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I am submitting herewith a dissertation written by Earl D. Brooks II entitled "The Influence of Grade and Body Type on the Performance of Purchased Feeder Pigs." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Animal Science.

John P. Hitchcock

John P. Hitchcock, Major Professor

We have read this dissertation
and recommend its acceptance:

Curtis C. Melton

Ralph F. Hall

J. B. McLaren

Frank B Masincupp

Accepted for the Council:

Lewis Minkel

The Graduate School

THE INFLUENCE OF GRADE AND BODY TYPE ON THE PERFORMANCE OF PURCHASED FEEDER PIGS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Earl D. Brooks, II

June 1984

The author wishes to dedicate this manuscript to his parents

Mr. and Mrs. Earl D. Brooks,

and to his wife

Sheila G. Brooks

ACKNOWLEDGMENTS

For their generous contributions of time and advice in assisting with the preparation of this dissertation and in making his graduate study possible, the author wishes to express his sincere appreciation and gratitude to the following persons:

To his wife, Sheila Gibbs Brooks, for her support, guidance, encouragement and patient cooperation, without which the author could not have completed his program of study.

To his parents, Mr. and Mrs. Earl D. Brooks, for their encouragement, advice, and many sacrifices that made college study a reality.

To his in-laws, Mr. and Mrs. Leslie Gibbs, for their encouragement and unselfish efforts to help make the graduate study easier.

To Dr. Frank B. Masincupp for serving as a co-major professor and for his time spent in counseling, advising, and assistance in the collection and summarization of the data, and for his continued encouragement and friendship throughout the program of study.

To Dr. John P. Hitchcock for serving as major professor and for his sincere interest and advice in collecting data from the experiment and for his suggestions in presenting the factual data herein.

To Dr. Ralph F. Hall for serving as a member of the graduate committee, reviewing the dissertation and for his cooperation and assistance in collecting data from the experiment.

To Dr. J. B. McLaren for serving on the graduate committee, reviewing the manuscript and for his advice on the statistical analysis.

To Dr. C. C. Melton for serving on the graduate committee, reviewing the manuscript and for his encouragement during the author's graduate program.

To Dr. W. L. Sanders for his advice and time spent on the statistical analysis of the data.

To Dr. Robert Freeland, Ernest Neal and other research personnel at the Plateau Experiment Station in Crossville, Tennessee for their cooperation and assistance in conducting the research and collecting the data.

To Mr. Claude Harris and personnel of the Tennessee Department of Agriculture for their time, interest and assistance in the grading of feeder pigs for the study.

To Jack Underdown, Tina Shipley, Lisa Bettison, Jack Glisson, John Copeland, and other graduate students for their assistance in collecting the data and for their interest and friendship.

To Mrs. Irene Goodin for her time, effort and preparation in the typing of this manuscript.

ABSTRACT

Two trials involving 480 pigs were conducted to determine the influence of grade and body type on the performance of purchased feeder pigs.

Ninety U.S. No. 1, 90 U.S. No. 2 and 60 U.S. No. 3 pigs were purchased in each trial. The No. 1 and No. 2 grades were divided into three body types: type 3--longer, taller pigs; type 2--average for the grade; and type 1--shorter, compact pigs. The U.S. No. 3 grade pigs were divided only into the type 2 and type 1 categories.

The addition of 10% oats to the basal diet increased ($P<.05$) average daily gain of pigs after 7 days while additions of 10% alfalfa meal resulted in more feed ($P<.05$) consumed per pound of gain after 21 days on experiment.

The addition of .3% potassium to the basal diet reduced ($P<.05$) average daily gain after 7 and 21 days and increased feed required per pound of gain ($P<.05$) when compared to feed per gain for pigs receiving 250 ppm copper during the first 21 days. The addition of 250 ppm copper to the diet improved performance during the first 21 days. Measurements from a life size projection of each pig and carcass measurements were obtained. Pig height from the floor perpendicular through the flank to the top of the animal accounted for 23% of the variability in grade.

Initially and at slaughter, grade 3 type 1 pigs and grade 2 type 1 pigs had higher ($P<.05$) backfat measurements than any other grade-body type combinations.

Grade 2 type 3 and grade 1 type 3 pigs were longer ($P<.05$) at slaughter than all other grade-body type combinations. All grade 1 pigs had higher ($P<.05$) muscling scores than grades 2 and 3 type 1 pigs.

