7.6	15.1

Any observations drawn from comparing the foregoing figures must be done with the hypothesis that the average meatiness for each group was the same. It has already been suggested that the pigs slaughtered at 200 pounds may have been heavier-muscled than the others. Carcass figures from Table IV tended to substantiate this observation. Nevertheless, if the means were equal, the stage of most rapid muscular development was from 175 to 200 pounds. Further, these pigs were about equal to the 200- to 225-pound pigs in fat deposition, giving them an advantage in edible product over the other two groups. It seems surprising to find the increment from 200 to 225 pounds yielding the least product. Loeffel (1943) and Hankins and Ellis (1945) found this weight range to be more productive than any other tested. The 7.5 pounds of separable lean production from the 225-pound group could be interpreted to be a slowing-down of muscular growth and a speeding-up of fat deposition, in accordance with McMeekan and Hammond's (1939) theory of decreasing muscular growth at about 175 pounds. At any rate, pigs in this test slowed in muscular growth at a considerably lower rate than those reported on by McMeekan and Hammond.

TABLE V

PHYSICAL SEPARATION OF CARCASSES FROM PIGS SLAUGHTERED AT 150, 175, 200, AND 225 POUNDS

	Slaughter Weight, Lbs.			
	150	175	200	225
Number of carcasses	8	8	8	8
Chilled carcass weight	106.3	125.2	144.7	160.6
Physical separation, lbs.				
Lean	64.6	73.9	83.7	91.2
Fat	17.9	24.1	31.4	39.0
Skin	6.2	7.3	7.4	8.2
Bone	9.0	9.9	10.3	11.3
Physical separation, % of chilled carcass				
Lean[a]	60.7	59.0	58.1	56.7
[b]	± 2.82	±5.78	±2.81	±1.86
Fat[a]	16.7	19.3	21.8	24.3
[b]	±2.85	±3.86	±3.59	±3.94
Skin[a]	5.80	5.87	5.18	5.07
[b]	±0.126	±0.117	±0.115	±0.138
Bone[a, c]	8.48	7.95	7.12	7.00
[b]	±0.525	±0.290	±0.321	±0.281

[a, b] Means and standard deviations

[c] Bones of the head not included

Physical separation of lean, fat, skin, and bone as a percentage of the chilled carcass revealed highly significant differences ($P < .01$), with the heavy hogs yielding a higher percent of fat and the others yielding more lean, skin, and bone. Figure 1 has been prepared to better illustrate the differences in separable fat and lean and make a comparison with the Nebraska research (Loeffel, 1943), which was comparable to that being reported in this study.

A striking difference in ratios of fat to lean is apparent between carcasses from animals slaughtered at the two experiment stations. The Nebraska workers reported over twice as much separable fat and considerably less separable lean than was found from similar weight carcasses in this study. The merging point of equal fat and lean was at approximately 220 pounds for the former, and was not approached at the maximum 225-pound weight of the latter. The rate of fat deposition as a percentage of the chilled carcasses of these test pigs was almost linear with each increase in weight as determined by physical separation (2.6 percent, 2.5 percent, and 2.5 percent). Muscular growth tended to decline after 200 pounds, compared to the 175- to 200-pound pigs.

Any comparison of separable lean made between different weight groups should be done with the knowledge that heavier weight carcasses possibly have an advantage because of intramuscular fat--a fact adequately demonstrated by Bowman (1962).

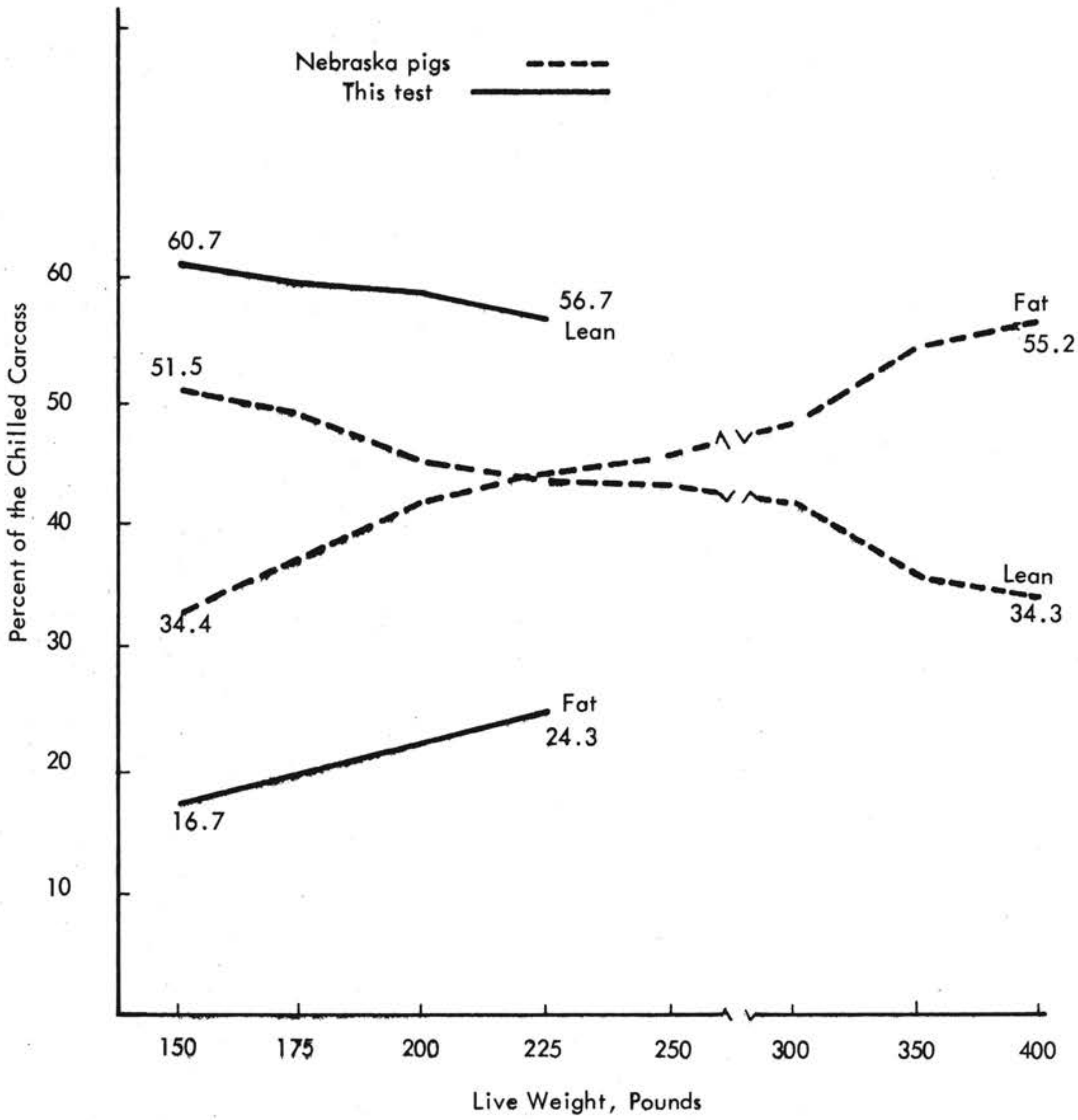

Figure 1. Separable lean-fat ratio of carcasses from hogs of different live weights.

Standard deviations recorded in Table V reflect small differences in separable fat and lean among animals within treatments. This would be expected because of similar breeding and because they were all gilts.

Carcass Composition--Chemical Analysis

The degree of difference between the four groups of pigs calculated from chemical analysis data is less than was observed from physical separation. Moisture was calculated to be significantly higher ($P < .05$) for lightweight hogs than for those of heavier weights, while fat was significantly less ($P < .05$) for lightweight pigs. No significant differences were found in protein or ash. A downward trend was observed at heavier weights for ash, however, and percent of protein was least from the heaviest carcasses (Table VI).

It is worthy of note that the pigs slaughtered at 200 pounds had a higher percent of protein than those of any other weight.

The relative percentages of moisture, fat, and protein among different weight groups are illustrated in Figure 2, along with comparable data from 68 hog carcasses reported on by Hankins and Ellis (1945) of the United States Department of Agriculture. These data represent swine from two populations that differed widely in percent separable lean and fat, but were remarkably similar within populations in trends of moisture, protein, and fat.