Type 1 pigs were ($P<.05$) fatter than all other pigs. The simple correlation between final ultrasonic fat and actual carcass backfat for both trials was .74 suggesting that backfat accounted for 55% of the variability among the grades.

Ultrasonic measurement of fat only over the last lumbar vertebra accounted for 61% of the variability among grades in carcass backfat postslaughter.

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CHAPTER I

INTRODUCTION

Approximately one-fifth of the market hogs slaughtered in the United States come from units finishing purchased feeder pigs (VanArsdall, 1978).

The production of feeder pigs has become a major swine enterprise in Tennessee. Many of these pigs are being marketed through organized feeder pig sales where they are sorted according to weight and grade. The grade of a feeder pig is determined by evaluating its logical slaughter potential and its thriftiness. The logical slaughter potential of a thrifty feeder pig is its expected slaughter grade at a market weight of about 230 pounds after a normal feeding period.

The grading standards for feeder pigs provide six grades--U.S. No. 1 through U.S. No. 4, U.S. utility and U.S. cull. Except for the U.S. cull grade, these grades correspond to the five grades for slaughter swine and for pork carcasses (U.S.D.A., 1970).

Tennessee swine producers raise approximately 1.75 to 2.25 million pigs each year. The number of pigs marketed in graded feeder pig sales increased from 21,822 (1.1%) in 1960 to 641,085 (35.7%) in 1971. Rawls (1983) reports that 609,841 pigs were marketed in graded feeder pig sales in 1982.

Both feeder pig buyers and graders can have more confidence in their judgments if they have an opportunity to observe and study

the performance of graded feeder pigs from the feedlot through the packing house. Under normal conditions, buyers and graders seldom are able to obtain reliable information on rate of gain, feed conversion, growth parameters and carcass data of pigs which were graded as feeders.

The objective of this experiment was to measure the performance, feed efficiency, growth parameters and carcass characteristics of pigs graded U.S. No. 1, U.S. No. 2 and U.S. No. 3.

CHAPTER II

LITERATURE REVIEW

1. GRADE CLASSIFICATIONS FOR SWINE

A system of classifying and grading market hogs was formulated by the United States Department of Agriculture (U.S.D.A.) in 1918 for use in the livestock market reporting service. According to Agnew (1969), the system was developed to represent the most generally accepted market groupings of the time. After meetings with producers, animal husbandmen, market representatives and processors in 1928 and 1929, revisions were made, consistent with changes in production and marketing conditions, and tentative standards were issued in 1930 (U.S.D.A., 1970). Further revisions were incorporated into the tentative standards in 1940 when they were published by the U.S.D.A.

The United States Department of Agriculture proposed new standards for grades of slaughter barrows and gilts in 1949. Field testing, discussion and demonstration of the standards resulted in slight revisions prior to adoption as the official United States standards for grades of slaughter barrows and gilts, effective September 12, 1952.

In July 1955, the grading standards were amended (U.S.D.A., 1970) by changing the designations of Choice No. 1, Choice No. 2 and Choice No. 3 to U.S. No. 1, U.S. No. 2 and U.S. No. 3, respectively.

At this time, the degree of finish or fatness was reduced for each grade and the descriptive specifications were reworded to reflect the reduced degrees of finish and to facilitate more uniform interpretation of the standards. Additional changes in the market hog grading standards, made in 1968, more adequately reflect the effect of variation from normal fat distribution and muscling on yields of cuts. Other changes have resulted in the present standards and specifications.

The tentative standards for grades of feeder pigs were developed and published by the Department of Agriculture in 1940 and served as the basis for federal and state markets news reports on feeder pigs.

The official standards for grades of feeder pigs were proposed by the United States Department of Agriculture in 1965 and after slight revisions became effective in 1966. In April 1969, the official standards were revised to coordinate them with the pork carcass and slaughter swine standards that were revised in 1968. In this revision, a new No. 1 grade was established to identify the superior feeder pigs then being produced. The former No. 1, No. 2 and No. 3 grades were renamed No. 2, No. 3 and No. 4, respectively. The medium grade was renamed U.S. Utility, and the standard section was revised to more clearly define the grade-determining factors and clarify their use in determining the grades.

The grade of a feeder pig is determined by evaluating two general value-determining characteristics--its logical slaughter

potential and its thriftiness (U.S.D.A., 1970). The logical slaughter potential of a thrifty feeder pig is its expected slaughter grade at a market weight of 230 pounds after a normal feeding period. In these feeder pig standards, logical slaughter potential is determined by a composite appraisal of the development of the muscular system and the skeletal system. Both of these factors have an important effect on the development of lean and fat as the animal grows and fattens, and therefore, on the expected slaughter and carcass grade.

Thriftiness in a feeder pig is its apparent ability to gain weight rapidly and efficiently. Size for age, health and other general indications of thriftiness are considered in appraising the thriftiness of feeder pigs.

The standards provide for six grades of feeder pigs--U.S. No. 1, U.S. No. 2, U.S. No. 3, U.S. No. 4, U.S. Utility and U.S. Cull. Except for the U.S. Cull grade these names correspond to the five grade names for slaughter swine and pork carcasses.

Most feeder pigs are marketed when relatively young and before reaching a weight of 125 pounds. Agnew (1969) suggested that at this age, sex condition exerts little influence on the basic factors determining the feeder grade. Therefore, the standards are equally applicable for grading barrow, gilt and boar pigs, although it is recognized that sex condition may influence the market price in some instances. It is assumed that boar pigs will be castrated prior to developing the secondary physical characteristics of a boar.

Sows, stags, and mature boars are seldom used as feeder animals, and these standards do not apply to those classes.

The U.S. No. 1, U.S. No. 2, U.S. No. 3 and U.S. No. 4 grades include all pigs which are thrifty. Differentiation between the U.S. No. 1, U.S. No. 2, U.S. No. 3 and U.S. No. 4 grades is based entirely on differences in logical slaughter potential. Feeder pigs in the U.S. No. 1 grade have sufficient muscling and frame to reach a market weight of 230 pounds with a minimum degree of finish. Feeder pigs in the U.S. No. 2, U.S. No. 3 and U.S. No. 4 grades usually have progressively less muscling and less frame and are expected to have progressively more finish when marketed at 230 pounds. The U.S. Utility and U.S. Cull grades include only pigs which lack thriftiness. Differentiation between the U.S. Utility and U.S. Cull grades is based entirely on differences in thriftiness.

However, many feeder pigs graded U.S. No. 3 and U.S. No. 4 often appear to be mismanaged, unhealthy pigs that lack the thriftiness of the U.S. No. 1 and U.S. No. 2 pigs. With proper management, these pigs may have better performance records than a U.S. No. 1 or U.S. No. 2 with less fat at slaughter as well.

Only one combination of muscling and skeletal characteristics is described in the standards for the U.S. No. 1, U.S. No. 2, U.S. No. 3 and U.S. No. 4 grades. However, feeder pigs qualifying for the U.S. No. 1, U.S. No. 2, U.S. No. 3 or U.S. No. 4 grades may vary with respect to the relative development of the individual grade factors (U.S.D.A., 1970). In fact, some will qualify for a particular

grade although they have some characteristics more nearly typical of another grade, except that feeder pigs in the U.S. No. 1 grade must have at least moderately thick muscling. Feeder pigs with other characteristics of the U.S. No. 1 grade, but with less than moderately thick muscling would be in the U.S. No. 2 grade. Since no attempt is made to describe the numerous combinations of characteristics that may qualify a feeder pig for a specific grade, making appropriate compensations for varying combinations of characteristics requires the use of sound judgment.

The following specifications for official United States standards for grades of feeder pigs were described by the U.S.D.A. (1970).

U.S. No. 1

Feeder pigs in this grade near the borderline of the U.S. No. 2 are long and have thick muscling throughout. They exhibit a large frame, a low degree of fatness and thickness of muscling is particularly evident in thick and full hams and shoulders. The hams and shoulders are thicker than the back, which is well rounded. They usually present a well-balanced appearance. In no case may a feeder pig be graded U.S. No. 1 with less than moderately thick muscling. Feeder pigs in this grade are expected to produce U.S. No. 1 grade carcasses when slaughtered at 230 pounds.

U.S. No. 2

Feeder pigs in this grade near the borderline of the U.S. No. 3 grade are moderately long and have moderately thick muscling

throughout. They are moderately large framed with only a moderate degree of fatness. Thickness of muscling is particularly evident in moderately thick and full hams and shoulders. The back usually appears slightly full and well-rounded. They usually present a well-balanced appearance. This grade also includes feeder pigs which otherwise qualify for the U.S. No. 1 grade but have less than moderately thick muscling. Feeder pigs in this grade are expected to produce U.S. No. 2 grade carcasses at slaughter.