As live weight increased, percentages of protein and

TABLE VI

CHEMICAL COMPOSITION OF CARCASSES FROM PIGS SLAUGHTERED AT 150, 175, 200, AND 225 POUNDS

	Slaughter Weight, Lbs.			
	150	175	200	225
Chemical Analysis (of lean plus fat) %				
Moisture	51.69	50.37	49.86	46.27
Protein	14.05	14.04	14.29	13.45
Fat	32.24	33.67	34.36	38.98
Ash	0.77	0.76	0.76	0.72

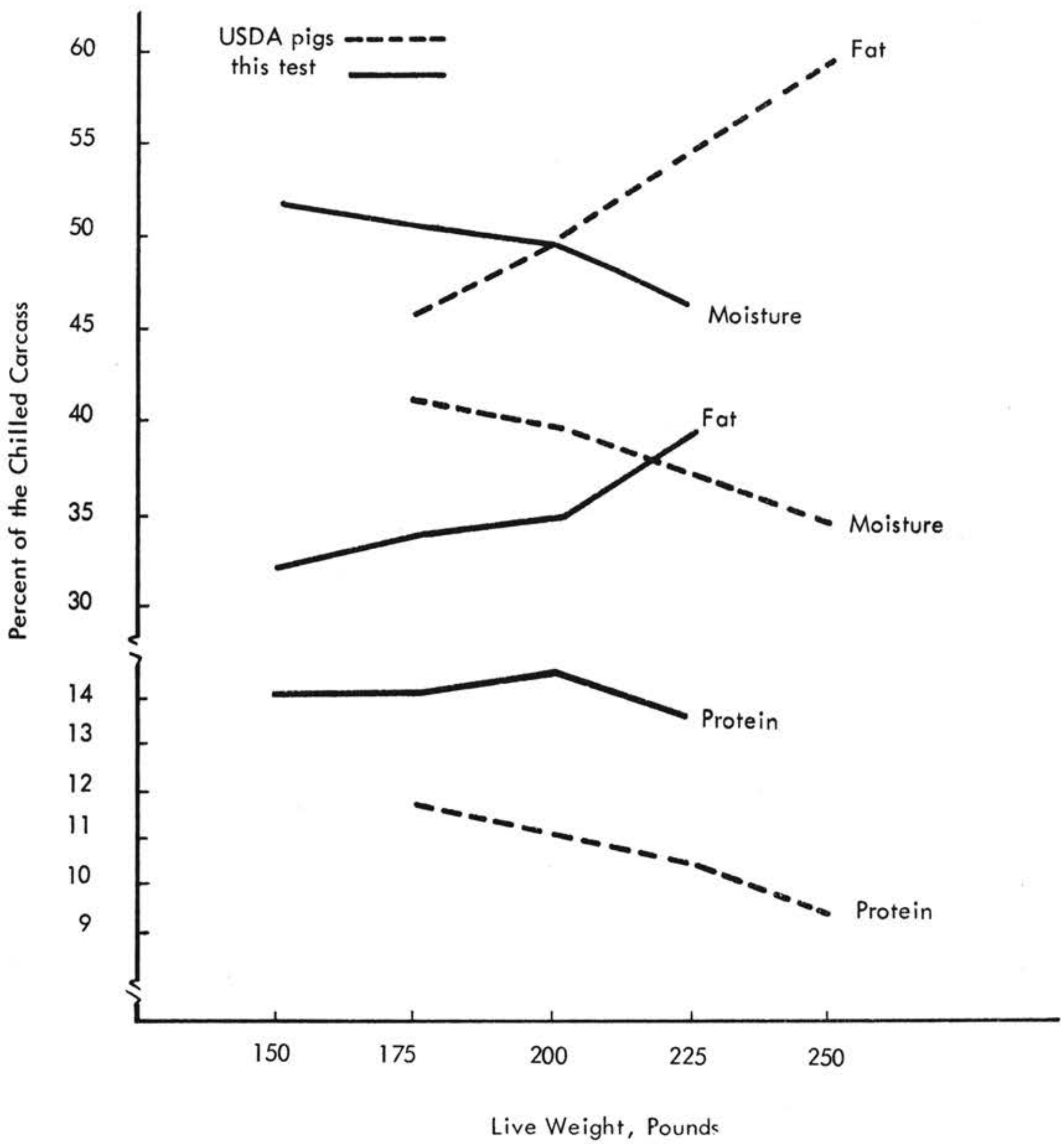

Figure 2. Percentage of protein, fat, and moisture in carcasses from hogs of different live weights.

moisture of the chilled carcass decreased and fat percentages increased. The greatest decrease in protein and moisture for the pigs of this experiment was from 200 to 225 pounds. This also represented the stage of fastest increase in fat production as determined by chemical analysis.

These data bring to mind the question posed by Mitchell (1929) of whether fat deposition accounts for all of the differences observed in the fat-lean ratio between different types of pigs and between those of different weights. His observation was that on a fat-free basis, carcasses from very chuffy pigs were essentially no different from those considered very rangy in type. In an attempt to answer this question, percent protein of the four weight groups was calculated on a fat-free basis. It was found to be as follows: carcasses from 150-pound live hogs, 21.86 percent protein; 175 pounds, 21.16 percent protein; 200 pounds, 22.17 percent; and 225 pounds, 21.11 percent protein on a fat-free basis.

TRIAL II

Pigs in Trial II were fed a 16 percent protein ration (Appendix Table I) from approximately 60 pounds to slaughter weights of 200 and 225 pounds. Half of each weight group was fed 80 percent of a full feed (NRC requirement) from 175 pounds to slaughter weight, while the remaining pigs were full-fed to slaughter weight.

Performance Phase

Growth rate and feed utilization data are presented in Table VII. It is apparent from the average slaughter age of these pigs shown in the table that they were slow gainers. Limit-fed pigs required eight days more time to reach 200 pounds than full-fed pigs, and 15.4 days more time was required for limit-fed pigs to reach 225 pounds than those full-fed. Crampton et al. (1954) noted that pigs limit-fed to 200 pounds required six or seven days longer than full-fed pigs. Lasley (1951) found this difference to be nine days, and recently Becker (1962) found that limit-fed pigs required ten days longer to reach 200 pounds than those full-fed.

Jordan et al. (1956) limit-fed pigs to 225 pounds and observed that eighteen fewer days were required to reach this weight by full-fed pigs than those fed 80 percent of a full-feed.

Although daily gain varied from 1.34 pounds for limit-fed pigs to 200 pounds to 1.69 for full-fed pigs to 225 pounds, feed efficiency was similar for all four groups in this test.

It has been previously stated that for limit-feeding to be effective the saving in energy by depositing less fat must exceed that incurred for maintenance for the additional time required to reach a given weight. Apparently under the conditions of this test the effects of these two opposing forces tended to offset each other in so far as feed

TABLE VII

PERFORMANCE OF PIGS FULL-FED TO 200 AND 225 POUNDS AND OF THOSE LIMIT-FED FROM 175 TO 200 AND 225 POUNDS

	Slaughter Weight, Lbs.			
	200		225	
Treatment	FF	LF	FF	LF
Number	8	8	8	8
Initial weight, lbs.	62.0	61.0	64.0	62.1
Final weight, lbs.[a]	200.5	199.4	226.3	224.3
Average daily gain, lbs.	1.50	1.34	1.69	1.37
Feed per pound gain	4.13	4.21	4.19	4.12
Daily feed intake, lbs.	6.05	5.66	5.72	5.52
Age at slaughter, days	204.4	212.1	213.4	228.8

[a]Shrunk live weight (twelve hours).

efficiency was concerned.

A comparison of daily feed intake by the full-fed pigs with those reported by Tribble *et al*. (1954) and Thrasher *et al*. (1962) follows:

Source	Weight Range (lbs.)	Daily Feed Intake (lbs.)
Tribble	50-215	6.30
Thrasher	125-200	6.21
Thrasher	125-200	6.66
This experiment	60-200	6.05
This experiment	60-225	5.72

There appeared to be a tendency for the full-fed pigs in this experiment to limit themselves on feed intake as compared to expected feed consumption and to actual consumption reported by these other two groups of workers. Thus, some of the expected advantage of limit-feeding during the fattening phase was obscure because of depressed feed intake of the full-fed pigs.

Slaughter Phase

Table VIII contains data of average slaughter yields and carcass information. Dressing percentages were similar for all treatments and were quite satisfactory. Although the effectiveness of limit-feeding in carcass improvement was apparent at 200-pound slaughter weight, it was more pronounced at 225 pounds. Limit-feeding to 80 percent of a full feed during the last 75 pounds decreased the backfat on 225-pound pigs from 1.45 to 1.25 inches. Jordan *et al*.

TABLE VIII

SLAUGHTER YIELD AND CARCASS INFORMATION OF PIGS FULL-FED TO 200 AND 225 POUNDS AND OF THOSE LIMIT-FED FROM 175 TO 200 AND 225 POUNDS

Treatment	Slaughter Weight, Lbs. 200		225	
	FF	LF	FF	LF
Number	8	8	8	8
Shrink, lbs.[a]	4.6	4.1	4.6	4.6
Shrunk live wt., lbs.	200.5	199.4	226.3	224.3
Chilled carcass wt., lbs.	142.7	142.0	161.8	159.4
Dressing percent	71.2	71.6	71.5	71.1
Carcass information				
Length, in.	30.9	30.4	31.4	31.5
Backfat, in.	1.20	1.17	1.45	1.25
Loin area, sq. in.	4.12	4.14	4.33	4.34
Lean cuts, %				
Live basis	38.8	39.7	38.2	39.6
Carcass basis	54.6	55.7	53.4	55.7
Weight of trimmed cuts, lbs.				
Ham	15.3	15.7	16.7	17.3
Loin	11.9	12.1	13.2	13.5
Shoulder	11.7	11.9	13.4	13.7
Ham firmness score[b]	2.88	3.13	2.88	2.63

[a]Twelve-hour shrink.