U.S. No. 3

Pigs in this grade are slightly short and have slightly thin muscling throughout. U.S. No. 3 pigs are slightly small framed and have a high degree of fatness. The hams and shoulders are slightly thin and flat and the back usually appears moderately full and thick. These pigs are expected to produce U.S. No. 3 grade carcasses at slaughter.

U.S. No. 4

Feeder pigs typical of this grade are short and have thin muscling throughout. They exhibit a small frame and a high degree of finish. The hams are thin and rather flat, particularly in the lower parts toward the shanks. The back usually appears slightly flat and the width at the topline usually is greater than at the underline. Feeder pigs in this grade are expected to produce U.S. No. 4 grade carcasses when slaughtered at 230 pounds.

U.S. Utility

Pigs typical of this grade are small for their age and appear unthrifty. They often have a rough, unkept appearance indicating the effects of disease or poor care. The hams and shoulders are usually thin and flat and taper toward the shanks. The back is thin and lacks fullness. Pigs in this grade near the borderline of the U.S. No. 1, U.S. No. 2, U.S. No. 3 and U.S. No. 4 grades are slightly small for their age and appear slightly unthrifty. It is recognized that U.S. Utility grade feeder pigs will produce U.S. No. 1, U.S. No. 2, U.S. No. 3 or U.S. No. 4 grade carcasses when slaughtered at 230 pounds provided their unthrifty condition is corrected. U.S. Utility grade feeder pigs whose unthrifty condition is not corrected will produce U.S. Utility grade carcasses.

U.S. Cull

Typical U.S. Cull grade feeder pigs are very deficient in thriftiness because of poor care or disease. They can be expected to reach a normal market weight only after an extremely long and costly feeding period, if at all.

2. PERFORMANCE OF VARIOUS GRADES

Feeder pig buyers and graders have associated improved overall performance with pigs which qualify for the higher U.S. feeder grades. A limited number of studies have been conducted to evaluate rate of growth, feed efficiency and carcass characteristics of the various grades.

Thrasher et al. (1965) selected pigs from graded feeder pig sales in Louisiana in order to study the performance and carcass traits of pigs falling into four grades. These grades were similar to the U.S.D.A. grading standards as described at that time. Pigs grading AA (the highest grade) and A (U.S. No. 2) as feeders produced carcasses and wholesale cuts which were acceptable in meatiness and quality. On the other hand, most of the pigs graded BA (U.S. No. 3) and AC (U.S. No. 4) as feeders produced carcasses and wholesale cuts which were unacceptable to most retailers and consumers due to low amount of lean and excessive fat content. Rate of gains by the four grades, AA, A, BA and AC were 1.77, 1.64, 1.49 and 1.47 pounds per head per day, respectively.

Results of a study conducted by Thrasher et al. (1968) indicated there was no difference in the rate of gain of pigs graded AA (U.S. No. 1 and Top U.S. No. 2), A (U.S. No. 2), BA1 (U.S. No. 3) and BA2 (low U.S. No. 3 and U.S. No. 4) as feeders. Average daily gains reported for the four grades were 1.60, 1.65, 1.64 and 1.67 pounds per head per day, respectively. They reported that 324, 317, 333 and 322 pounds of feed per 100 pounds of gain was required by the four grades, respectively.

Two feeding trials with lean-type and fat-type pigs were conducted by Barth, McConnell and Griffin (1970). When fed a ration with ample protein (20% protein from 60 to 125 pounds and 16% from 125 pounds until slaughter), the lean pigs gained slightly faster (1.65 vs 1.59 pounds per day) than the fat-type pigs. However, this

difference was not significantly different. Lean type pigs required less feed per pound of gain and were more efficient in converting feed protein into edible-carcass protein. In contrast, when fed a ration of 18-16% and 14-12% protein the gain of fat-type and lean-type pigs was similar. The lean-type pigs fed the high protein ration had the leanest carcasses. Carcasses of lean-type pigs had 5 pounds more bone, 19 pounds less fat and 14 pounds more trimmed ham, shoulder and loin than carcasses of fat-type pigs.

The results of Barth et al. (1970) were comparable to Davey and Morgan (1969) who also fed lean-type and fat-type pigs different protein levels. In their experiment, low-fat pigs fed a 20% protein diet had an average of 21.4 kg of lean in their carcasses compared to 16.3, 14.8 and 15.7 kg for high fat pigs fed 20% protein and high and low fat pigs fed 12% protein, respectively. Their research also indicated that lean-type pigs were more efficient feed converters.