[b]As compared to photographic standards. The range in scores was one to five with one being firmest.

(1956) also noted a decrease of 0.2 inch with 225-pound fat-type Durocs (from 2.09 to 1.89 inches) that were fed 80 percent of a full-feed.

A second major carcass advantage for the limit-fed pigs, especially at heavier weights, was that of a higher percentage of lean cuts both on a live weight and carcass basis. Table VIII shows the advantages to be 1.4 and 2.3 percent, respectively. When considered in terms of actual pounds of trimmed lean cuts, the advantages noted for hams, loins, and shoulders from 200-pound limit-fed pigs were 0.4, 0.2, and 0.2 pound, respectively. At 225-pound weights the advantage increased to 0.5, 0.3, and 0.3 pound, respectively, for trimmed hams, loins, and shoulders. It should be pointed out that these latter cuts came from 2.4-pound lighter carcasses than those to which they were compared.

Unlike Experiment I where significance for ham firmness was obtained, there appeared to be little difference in firmness between weights and treatments. The average of each group was relatively softer than had been observed in Experiment I. Both firm and soft carcasses were noted in each weight and treatment. A survey of the breeding of each animal failed to show any correlation between softness and sire groups or littermates.

The statistical design of Experiment II was that of a 2 x 2 factorial. Upon analysis of variance a large interaction component appeared between treatments and blocks which made interpretation of results by this method of doubtful importance; therefore, its use has been employed sparingly.

<u>Indices of Leanness</u>

A number of carcass measurements were taken for leanness in an effort to determine their accuracy and convenience. Specific gravity of the right ham and of the entire carcass was determined. Cross-section tracings were made in front and back of the shoulder at the tenth rib and face of the ham. Backfat, loin lean area, and chemical analysis of the right ham were also taken.

Whiteman (1952) found a high correlation between specific gravity of the carcass and lean of the ham as determined by chemical analysis. He noted that the error encountered in sampling for chemical analysis could account for considerable of the component of variance analysis. Price <u>et al</u>. (1957) found chemically-determined protein of the ham to be more closely correlated with specific gravity of the carcass than the ham's own specific gravity.

Bowman <u>et al</u>. (1962) found specific gravity of either the carcass or ham superior to backfat thickness or loin lean area in identifying carcass leanness. He further noted that cross-sectional tracings were more accurate in predicting weight of lean in the carcass than either backfat or loin area.

Some inconsistency was encountered with different kinds of measures of leanness in this test. For examples figures in Table IX show mean specific gravity of the right hams and chemical protein indicated more leanness in carcasses from full-fed pigs to 200 pounds than limit-fed pigs of the same weight. Conversely, carcass specific gravity, backfat, loin lean area, percent lean cuts, and cross-sectional tracings all indicated the opposite condition.

A series of correlations of the various carcass measures of leanness was calculated. Specific gravity of the entire carcass was used as one of the variables with which to compare all of the other measures. Within- and between-group correlations appear in Table X. Although these data represent limited numbers (32 animals), perhaps they do reflect trends that are realistic.

The percentage lean and fat at all four of the cross-section tracings of the carcass was rather highly correlated with carcass specific gravity. Correlations of 0.90 and 0.88 were calculated for lean and fat, respectively, at the second thoracic vertebra. This observation is in agreement with that of Bowman et al. (1962) where correlations were calculated at the second thoracic vertebra to be 0.825 and 0.704, respectively. Percentages of lean or fat obtained from a cross-section tracing at the second vertebra appear to reflect leanness in the carcass very well.

Chemically-determined protein and specific gravity of the right ham were correlated with specific gravity of the carcass on the order of 0.60 and 0.54, respectively. Backfat and loin area showed correlations of 0.34 and 0.60, respectively. Percentage lean cuts on a carcass basis

TABLE IX

SPECIFIC GRAVITY, BACKFAT, LOIN AREA, CROSS-SECTION TRACING, AND CHEMICAL DATA OF PIGS FULL-FED TO 200 AND 225 POUNDS AND OF THOSE LIMIT-FED FROM 175 TO 200 AND 225 POUNDS

	Slaughter Weight, Pounds			
	200		225	
Treatment	FF	LF	FF	LF
Number	8	8	8	8
Specific gravity				
Carcass	1.0463	1.0492	1.0438	1.0484
Right ham	1.0673	1.0678	0.0639	1.0632
Chemical analysis of right ham				
Moisture	61.08	60.12	57.04	59.42
Protein	17.68	16.70	16.40	16.87
Fat	20.09	21.44	25.85	21.69
Ash	1.01	0.94	0.89	0.92
Cross-section tracings, %				
Front of shoulder				
Lean	47.53	48.87	44.10	48.54
Fat	49.72	48.31	53.28	48.45
Second thoracic vertebra				
Lean	51.79	53.91	48.42	51.87
Fat	39.99	37.97	45.68	39.17
Tenth thoracic vertebra				
Lean	37.41	38.88	34.05	37.43
Fat	56.08	54.31	60.32	55.67
Second sacral vertebra				
Lean	58.32	58.62	54.47	56.96
Fat	37.57	36.81	41.75	38.51
Backfat, inches	1.20	1.17	1.45	1.25
Loin area, sq. in.	4.12	4.14	4.33	4.34

TABLE X

VARIOUS CARCASS MEASURES OF LEANNESS CORRELATED WITH CARCASS SPECIFIC GRAVITY (POOLED DATA ON 32 ANIMALS)

Indice	Between Group	Within
Cross-section tracing		
Percent lean		
Front of shoulder	0.97	0.78
Second thoracic vertebra	0.95	0.90
Tenth thoracic vertebra	0.98	0.79
Face of ham	0.78	0.77
Percent fat		
Front of shoulder	-0.91	-0.79
Second thoracic vertebra	-0.95	-0.88
Tenth thoracic vertebra	-0.95	-0.80
Face of ham	-0.76	-0.78
Ham specific gravity	-0.01	0.54
Chemically-determined protein	0.48	0.60
Percent lean cuts, carcass	0.86	0.83
Loin-eye area	-0.17	0.60
Backfat thickness	-0.79	-0.34

showed the second highest correlation of 0.83. Where cutting procedure is standardized, percentage lean cuts remained one of the most practical measures of carcass leanness.

SUMMARY

The amount of feed required to produce 1 pound of separable lean was 27.8 percent less for pigs growing from 175-200 pounds than for those growing from 200-225 pounds. Feed efficiency per pound of live gain decreased with increased live weight. A slowing-down of muscular growth seemed to appear at about 180-200 pounds.

Dressing percent was satisfactory for all carcass weights and did not tend to favor heavier weights. Carcasses from lightweight pigs were leaner, shorter, and tended to be softer than those of heavier weights. Cuts from lightweight carcasses were more desirable in weight (based on wholesale prices) than those from heavier carcasses with the exception of chops, which tended to be too small. Bellies appeared to be thin at lighter weights.

About one-fifth of the edible product from a 120-pound meat-type carcass was separable fat. About one-third was separable fat from a similar carcass weighing 160 pounds. These ratios could be expected to increase to one-third and one-half, respectively, with fat-type carcasses.

Chemical analysis indicated that as live weight increased the percent of protein and moisture of the carcass decreased and the percent of fat increased. The greatest percentage decrease in protein and moisture was from 200 to 225 pounds. This stage also represented the stage of fastest fat deposition.

Trial I indicated that excellent carcasses could be produced from self-fed pigs of a variety of live weights. There was no advantage in feed efficiency from limit-feeding 80 percent of a full-feed from 175 pounds to either 200 or 225 pounds under the conditions of this test. The major advantage was observed in carcass improvement. Limit-feeding produced carcasses with a higher percent of lean cuts, larger loin-eyes, and less backfat than those from full-fed meaty pigs. Average backfat was decreased from 1.45 to 1.25 inches on carcasses from limit-fed pigs to 225 pounds live weights.

The problem of limit-feeding the right amount of feed to obtain an advantage in feed efficiency over full-feeding is difficult. Under practical conditions of farm feeding in groups, this problem would seem monumental.

Some good indices of leanness are available to both the researcher and the person seeking information in more haste but requiring less precision.

Specific gravity of the entire carcass appears to reflect leanness to a high degree. When weighing the carcass in water, care must be exercised to attain accuracy. Chemical analysis of the entire carcass also is a good measure of leanness, but requires much more labor and also greatly reduces the value of the product.

Fat and lean percentages calculated from a cross-sectional tracing taken at the second thoracic vertebra were found to be excellent indices of meatiness in this test. Tracings at this point are fast and easy to take, except in the case of soft carcasses, which render precision difficult. However, the second thoracic vertebra tracing is easier to take accurately from a soft carcass than any other tracing.

Lean cuts as a percent of the carcass may be quickly and easily calculated to afford a good measure of leanness where some accuracy can be sacrificed for speed.

LITERATURE CITED

Becker, D. E., A. H. Jensen, and B. C. Breidenstein. 1962. Limit-feeding for finishing pigs. Mimeo. form AS-571. Illinois Swine Growers' Day.

Bell, J. M. 1958. Nutrient requirement for Canadian Yorkshire swine. Can. J. Animal Sci. 38:73.

Blunn, C. T. and M. L. Baker. 1947. The relation between average daily gain and some carcass measurements. J. Animal Sci. 6:424.

Bohman, V. R., J. E. Hunter, and J. McCormik. 1955. The effect of graded levels of alfalfa and aureomycin upon growing-fattening swine. J. Animal Sci. 14:499.

Bowman, G. H. 1962. Measures of leanness in swine. Ph. D. thesis. Okla. State University, Stillwater, Okla.

Bowman, G. H., J. A. Whatley, and L. E. Walters. 1962. Physical indices of leanness in swine. J. Animal Sci. 21:955.

Braude, R. and M. J. Townsend. 1958. A long-scale test on the effects of food restriction on the performance of fattening pigs. J. Agr. Sci. 51:Part 2:208.

Brody, Samuel. 1945. Bioenergetics and Growth. Reinbold Publishing Corp., N. Y., p. 86.

Bruner, W. 1962. The Ohio pork improvement program. Ohio Agr. Ext. Bul. 419, p. 16.

Bull, S. and J. H. Longwell. 1929. Swine type studies. II. Type in swine as related to quality of pork. Ill. Agr. Exp. Sta. Bul. 322:489.

Callow, E. H. 1935. Carcass quality of the pig in relation to growth and diet. Empire J. Exp. Agr. 3:80.

Comstock, R. E., L. M. Winters, and J. N. Cummings. 1944. The effect of sex on the development of the pig. III. Differences in growth rate between gilts and barrows by line of breeding. J. Animal Sci. 3:120.

Crampton, E. W. 1940. Effect of early rate of growth on leanness of carcass. Sci. Agr. 20:592.

Crampton, E. W., G. C. Ashton, and L. E. Lloyd. 1954. Effect of restricting feed intake on market hogs during the finishing period on the quality bacon carcass. J. Animal Sci. 13:321.

Cummings, J. N. and L. M. Winters. 1951. A study of factors related to carcass yield in swine. Minn. Agr. Exp. Sta. Tech. Bul. 195:59.

Dickerson, G. E. 1947. Composition of hog carcasses as influenced by heritable differences in rate and economy of gain. Iowa Agr. Exp. Sta. Res. Bul. 354:495.

Donald, H. P. 1940. Growth rate and carcass quality in bacon pigs. J. Agr. Sci. 30:582.

Emerson, J. A., A. M. Pearson, J. A. Hoefer, and L. A. Bratzler. 1961. Carcass characteristics of 100- to 200-pound hogs. J. Animal Sci. 20:916.

Ellis, N. R. and J. H. Zeller. 1934. Effect of quality and kind of feed on economy of gains and body composition of hogs. USDA Tech. Bul. 413:29.

Field, R. A., W. Y. Varney, and J. D. Kemp. 1961. Processing costs, market values, and consumer acceptance of light and normal weight hogs. J. Animal Sci. 20:742.

Haecker, T. L. 1916. Investigations in animal nutrition. Beef production. Minn. Agr. Exp. Sta. Bul. 155.

Haecker, T. L. 1920. Investigations in beef production. Minn. Agr. Exp. Sta. Bul. 193.

Hammond, J. 1940. Farm Animals; Their Breeding, Growth, and Inheritance. New York, Longman, Green & Co.; London, E. Arnold & Co. p. 99.

Hammond, J. and C. P. McMeekan. 1940. The relation of environmental conditions to breeding and selection for commercial types in pigs. Empire J. Exp. Agr. 8:8.

Hankins, O. G. and N. R. Ellis. 1934. Physical characteristics of hog carcasses as measures of fatness. J. Agr. Res. 48:257.

Hankins, O. G. and N. R. Ellis. 1945. Composition and nutrient value of pork as related to weights of animals and cuts. USDA Cir. No. 731.

Hankins, O. G., R. L. Hiner, and H. S. Sloane. 1953. A new look at the significance of fat and hog dressing yields. National Provisioner, 128. March 14, p. 34.

Hatesohl, D. E. 1959. Consumer evaluation of pork from lightweight hogs. Master's thesis, University of Missouri. P. 75.

Henry, W. A. 1902. Feeds and Feeding. Fourth Ed. Published by the author. Madison, Wisc. P. 553.

Hogan, A. G., L. A. Weaver, A. T. Edinger, and E. A. Trowbridge. 1925. The relation of feed consumed to protein and energy retention. Mo. Agr. Exp. Sta. Res. Bul. 73.

Jordan, C. E., W. M. Beeson, and J. R. Wiley. 1956. Producing leaner market hogs by different feed combinations and controlled corn intake. J. Animal Sci. 15:869.

Lasley, J. F. 1951. Influence of feeding levels on production costs and carcass quality. Missouri Feeders Day Report, April. P. 3.

Lasley, J. F. and L. F. Tribble. 1952. Full vs. limited-feeding of growing-fattening swine. Missouri Feeders Day Report, April. Progress Rept. 17.

Loeffel, W. J., W. W. Derrick, and M. Peters. 1943. Weight of pigs as it affects gains and carcass qualities. Neb. Agr. Exp. Sta. Bul. 351.

Lucus, I. M. A. and A. F. C. Calder. 1956. The response of different types of pigs to varying levels of feeding from weaning to bacon weight with particular reference to carcass quality. J. Agr. Sci. 47:287.

McCampbell, H. C. and D. M. Baird. 1961. Carcass evaluation of swine slaughtered at 170, 190, 210, and 230 pounds. J. Animal Sci. 20:919.

McMeekan, C. P. 1939. The nature and variability of carcass characteristics of Danish and English bacon pigs. J. Agr. Sci. 29:131.

McMeekan, C. P. 1940. Growth and development in the pig with special reference to carcass quality characteristics. J. Agr. Sci. 30:387.

McMeekan, C. P., I. L. Campbell, M. M. Cooper, G. P. Stevens, and A. H. Ward. 1943. Principles of Animal Production. Whitcomb and Tombs, London. P. 94.

McMeekan, C. P. and J. Hammond. 1939. Improvement of carcass quality in pigs. Jour. of the Ministry of Agr. 46:238.

Merkel, R. A., R. W. Bray, R. H. Grummer, P. H. Phillips, and G. Bohstedt. 1953. The influence of limited-feeding by use of high-fiber rations upon growth, fattening, and carcass characteristics of swine. J. Animal Sci. 12:903.

Mitchell, H. H. and T. S. Hamilton. 1929. Energy and protein requirements of growing swine and the utilization of feed energy in growth. Ill. Agr. Exp. Sta. Bul. 323:564.

Morrison, F. B. 1936. Feeds and Feeding. 20th ed. Morrison Pub. Co., Ithaca, N. Y. P. 810.

Mullins, A. M. 1960. Lean hogs outweigh fat hogs in value. Il. tabs. La. Agr. Exp., La. Agr. 4:4.

National Research Council. 1959. Nutrient requirements of domestic animals. No. 11. Nutrient requirements of swine. Pub. 648:8. National Academy of Sciences, Washington, D. C.

Price, J. F., A. M. Pearson, and E. J. Beeune. 1957. Specific gravity and composition of the untrimmed ham as related to leanness of the pork carcass. J. Animal Sci., 16:85.

Saint-Pierre, J. M., F. B. Morrison, and J. P. Williams. 1934. Relative efficiency of limited- and full-feeding for fattening pigs in drylot. Proc. Am. Soc. Animal Prod. 27:101.

Scott, E. L. 1930. The influence of growth and fattening processes on the quality and quantity of meat yielded by swine. Ind. Agr. Exp. Sta. Bul. 340.

Smith, W. W. 1920. Pork Production. The Rural Science Series. T. H. Bailey, Editor. The MacMillan Co. New York. P. 372.

Stevenson, J. W., R. J. Davey, and R. L. Hiner. 1960. Some effects of dietary levels of protein and alfalfa meal and of antibiotic supplementation on growth, feed efficiency, and carcass characteristics in swine. J. Animal Sci. 19:887.

Thrasher, D. M. 1962. Livestock Producers' Day Report, Louisiana State University.

Tribble, L. F., J. F. Lasley, and S. E. Zobrisky. 1954. Effect of level of feeding on efficiency of production and carcass quality. Mo. Feeders Day Report, Apr., p. 6.