A breeding experiment at the U.S.D.A. Agricultural Research Center, Beltsville, Maryland, demonstrated the value of collecting and using backfat measurements in selective breeding for meat-type hogs. They developed a high-fat line and low-fat line that was carried through 15 generations. The results demonstrated that backfat thickness increased from 1.49 to 2.55 inches in the high-fat line and decreased from 1.49 to 0.96 inches in the low-fat line (U.S.D.A., 1971). When slaughtered at 210 pounds, fifteenth generation low-fat pigs excelled high-fat pigs by 20.8 pounds or 28% in yield of lean cuts and by 2.4 squares inches or 95% in loin eye muscle area. The low-fat pigs also had 27.4 pounds or 48% less fat.

There was no significant change in growth rate when selecting for either high or low fatness. However, feed requirements per unit weight gain have been considerably higher in high-fat than low-fat pigs.

Thrasher et al. (1965) reported that 83, 59, 17 and 8% of the pigs graded AA, A, BA, and AC, respectively, as feeder pigs produced U.S. No. 1 carcasses at slaughter. The percent of U.S. No. 1 carcasses produced by the AA, A, BA1 and BA2 feeder pigs compared by Thrasher et al. (1968) was 52, 48, 35 and 17%, respectively. Fat-type pigs fed a high protein ration produced carcasses which yielded 48.1% ham, loin and shoulder compared to 53.5% for the lean-type pig according to McConnell, Barth and Griffin (1971). The fat- and lean-type pigs on the low protein ration yielded 47.5 and 50.8% ham, loin and shoulder, respectively. No increase in carcass leanness was observed when the fat-type pigs were fed the high-protein diet, however, higher protein levels improved carcass leanness in the lean-type pigs.

Research performed by Tracy (1972) involved the random selection of 20 pigs, weighing 40-50 pounds, from each of three graded pens; mixed U.S. No. 1 and U.S. No. 2, U.S. No. 3 and U.S. No. 4. The pigs were wormed, sprayed for external parasites and fed a 16% protein wheat-supplement ration for 105 days.

Average daily gain, during the 105-day finishing period, of pigs graded U.S. No. 1-2, U.S. No. 3 and U.S. No. 4 at weaning (40-50 pounds) was 1.67, 1.68 and 1.74 pounds per head per day, respectively.

The pigs which were graded U.S. No. 4 as feeders were fatter, slightly shorter, less muscular and graded lower at slaughter than the pigs graded higher, U.S. No. 1 through 3.

The average backfat probe for the three feeder grade groups, U.S. No. 1-2, U.S. No. 3 and U.S. No. 4 were 1.30, 1.33 and 1.53 inches, respectively. The leaner, U.S. No. 1 through U.S. No. 3, pigs were more efficient feed converters than the fatter U.S. No. 4 pigs.

Pigs graded U.S. No. 4 as feeders tended to grade higher at slaughter. Ten percent of the pigs in this feeder grade were graded U.S. No. 1 at slaughter, 35% were graded U.S. No. 2, 50% graded U.S. No. 3 and only 5% were graded U.S. No. 4. Tracy concluded that many Tennessee feeder pigs are being placed in feeder grades below their potential slaughter grade and genetic potential at feeder pig sales due to poor presale management and nutrition. The response of the U.S. No. 4 pigs, especially during a 12-day adjustment period showed that many producers have an opportunity, through improved management and nutritional practices, to have a greater percentage of their pigs graded higher as feeders.

3. MANAGEMENT OF PURCHASED FEEDER PIGS

The movement of feeder pigs through public markets (terminal and auction) exposes the pig to numerous diseases and other stresses. Transportation of animals results in tissue shrinkage, even when transported a relatively short distance (Hails, 1978). In addition,

movement of pigs often involves mingling, thereby creating fighting and other social stresses. Sherritt et al. (1974) concluded that mixing of pigs, in conjunction with other stresses, adversely affected pig growth.

Recommendations for management of newly purchased feeder pigs are many and varied (Giesler et al., 1978; Albrecht et al., 1979; Tracy, 1979) and research with feeder pig receiving programs to reduce stress is limited.