Tribble, L. F., W. H. Pfander, J. F. Lasley, S. E. Zobrisky, and D. E. Brady. 1956. Factors affecting growth, feed efficiency and carcass in swine. Mo. Agr. Res. Bul. 609, p. 29.

U. S. Department of Agriculture, Livestock and meat statistics, supplement for 1961. Statistical Bul. 230:104.

Varney, W. Y., J. D. Kemp, C. D. Phillips, and C. E. Barnhart. 1962. Relative cut-out percentages and values of light and heavier weight hogs. J. Animal Sci. 21: 377.

Vaughan, H. W. 1935. Types and Market Classes of Livestock. Third ed. R. G. Adams & Co. Columbus, Ohio, p. 353.

Wagner, G. R., A. J. Clark, V. W. Hays, and C. V. Spear. 1963. Effect of protein-energy relationships on the performance and carcass quality of growing swine. J. Animal Sci. 22:202.

Wallace, H. D., G. E. McCabe, A. Z. Palmer, M. Koger, J. W. Carpenter, and E. Combs. 1959. Influence of slaughter weight on economy of production and carcass value of swine. J. Animal Sci. 18:1484. (Abstr.)

Winters, L. M., C. F. Sierk, and J. N. Cummings. 1949. The effect of plane of nutrition on the economy of production and carcass quality of swine. J. Animal Sci. 8:132

Whiteman, J. V. 1952. A further investigation of specific gravity and other measures of pork carcass value. Ph. D. thesis, Oklahoma State University, Stillwater, Oklahoma.

Zobrisky, S. E. 1958. Carcass evaluation. Missouri Swine Day Report, Sept. 5.

Zobrisky, S. E., H. D. Naumann, J. F. Lasley, D. E. Brady, and A. M. Mullins. 1958. Physical composition of swine during growth and fattening. Mo. Agr. Res. Bul. 672, p. 15.

Zobrisky, S. E. 1960. Carcass characteristics and consumer acceptance of lightweight hogs. Mo. Agr. Exp. Sta. Res. Bul. 739:12.

A P P E N D I X

TABLE I

PERCENTAGE COMPOSITION OF RATION
TRIALS I AND II

Ingredient	Per Cent
Milo	79.0
Soybean oil meal (50%)	13.0
Dehydrated alfalfa meal (17%)	5.0
Dicalcium phosphate (28-18)	1.5
Calcium carbonate	0.5
B complex vitamin supplement[1]	0.1
Aurofac 10[2]	0.1
Zinc sulfate (50 p.p.m.)	0.02
Trace mineral salt	0.5
Vitamins A, D, and B_{12} supplement[3]	0.3
Total	100.02

[1]B complex vitamin supplement (per pound)

Riboflavin	2,000 mg.
Pantothenic acid	3,680 mg.
Niacin	9,000 mg.
Choline chloride	10,000 mg.

[2]Aurofac 10--10 gm. aureomycin per pound.

[3]Supplied 400 I. U. of vitamin A, 90 I. U. vitamin D, and 6 micrograms of B_{12} per pound of ration.

TABLE II

PRODUCTION DATA ON PIGS SLAUGHTERED AT FOUR DIFFERENT LIVE WEIGHTS. EXPERIMENT I.

Live Wt.	Pig No.	Initial Wt.	Slaughter Wt.*	Av. Daily Gain	Age at Slaughter Days	Feed/ Pound Gain
150 Lbs.	9-6	64	158	1.45	137	3.87
	11-5	62	160	1.63	141	3.89
	7-6	62	147	1.57	139	3.82
	23-6	53	147	1.49	138	3.31
	15-1	61	152	1.54	140	3.28
	24-7	56	153	1.39	149	4.14
	26-4	64	150	1.69	122	3.63
	27-6	73	155	1.39	135	--
Av.		61.8	152.8	1.52	137.6	3.70
175 Lbs.	11-3	62	180	1.66	141	3.64
	8-6	64	173	1.12	171	4.54
	17-6	60	170	1.49	143	3.82
	22-9	54	182	1.15	187	3.98
	23-1	56	181	1.29	172	4.34
	25-6	57	181	1.49	159	3.86
	20-9	60	164	1.49	159	3.26
	23-4	71	188	1.31	181	--
Av.		60.5	177.4	1.37	164.1	3.92
200 Lbs.	12-1	61	184	1.21	174	4.78
	14-9	68	197	1.57	160	3.76
	14-5	60	200	1.37	180	3.82
	23-3	52	203	1.45	179	4.07
	16-8	61	215	1.45	187	3.21
	20-3	57	207	1.53	181	4.54
	21-3	63	218	1.68	181	3.56
	26-5	61	192	1.12	192	--
Av.		60.4	202.0	1.42	179.3	3.96
225 Lbs.	4-4	62	226	1.48	183	4.03
	1-2	68	226	1.44	205	4.35
	7-7	60	222	1.49	194	4.34
	22-1	53	223	1.44	194	4.71
	15-4	55	229	1.48	199	3.82
	22-5	56	225	1.51	194	4.06
	26-1	62	243	1.15	264	--
Av.		60	227.1	1.44	203.3	4.28

*Shrunk 12 hours.

TABLE III

SLAUGHTER DATA ON PIGS AT FOUR DIFFERENT LIVE WEIGHTS EXPERIMENT I

Live Wt.	Pig No.	Wt. Off Feed	Shrunk Wt.[1]	Chilled Carcass Wt.	Dress-ing %[2]	Length	B.F.	Loin Area
		(lbs.)	(lbs.)	(lbs.)		(in.)	(in.)	(sq.in.)
150	9-6	167	158	115.0	72.7	29.4	1.17	3.65
lbs.	11-5	164	160	104.9	65.6	28.2	1.05	3.02
	7-6	152	147	107.0	72.8	27.8	1.15	4.00
	23-6	153	147	99.3	70.8	29.8	0.68	3.13
	15-1	154	152	105.8	69.5	29.0	0.98	3.02
	24-7	154	153	106.2	69.5	29.0	0.97	3.26
	26-4	150	150	104.8	69.8	28.8	0.97	3.11
	27-6	159	155	107.5	69.4	29.0	0.95	3.67
Av.		156.3	152.8	106.3	70.0	28.9	0.99	3.36
175	11-3	183	180	126.2	70.1	29.0	0.90	4.04
lbs.	8-6	175	173	124.6	72.0	30.5	1.08	4.16
	17-6	177	170	120.0	70.6	29.5	1.25	3.14
	22-9	187	182	129.3	71.1	30.5	0.97	3.92
	23-1	192	181	132.2	73.1	29.6	0.97	4.03
	25-6	190	181	127.9	70.6	30.3	1.13	4.62
	20-9	172	164	117.5	71.7	29.5	1.04	3.85
	23-4	195	188	123.8	65.9	31.0	0.87	4.08
Av.		183.8	177.4	125.2	70.6	30.1	1.02	3.98
200	12-1	196	184	142.8	77.6	30.0	1.58	4.00
lbs.	14-9	204	197	144.4	73.3	29.6	1.27	4.70
	14-5	207	200	147.3	73.6	30.2	1.03	5.03
	23-3	212	203	145.6	70.6	31.6	0.97	4.10
	16-8	222	215	150.2	70.0	31.0	1.15	4.57
	20-3	213	207	148.9	69.6	31.5	1.13	3.78
	21-3	223	218	147.6	67.8	31.0	1.10	4.95
	26-5	199	192	131.0	68.2	29.8	1.00	4.12
Av.		209.4	202.0	144.7	71.3	30.6	1.15	4.41
225	4-4	223	226	166.6	73.8	32.0	1.28	4.42
lbs.	1-2	230	226	158.1	70.0	32.0	1.23	3.90
	7-7	226	222	155.4	69.5	31.5	1.13	3.78
	22-1	228	223	152.8	68.5	31.5	1.23	3.89
	15-4	237	229	165.5	72.2	33.5	1.23	4.40
	25-5	232	225	155.4	69.1	32.0	1.28	3.98
	22-2	231	223	158.1	71.0	32.6	1.17	4.33
	26-1	250	243	173.0	71.2	31.6	1.37	5.23
Av.		233.4	227.1	160.6	70.7	32.1	1.24	4.24

[1]Shrunk 12 hours.

[2]Basis--chilled carcass weight divided by shrunk live weight x 100.