Research conducted by Brumm et al. (1982) concluded that pigs purchased from distant auction markets gained slower for the first 13 days post-arrival than pigs of similar size purchased from local, one owner sources ($P<.01$). These pigs also required more medical treatment than the local, one-owner sources ($P<.01$). Pigs which were fed a 16% crude protein receiving diet for 13 days containing 20% oats had a poorer ($P<.01$) feed efficiency than those fed a corn-soy basal diet or a diet containing 20% oats plus 5% lard. At the termination of their trials, there were no differences in rate of gain or feed to gain ratio between the three receiving diets. Feeding diets containing 20% oats had no effect on the incidence of post-arrival scours but death loss was less ($P<.01$) for pigs fed the receiving diet containing 20% oats.

Fritschen and Moser (1979), however, demonstrated that limit feeding a diet containing whole oats (25 and 50%) for 10 days delayed the onset and severity of diarrhea of 12.5 kg purchased feeder pigs.

Antibiotics effectively improve growth rate and feed efficiency in starter diets, but the response decreases as pigs get larger (Allee, 1979). He conducted two trials to evaluate Tylan, Stafac, Lincomix and Flavomycin by growth rate and feed efficiency. In Trial I, none of the antibiotics improved growth rate or feed efficiency. In Trial II, where pigs were more crowded, feeding an antibiotic slightly, but not significantly, increased daily gain and feed efficiency, with no significant difference among antibiotics. He concluded that the response or lack of response to feeding low levels of antibiotics will depend on the level of stress imposed.

Wilson et al. (1981) reported that the addition of Aureo SP-250 to the diet significantly ($P<.01$) increased daily gains where the pigs had the greater floor space (2.5 sq. ft.) but did not when confined to 1.5 square feet. They found no significant difference between the gains of the pigs due to extra pen space when the diet did not contain Aureo SP-250.

The value of antibiotics in swine rations has been adequately reviewed by Braude et al. (1953). This summary indicated that chlortetracycline (Aureomycin) increased the daily gain of growing-fattening swine 35% more than control animals in experiments conducted throughout the United States. Terramycin in a ration containing 20% alfalfa had no effect upon rate of gain of swine (Bohman et al., 1953).

Bell et al. (1950) have indicated that antibiotics may adversely affect the beneficial symbiotic bacteria in ruminants.

Hogs must also depend upon intestinal bacteria for cellulose and fiber digestion. Since Forbes and Hamilton (1952) decreased the digestibility of cellulose and crude fiber by swine with the addition of sulfathalidine, it seems that antibiotics may play a similar role. This could be reflected by a reduced rate of gain or no difference in rate of gain when a high roughage ration is fed with antibiotics. However, Bohman et al. (1955) reported that aureomycin accelerated the growth rate and decreased the feed required per pound of gain even at high levels of alfalfa feeding. They concluded that swine apparently adjust to a high level of alfalfa intake by enlarging the size of their digestive tracts where limited transitory feed storage takes place as indicated by the increased weights of stomach and large intestine.

Purchased feeder pigs consume little feed the first few days probably because they are just weaned, stressed, have experienced the adverse effects of mingling or a combination of these and possible other factors. Diarrhea and disease is often a problem during this time even when the feed contains a high level of antibacterial fortification; the actual intake of the drug is minimal because they eat so little feed. Medicating the water appears to be a better way to get sufficient intake of an antibacterial into the feeder pigs. One of the problems with water medication is the limited information on water consumption of pigs for the first few days of transition.

Allee and Schoneweis (1979) conducted two trials to evaluate the effects of various water medications (sulfademethoxime, electrolytes plus sodium arsenate and neomycin sulfate) on performance and feed and water consumption of pigs. Adding medications to the water did not affect gain of the pigs in either trial. Water medications did not reduce water consumption and it did not affect the quantity of feed consumed, nor weight gain or death loss.

4. EFFECT OF RATION ON PERFORMANCE AND CARCASS CHARACTERISTICS

The feeding of low energy, high fiber diets to swine has been shown to reduce daily gain and carcass backfat and to increase carcass leanness (Bohman et al., 1955). Similar changes in gains and carcass leanness were observed with limit feeding of conventional, high energy diets (Baird et al., 1971). The reduced energy content of high fiber diets, not fiber level per se, has been shown to be responsible for decreased gain and increased carcass leanness. Baird further observed similar gains by and carcass measurements for full-fed and limit-fed pigs when the limit-fed diet was adjusted to give energy intake equal to that provided by the full-fed diets.

Research conducted by Drewry (1981) suggests that pigs fed lower energy-high fiber diets grew more slowly than pigs fed normal energy-normal fiber diets. Daily gains by pigs fed 8.8% fiber diets were approximately 9% lower and these pigs were approximately 14 days older at market than the pigs fed 3.9% fiber diets.

Considerable research has shown that higher levels of protein than normally used will improve growth, feed conversion and carcass leanness (Davey and Morgan, 1969). Since the pig can tolerate rather wide ranges in energy and protein levels, a non-critical relationship between protein and energy levels has been shown to exist by Baird (1957). Seerley et al. (1964) showed more efficient use of protein on high energy diets, but less efficient protein conversion on high protein diets.

Baird et al. (1975) reported that levels of crude fiber had no effect on growth rate provided energy density was adequate. The low fiber diets produced leaner carcasses than the high fiber diets, which may be partially due to added fats in the high fiber diets to equate energy levels.

Crude protein level did not significantly increase growth rate when fed in diets of equal energy. High protein diets generally significantly improved carcass leanness and resulted in significantly higher cooler shrinkage.

The two most common sources of fiber for swine rations are alfalfa meal and oats. Hogs receiving the higher levels of alfalfa meal consumed less feed daily and required more feed per unit of gain according to Bohman et al. (1955). Decreased rate of gain due to feeding increased levels of alfalfa has been reported by many others including Merkel et al. (1958), Becker et al. (1956) who indicated a lower daily feed consumption on high alfalfa rations, whereas increased feed intake due to increased fiber content and to increased alfalfa levels was reported by Merkel et al. (1958).

Heitman and Meyer (1959) reported that rate of gain, feed consumption and gain per unit of feed consumed were reduced by increased levels of alfalfa meal ($P<0.01$). Using gains adjusted to equal feed consumption, it was calculated that the average replacement value of one pound of the alfalfa meal used in this experiment was 0.28 pound of concentrate.

Many investigations have demonstrated that the fibrous nature of oats render them inferior to corn as an ingredient in swine diets. However, Carroll et al. (1937) reported results of an extensive study and concluded that oats could be fed to growing-finishing swine to the extent of nearly one-half the ration for 60 and 70 pound pigs without appreciably affecting growth rate, although feed required per pound of gain increased slightly as the percentage of oats increased. He also suggested that any method of preparation that made the hulls less noticeable increased palatability of oats for pigs.

Robinson (1939) found that ground oats had a feed value of approximately 79% that of corn when fed as the only grain in drylot, and 82% when fed as one-fourth of the grain in the ration on pasture.

Crampton and Bell (1946) reported that a fine grind was more advantageous than a medium or coarse grind because the physical identity of the hull was more completely destroyed and the product was more acceptable to the pig. Oats in present day, high energy rations would presumably show a different effect than in earlier rations. Further, the quality of oats, in general, has also changed

and varieties currently produced may differ nutritionally from those of several years ago.

Jensen et al. (1959) reported pigs in drylot had gains and feed per pound of gain, respectively, of 1.77, 3.67; 1.55, 4.20; 1.38, 4.44; and 1.26, 4.77 for rations containing 0, 29, 60 and 95% oats. In a second experiment using a different source of oats, growth and feed efficiency were decreased markedly on the two higher levels but not on the 29% oats rations on drylot. On pasture, however, reductions in performance for all oats rations were similar. With weanling pigs, neither 8.16 nor 32% oats in the rations enhanced growth rate and/or feed efficiency.

Calculated total digestible nutrient (TDN) values of the rations decreased as the percent of oats increased. Variations in performance on the diets containing different levels of oats appear to reflect the TDN value of the ration and the total TDN intake. They also report that replacing corn with oats in a corn-soybean oil meal type ration can be expected in general to reduce growth rate and feed efficiency, the degree of reduction being largely determined by the percent hull of the oat and percent oats in the ration.

Hochstetler et al. (1959) studied growing-fattening pigs fed a series of rations containing 0, 20 and 40% oats; 0, 20 and 40% wheat bran; and 0, 10 and 20% alfalfa meal. There were no significant differences in feedlot performance or carcass characteristics between pigs fed rations containing 0, 20 and 40% oats. There was a

non-significant decrease in rate of gain and backfat thickness as alfalfa meal was increased in the ration. There was a significant decrease in rate of gain, feed efficiency, dressing percentage and percent of fat trim in pigs fed a ration containing 40% wheat bran. This was accompanied by a similar increase in lean and primal cuts (carcass basis).