TABLE IV

CARCASS DATA ON PIGS SLAUGHTERED AT FOUR DIFFERENT LIVE WEIGHTS
EXPERIMENT I

Live Wt.	Pig No.	Chilled Carcass Weight	Weight of Trimmed Cuts: Ham	Weight of Trimmed Cuts: Loin	Weight of Trimmed Cuts: Shoulder	Percentage Trimmed Cuts of Carcass Wt.: Ham	Percentage Trimmed Cuts of Carcass Wt.: Loin	Percentage Trimmed Cuts of Carcass Wt.: Shoulder	% Lean Cuts: Carcass Weight	% Lean Cuts: Live Wt.
150 lbs.	9-6	115.0	12.1	10.4	10.3	21.0	18.1	17.9	55.5	41.5
	11-5	104.9	12.2	9.1	9.2	23.3	17.3	17.5	58.2	38.3
	7-6	107.0	11.7	8.3	10.2	21.9	17.4	19.1	56.4	41.1
	23-6	99.3	10.8	9.5	8.6	21.8	19.1	17.3	58.2	39.3
	15-1	105.8	11.8	10.6	9.1	22.3	20.0	17.2	59.6	41.5
	24-7	106.2	12.0	9.5	8.6	22.6	17.8	16.2	56.7	39.4
	26-4	104.8	11.2	9.1	8.9	21.4	17.4	17.0	55.7	38.9
	27-6	107.5	12.3	9.1	8.5	22.9	16.9	15.8	55.6	38.6
Av.		106.3	11.8	9.5	9.2	22.2	18.0	17.3	57.0	39.8
175 lbs.	11-3	126.2	14.7	11.4	10.1	23.3	18.1	16.0	57.4	40.2
	8-6	124.6	14.0	11.5	10.4	22.4	18.5	16.7	57.6	41.5
	17-6	120.0	12.0	10.1	9.3	20.0	16.8	15.5	52.3	36.9
	22-9	129.3	15.4	11.3	11.3	23.8	17.5	17.3	58.8	42.0
	23-1	132.2	14.9	11.5	10.7	22.5	17.4	16.2	56.1	41.0
	25-6	127.9	13.7	11.9	11.2	21.4	18.6	17.5	57.5	40.7
	20-9	117.5	13.1	11.3	9.2	22.3	19.2	16.9	58.4	41.8
	23-4	123.8	15.3	11.7	11.2	24.7	18.9	18.1	61.7	40.5
Av.		125.2	14.1	11.3	10.5	22.6	18.1	16.8	57.5	40.6
200 lbs.	12-1	142.8	15.2	12.2	11.8	21.3	17.1	16.5	54.9	42.6
	14-9	144.4	14.7	13.4	12.5	20.4	18.6	17.3	56.0	41.2
	14-5	147.3	17.4	14.3	13.1	23.6	19.4	17.8	60.8	44.8
	23-3	145.6	15.8	11.5	12.0	21.7	15.7	16.5	54.0	38.7
	16-8	150.2	17.6	13.8	12.5	23.4	18.4	16.6	58.5	40.8
	20-3	148.9	16.3	13.7	12.5	21.9	18.4	16.8	53.5	41.1
	21-3	147.6	17.1	13.3	12.8	23.2	18.0	17.3	58.5	39.6
	26-5	131.0	15.1	12.8	11.9	23.1	19.5	18.2	60.8	41.5
Av.		144.7	16.2	13.1	12.4	22.3	18.1	17.1	57.1	41.3

TABLE IV, continued

Live Wt.	Pig No.	Chilled Carcass Weight	Weight of Trimmed Cuts: Ham	Loin	Shoulder	Percentage Trimmed Cuts of Carcass Wt.: Ham	Loin	Shoulder	% Lean Cuts: Carcass Weight	Live Weight
225	4-4	166.6	17.1	14.4	12.8	20.5	17.3	15.4	53.2	39.2
lbs.	1-2	158.1	17.4	13.3	12.8	22.0	16.8	16.2	55.0	38.5
	7-7	155.4	15.9	13.3	13.6	20.5	17.1	17.5	55.0	38.6
	22-1	152.8	17.3	14.0	12.7	22.6	18.3	16.6	57.6	39.5
	15-4	165.5	18.5	15.6	14.0	22.4	18.9	16.9	58.0	42.0
	22-5	155.4	17.3	13.6	13.6	22.3	17.5	17.5	57.4	39.6
	22-2	158.1	17.8	15.2	12.7	22.5	19.2	16.1	57.8	41.0
	26-1	173.0	19.5	16.0	15.2	22.5	18.5	17.6	58.6	41.7
Av.		160.6	17.6	14.4	13.4	21.9	18.0	16.7	56.7	40.0

TABLE V

CARCASS COMPOSITION OF PIGS SLAUGHTERED AT FOUR DIFFERENT LIVE WEIGHTS
EXPERIMENT I
PHYSICAL SEPARATION

Live Wt.	Pig No.	Weight, Pounds					Percentage of Chilled Carcass			
		Carcass	Lean	Fat	Skin	Bones	Lean	Fat	Skin	Bone
150 lbs.	9-6	115.0	73.3	18.8	6.4	10.5	63.7	16.3	5.57	9.13
	11-5	104.9	62.2	18.4	6.8	8.9	59.3	17.5	6.48	8.48
	7-6	107.0	70.2	12.8	6.3	9.3	65.6	12.0	5.89	8.69
	23-6	99.3	59.4	15.6	6.0	8.8	60.0	15.8	6.01	8.88
	15-1	105.8	65.7	16.0	6.0	9.2	62.1	15.1	5.67	8.70
	24-7	106.2	61.8	22.1	5.4	8.4	58.2	20.1	5.08	7.91
	26-4	104.8	60.6	18.8	6.1	8.2	57.8	17.9	5.82	7.82
	27-6	107.5	63.2	20.5	6.4	8.8	58.8	19.1	5.95	8.19
Average		106.3	64.6	17.9	6.2	9.0	60.7	16.7	5.80	8.48
175 lbs.	11-3	126.2	77.8	20.1	7.7	10.4	61.6	15.9	6.10	8.24
	8-6	124.6	76.0	20.0	7.6	10.4	61.0	16.1	6.10	8.34
	17-6	120.0	62.7	31.2	7.3	9.2	52.3	26.0	6.08	8.17
	22-9	129.3	80.2	19.8	7.5	9.8	62.0	15.3	6.20	7.76
	23-1	132.2	73.2	30.9	7.9	10.0	55.4	23.4	5.98	7.56
	25-6	127.9	75.9	26.4	7.4	10.0	59.3	20.6	5.79	7.81
	20-9	117.5	69.4	22.7	6.6	9.0	59.1	19.3	5.62	7.66
	23-4	123.8	75.6	21.7	6.3	10.0	61.1	17.5	5.09	8.07
Average		125.2	73.9	24.1	7.3	9.9	59.0	19.3	5.87	7.95
200 lbs.	12-1	142.8	75.4	39.0	7.6	10.4	52.8	27.3	5.32	7.28
	14-9	144.4	83.1	33.4	7.9	10.0	57.5	23.1	5.47	6.92
	14-5	147.3	92.1	24.9	7.6	10.8	62.5	16.9	5.16	7.33
	23-3	145.6	80.1	34.1	8.3	10.1	55.0	23.4	5.70	6.93
	16-8	150.2	88.5	30.2	7.5	11.0	58.9	20.1	4.99	7.32
	20-3	148.9	85.5	35.3	6.4	10.0	59.4	25.0	4.54	6.71
	21-3	147.6	86.8	31.8	7.2	10.1	58.8	21.5	4.88	6.84
	26-5	131.0	78.3	22.7	7.0	10.0	59.8	17.3	5.34	7.63
Average		144.7	83.7	31.4	7.4	10.3	58.1	21.8	5.18	7.12

TABLE V, continued

Live Wt.	Pig No.	Weight, Pounds Carcass	Lean	Fat	Skin	Bones	Percentage of Chilled Carcass Lean	Fat	Skin	Bones
225	4-1	166.6	91.9	43.1	8.0	11.6	55.2	25.1	4.80	6.96
lbs.	1-2	158.1	86.4	43.4	7.2	10.8	54.6	27.5	4.55	6.83
	7-7	155.4	84.0	48.9	7.6	10.6	54.1	31.5	4.89	6.82
	22-1	152.8	87.4	36.7	7.4	10.2	57.2	24.0	4.84	6.68
	15-4	165.5	98.5	32.2	9.8	12.4	59.5	19.5	5.92	7.49
	25-5	155.4	87.4	37.4	7.8	10.8	56.2	24.1	5.02	6.95
	22-2	158.1	93.0	36.2	7.4	10.9	58.8	22.9	4.68	6.89
	26-1	173.0	100.7	34.4	10.2	12.8	58.2	19.9	5.89	7.40
Average		160.6	91.2	39.0	8.2	11.3	56.7	24.3	5.07	7.00

TABLE VI

CHEMICAL COMPOSITION OF PORK CARCASSES FROM PIGS SLAUGHTERED AT FOUR DIFFERENT LIVE WEIGHTS
EXPERIMENT I

	Ear No.	Percentage Composition			
		Moisture	Ash	Fat	Protein
150#					
A	9-6	50.14	0.73	34.47	13.70
B	11-5	51.52	0.82	31.24	14.30
C	7-6	52.10	0.79	30.77	14.77
D	23-6	51.18	0.75	32.84	14.19
E	15-1	55.37	0.82	27.54	14.66
F	24-7	49.49	0.76	34.35	14.06
G	26-4	49.53	0.69	34.70	13.15
H	27-6	54.18	0.77	32.00	13.57
Average		51.69	0.77	32.24	14.05
175#					
A	11-3	51.94	0.81	31.79	14.31
B	8-6	52.72	0.77	31.55	13.67
C	17-6	45.07	0.66	42.00	11.50
D	22-9	51.89	0.77	31.55	14.96
E	23-1	45.01	0.70	39.09	13.47
F	25-6	51.62	0.76	32.18	14.23
G	20-9	48.67	0.76	34.49	14.18
H	23-4	56.01	0.85	26.69	16.01
Average		50.37	0.76	33.67	14.04
200#					
A	12-1	41.97	0.65	44.29	11.94
B	14-9	51.23	0.71	34.80	13.23
C	14-5	52.78	0.80	28.34	15.16
D	23-3	50.95	0.77	34.03	15.43
E	16-8	51.15	0.75	32.15	14.97
F	20-3	45.90	0.74	39.46	13.55
G	21-3	50.57	0.76	32.56	14.65
H	26-5	54.31	0.87	29.22	15.38
Average		49.86	0.76	34.36	14.29
225#					
A	4-4	45.06	0.63	42.36	13.65
B	1-2	41.64	0.69	44.21	12.36
C	7-7	42.10	0.67	45.57	11.80
D	22-1	46.05	0.75	39.76	13.21
E	15-4	50.64	0.76	33.57	13.57
F	22-5	47.15	0.75	35.81	14.10
G	22-2	49.11	0.77	34.90	14.40
H	26-1	48.40	0.78	35.70	14.54
Average		46.27	0.72	38.98	13.45

TABLE VII

PRODUCTION DATA, PIGS SLAUGHTERED AT 200 AND 225 POUNDS AFTER FULL- AND LIMITED-FEEDING FROM 175 POUNDS
EXPERIMENT II

	Pig No.	Ini-tial Wt.	Shrunk Slaugh-ter Wt.	Av. Daily Gain	Age at Slaugh-ter	Feed/ Pounds Gain
Full-	2-4	62	213	1.51	201	3.93
fed	3-6	53	193	1.40	200	3.93
to	3-4	65	209	1.69	200	4.35
200	15-2	58	203	1.58	193	4.35
lbs.	3-9	60	192	1.26	234	3.97
	8-7	59	194	1.24	239	3.97
	26-1	75	200	1.60	180	4.25
	27-2	64	200	1.68	178	4.25
Average		62.0	200.5	1.50	204.4	4.13
Limit-	2-8	57	198	1.10	229	4.73
fed	8-5	55	196	1.24	211	4.73
to	14-4	59	192	1.34	201	3.79
200	18-3	55	195	1.28	205	3.79
lbs.	26-4	55	204	1.21	187	3.70
	26-5	65	200	1.47	193	3.70
	2-7	67	214	1.73	253	4.42
	8-1	75	196	1.33	218	4.42
Average		61.0	199.4	1.34	212.1	4.21
Full-	4-9	62	228	1.24	234	4.21
fed	6-6	56	230	1.14	249	4.11
to	4-7	66	223	1.70	207	3.45
225	22-3	62	222	1.51	173	3.45
lbs.	25-1	68	220	1.88	194	4.59
	27-9	76	221	1.46	188	4.59
	4-5	70	226	1.49	224	4.49
	9-4	52	240	1.79	238	4.49
Average		64.0	226.3	1.69	213.4	4.19
Limit-	3-7	58	228	1.20	242	4.07
fed	6-2	59	221	1.31	221	4.07
to	1-2	67	218	1.53	229	3.85
225	21-2	60	226	1.31	221	3.85
lbs.	3-10	61	222	1.32	252	4.21
	9-2	52	225	1.42	248	4.21
	26-2	70	228	1.45	211	4.35
	27-6	70	226	1.43	206	4.35
Average		62.1	224.3	1.37	228.8	4.12

TABLE VIII

SLAUGHTER DATA ON PIGS FULL- AND LIMIT-FED FROM 175 POUNDS AND SLAUGHTERED AT 200 OR 225 POUNDS EXPERIMENT II

	Pig No.	Wt. Off Feed (lbs.)	Shrunk Wt. (lbs.)	Chilled Carcass Wt. (lbs.)	Dress-ing %	Length (in.)	Back Fat (in.)	Loin Area (sq. in.)
Full-	2-4	223	213	153.5	72.0	31.7	1.30	3.59
fed	3-6	203	193	137.0	71.0	30.8	1.13	3.90
to	3-4	216	209	148.0	70.8	31.3	1.27	3.87
200	15-2	205	203	143.0	70.8	30.4	1.38	4.23
lbs.	3-3	193	192	135.9	70.8	31.1	1.13	3.82
	8-7	199	194	136.0	70.1	31.0	0.97	4.32
	26-1	198	200	145.0	72.5	30.5	1.10	4.27
	27-2	204	200	143.0	71.5	30.2	1.28	4.92
Av.		205.1	200.5	142.7	71.2	30.9	1.20	4.12
Limit-	2-8	204	198	141.8	71.6	31.3	0.98	4.25
Fed	8-5	199	196	139.4	71.1	30.0	1.47	4.06
to	14-4	197	192	136.1	70.9	30.4	1.03	4.52
200	18-3	198	195	137.6	70.6	30.6	1.10	3.92
lbs.	26-4	212	204	145.5	71.3	29.4	1.52	4.23
	26-5	204	200	146.9	73.5	30.3	1.17	3.98
	2-7	216	214	151.0	70.6	31.1	0.98	3.81
	8-1	198	196	139.1	71.0	30.3	1.12	4.33
Av.		203.5	199.4	142.0	71.6	30.4	1.17	4.14
Full-	4-9	230	228	161.8	71.0	31.5	1.33	4.44
fed	6-6	232	230	166.7	72.5	31.9	1.15	4.79
to	4-7	226	223	157.0	70.4	31.1	1.40	4.49
225	22-3	229	222	160.1	72.1	32.0	1.28	4.60
lbs.	25-1	227	220	160.2	72.8	31.3	1.85	3.10
	27-9	228	221	161.6	73.1	30.6	1.67	4.71
	4-5	230	226	160.0	70.8	31.0	1.43	3.95
	9-4	245	240	166.6	69.4	31.4	1.47	4.52
Av.		230.9	226.3	161.8	71.5	31.4	1.45	4.33
Limit-	3-7	232	228	165.0	72.4	32.0	1.33	4.79
fed	6-2	224	221	157.6	71.3	30.9	1.48	4.76
to	1-2	227	218	154.4	70.8	32.0	1.15	4.26
225	21-2	227	226	154.6	68.4	31.3	1.18	4.36
lbs.	3-10	230	222	158.0	71.2	31.9	1.18	4.70
	9-2	228	225	161.6	71.8	32.2	1.20	3.53
	26-2	232	228	163.5	71.7	31.7	1.28	3.46
	27-6	231	226	161.2	71.3	30.2	1.22	4.86
Av.		228.9	224.3	159.4	71.1	31.5	1.25	4.34

TABLE IX

CARCASS DATA OF 200- AND 225-POUND PIGS FULL- AND LIMIT-FED FROM 175 POUNDS TO MARKET EXPERIMENT II

	Pig No.	Chilled Carcass Weight	Weight of Trimmed Cuts			Percentage Trimmed Cuts of Carcass Wt.			% Lean Cuts	
			Ham	Loin	Shoulder	Ham	Loin	Shoulder	Carcass Weight	Live Weight
Full-	2-4	153.5	15.2	10.8	12.8	19.8	14.1	16.7	50.6	36.4
fed	3-6	137.0	14.8	11.5	9.6	21.6	16.8	14.0	52.4	37.2
to	3-4	148.0	16.9	12.0	11.3	22.8	16.2	15.3	54.2	38.4
200	15-2	143.0	15.1	12.6	12.6	21.1	17.6	17.6	56.0	39.5
lbs.	3-3	135.9	14.2	11.6	11.8	20.9	17.1	17.4	55.2	39.1
	8-7	136.0	15.6	12.1	11.8	22.9	17.8	17.4	57.9	40.6
	26-1	145.0	15.2	13.0	11.9	21.0	17.9	16.4	55.1	40.0
	27-2	143.0	15.6	11.6	11.8	21.8	16.2	16.5	54.3	38.9
Av.		142.7	15.3	11.9	11.7	21.5	16.7	16.4	54.6	38.8
Limit-	2-8	141.8	16.4	12.8	12.8	23.1	18.1	18.1	59.2	42.4
fed	8-5	139.4	15.6	12.4	11.2	22.4	17.5	16.1	55.4	39.4
to	14-4	136.1	16.1	12.2	10.6	23.7	17.9	15.6	57.8	40.9
200	18-3	137.6	14.5	10.9	11.5	21.0	15.8	16.7	53.6	37.9
lbs.	26-4	145.5	15.0	11.7	12.5	20.6	16.1	17.2	53.7	38.3
	26-5	146.9	15.0	12.1	11.4	20.4	16.5	15.5	52.3	38.4
	2-7	151.0	17.0	12.7	13.6	22.5	16.8	18.0	57.4	40.5
	8-1	139.1	15.9	11.7	11.8	22.9	16.8	17.0	56.5	40.1
Av.		142.0	15.7	12.1	11.9	22.1	16.9	16.8	55.7	39.7
Full-	4-9	161.8	17.6	12.5	12.9	21.8	15.5	15.9	53.1	37.7
fed	6-6	166.7	17.5	14.0	14.4	21.0	16.8	17.3	54.9	39.8
to	4-7	157.0	16.7	13.0	13.6	21.3	16.6	17.3	55.0	38.7
225	22-3	160.1	17.2	14.2	13.7	21.5	17.7	17.1	56.3	40.6
lbs.	25-1	160.2	14.5	12.1	12.5	18.1	15.1	15.6	48.6	35.4
	27-9	161.6	16.7	13.9	13.5	20.7	17.2	16.7	54.3	39.7
	4-5	160.0	16.5	12.3	12.6	20.6	15.4	15.8	51.7	36.6
	9-4	166.6	17.0	13.5	14.0	20.4	16.2	16.8	53.4	37.1
Av.		161.8	16.7	13.2	13.4	20.7	16.3	16.6	53.4	38.2

TABLE IX, continued

	Pig No.	Chilled Carcass Weight	Weight of Trimmed Cuts			Percentage Trimmed Cuts of Carcass Wt.			% Lean Cuts	
			Ham	Loin	Shoulder	Ham	Loin	Shoulder	Carcass Weight	Live Weight
Limit-	3-7	165.0	18.1	14.7	13.7	21.9	17.8	16.6	56.4	40.8
fed	6-2	157.6	17.6	13.3	13.4	22.4	16.9	17.0	56.1	40.0
to	1-2	154.4	17.5	13.4	14.6	22.7	17.4	18.9	58.9	41.7
220	21-2	154.6	18.6	13.1	13.4	24.1	16.9	17.3	58.3	39.9
lbs.	3-10	158.0	17.2	14.4	13.9	21.8	18.2	17.6	57.5	41.6
	9-2	161.6	16.3	13.0	14.0	20.2	16.0	17.3	53.6	38.5
	26-2	163.5	16.2	12.4	13.1	19.8	15.2	16.0	50.9	36.5
	27-6	161.2	16.8	13.6	13.3	20.8	16.9	16.5	54.2	38.6
Av.		159.4	17.3	13.5	13.7	21.7	16.9	17.1	55.7	39.6

TABLE X

CHEMICAL COMPOSITION OF RIGHT HAM OF 200- AND 225-POUND PIGS FULL- AND LIMIT-FED FROM 175 POUNDS EXPERIMENT II

	Ear No.	Percentage Composition			
		Moisture	Ash	Fat	Protein
FF 200# Pen					
3	2-4	64.81	1.03	13.81	19.52
3	3-6	66.90	1.19	11.37	20.03
6	3-4	59.06	0.94	23.23	16.82
6	15-2	58.29	0.92	24.45	16.51
11	3-9	59.49	0.94	21.64	17.75
11	8-7	63.45	1.04	18.13	16.98
16	26-1	58.23	1.10	23.33	17.70
16	27-2	58.13	0.91	24.80	16.12
Average		61.04	1.01	20.09	17.69
LF 200# Pen					
2	2-8	63.52	0.98	17.05	17.11
2	8-5	58.01	0.98	23.06	16.97
7	14-4	61.63	0.98	19.87	17.30
7	18-3	60.45	0.92	21.31	16.75
10	26-4	57.36	0.87	24.90	15.35
10	26-5	54.38	0.84	28.13	15.93
14	2-7	62.27	0.99	18.53	17.24
14	8-1	63.34	0.95	18.65	16.97
Average		60.12	0.94	21.44	16.70
FF 225# Pen					
1	4-9	56.92	0.92	23.81	17.48
1	6-6	60.61	0.93	22.93	16.87
8	4-7	56.13	0.93	25.47	16.47
8	22-3	61.22	0.98	20.14	17.84
9	25-1	51.26	0.79	33.17	14.37
9	27-9	56.99	0.90	26.39	16.41
13	4-5	55.37	0.82	29.09	15.79
13	9-4	57.85	0.85	25.77	15.94
Average		57.04	0.89	25.85	16.40
LF 225# Pen					
4	3-7	59.89	0.96	22.45	16.86
4	6-2	59.98	0.90	22.14	17.16
5	1-2	61.65	0.94	19.36	18.00
5	21-2	61.69	0.99	19.53	17.05
12	3-10	61.14	0.98	19.57	17.41
12	9-2	58.09	0.87	25.15	15.61
15	26-2	53.59	0.84	26.83	15.62
15	27-6	59.37	0.91	18.53	17.24
Average		59.42	0.92	21.69	16.87

TABLE XI

SPECIFIC GRAVITY VALUES FOR THE WHOLE CARCASS AND THE RIGHT HAM OF PIGS SLAUGHTERED AT 200 AND 225 POUNDS AFTER BEING SELF- AND LIMIT-FED FROM 175 POUNDS
EXPERIMENT II

	Pig No.	Specific Gravity Carcass	Specific Gravity Ham	Back Fat (in.)	Loin Area (Sq. in.)	Lean Cuts (Carc.)	Ham Protein (Percentage)
Full-fed to 200 lbs.	2-4	1.0378	1.0710	1.30	3.59	50.6	19.52
	3-6	1.0445	1.0615	1.13	3.90	52.4	20.03
	3-4	1.0419	1.0653	1.27	3.87	54.3	16.84
	15-2	1.0483	1.0582	1.38	4.23	56.4	16.51
	3-3	1.0486	1.0698	1.13	3.82	55.3	17.75
	8-7	1.0529	1.0707	1.00	4.32	58.1	16.98
	26-1	1.0476	1.0743	1.10	4.27	55.3	17.70
	27-2	1.0490	1.0677	1.28	4.92	54.5	16.12
Av.		1.0463	1.0673	1.20	4.12	54.6	17.68
Limit-fed to 200 lbs.	2-8	1.0564	1.0732	0.98	4.25	59.2	17.11
	8-5	1.0495	1.0684	1.47	4.06	56.2	16.97
	14-4	1.0507	1.0652	1.03	4.52	57.2	17.30
	18-3	1.0487	1.0674	1.10	3.92	53.6	16.75
	26-4	1.0440	1.0645	1.52	4.23	53.6	15.35
	26-5	1.0354	1.0641	1.22	3.98	52.4	15.93
	2-7	1.0570	1.0697	1.02	3.81	57.4	17.24
	8-1	1.0518	1.0699	1.12	4.33	56.6	16.97
Av.		1.0492	1.0678	1.17	4.14	55.8	16.70
Full-fed to 225 lbs.	4-9	1.0439	1.0691	1.33	4.44	53.1	17.48
	6-6	1.0478	1.0660	1.15	4.79	55.1	16.87
	4-7	1.0446	1.0625	1.40	4.49	55.2	16.47
	22-3	1.0500	1.0728	1.28	4.60	56.3	17.84
	25-1	1.0344	1.0532	1.85	3.10	48.8	14.37
	27-9	1.0421	1.0640	1.67	4.71	54.6	16.41
	4-5	1.0456	1.0625	1.43	3.95	51.7	15.79
	9-4	1.0420	1.0613	1.48	4.52	53.4	15.94
Av.		1.0438	1.0639	1.40	4.33	53.5	16.40
Limit-fed to 225 lbs.	3-7	1.0512	1.0586	1.33	4.79	56.4	16.86
	6-2	1.0514	1.0697	1.48	4.76	56.2	17.16
	1-2	1.0499	1.0648	1.15	4.26	58.9	18.00
	21-2	1.0498	1.0594	1.18	4.36	58.3	17.05
	3-10	1.0513	1.0693	1.15	4.70	57.6	17.41
	9-2	1.0421	1.0580	1.20	3.53	53.6	15.61
	26-2	1.0410	1.0631	1.28	3.46	51.7	15.62
	27-6	1.0502	1.0625	1.22	4.86	54.2	17.24
Av.		1.0484	1.0632	1.25	4.34	55.9	16.87

VITA

Clarence Melvin Bradley

Candidate for the Degree of

Doctor of Philosophy

Thesis: THE EFFECT OF SLAUGHTER WEIGHT AND FEED RESTRICTION ON PERFORMANCE AND CARCASS CHARACTERISTICS OF SWINE

Major Field: Animal Nutrition

Biographical:

Personal Data: Born near Kaiser, Missouri, March 2, 1920, the son of Charles and Ida Bradley.

Education: Bachelor of Science degree from the University of Missouri in January, 1949. Master of Science degree in June, 1952. Both in Animal Husbandry.

Experiences: Served forty-six months in the United States Army in World War II. Instructor and Assistant Professor of Animal Husbandry ten years. Extension Specialist and Project leader, one year.