CHAPTER III

EXPERIMENTAL PROCEDURE

1. MANAGEMENT

A total of 480 feeder pigs were used for two trials in 1983 at the Plateau Experiment Station in Crossville. Each trial involved 240 feeder pigs with Trial I conducted from January until May and Trial II lasting from June until November. All pigs were purchased from Tennessee feeder pig sales in Cookeville. As many of the pigs as possible were purchased from the 40-49 pound weight group for uniformity.

The grades and types of pigs within grades were determined by Claude Harris, a Marketing Specialist with the Tennessee Department of Agriculture. Type within grade was based on the following characteristics: Type 3 was a large framed, late maturing pig with a moderate degree of muscling; Type 2 was a medium framed, average maturing pig with an average degree of muscling, and Type 1 was a small framed, early maturing pig with thin muscling.

The number of pigs by USDA grade for each trial are presented in Table 1.

TABLE 1. Pigs by U.S.D.A. Grade

Grade	No. of Body Types	No. Pens of Pigs	Total No. Pigs
1	3	15	90
2	3	15	90
3	2	10	60

All pigs were identified with plastic allflex tags upon selection at the sale site. A tagging procedure utilizing different colors and numbers allowed for easy identification of each grade and body type.

The pigs were randomly allotted to pens after their arrival at the experiment station. Two of the five pens within each type were located on the short side of the barn (16 total pens) and three of the five pens within each type were located on the long side of the barn (24 total pens).

All treatments (ration-antibiotic-wormer combinations) were available to each pig upon allotment. Pigs from each trial were treated for lice and mange 7 days after arrival and again 14 days later (day 21) with Lindane spray. A second application was then administered to the pigs at 8 weeks (day 56).

There were several differences between the two trials with respect to dietary treatment and rations which were stratified across grade-body type combinations. All pigs in Trial I were placed on one of four treatments upon allotment. A description of each treatment/ration is given in Table 2.

These treatments/rations were in effect for 21 consecutive days except the water medication which was withdrawn after 7 days and the wormer which was withdrawn after 3 days. Neomix was used as the water medication. From day 3 until day 42 (6 weeks) the pigs received no wormer and from day 7 until the end of the experiment the pigs received no further water medication. All pigs in Trial I

TABLE 2. Treatment/Rations for Feeder Pigs in Trial I

Ingredient	B	BA	BO	BTF	Post 21 Days
No. 2 Yellow Corn	788.0	707.5	690.5	788.0	784.0
Soybean Oil Meal (44%)	134.5	115.0	132.0	134.5	178.5
Dehydrated Alfalfa Meal (17%)	-	100.0	-	-	-
Oats	-	-	100.0	-	-
Hog Premix 100[a]	75.0	75.0	75.0	75.0	-
Swine Premix 50[b]	-	-	-	-	35.0
ASP - 250	2.5	2.5	2.5	2.5	-
Neoterramycin	-	-	-	-	2.5
Levamisole wormer administered by	water	water	water	feed	
Total Pounds	1000	1000	1000	1000	1000

[a]Provided a guaranteed analysis per pound of 25% (min) crude protein, 2% (min) crude fat, 2% (max) crude fiber, 70,000 USP units of Vitamin A, 12,000 USP units of Vitamin D3, 185 USP units of Vitamin E, 50 mg of riboflavin, 100 mg of pantothenic acid, 250 mg of niacin, 200 mcg of Vitamin B 12 supplement, 3,875 mg of choline, 20 mg of Vitamin K, .12% manganese, .22% iron, .03% copper, .0015% cobalt, .005% iodine, .15% zinc, 12% (min) calcium, 6.5% (min) phosphorus, .0002% selenium and 10% salt.

[b]Provided a gruaranteed analysis per pound of 140,000 USP units of Vitamin A, 25,000 USP units of Vitamin D 3, 375 USP units of Vitamin E, 100 mg of riboflavin, 200 mg of pantothenic acid, 500 mg of niacin, 400 mcg of Vitamin B 12 supplement, 7,750 mg of choline, 40 mg of Vitamin K, .24% manganese, .45% iron, .06% copper, .003% cobalt, .01% iodine, .30% zinc, 20% (min) calcium, 8.50% (min) phosphorus, .0004% selenium and 10% (min) salt.

were wormed again at 42 days (6 weeks) with Piperazine in the drinking water. The ration after the 21-day treatment period was the basic corn--soybean oil meal--premix ration as described in Table 2.

The rations for pigs in Trial II were available to the pigs upon allotment. ASP-250 was used in three of the rations and Neoterramycin in two rations during the first 21 days. Levamisole wormer was administered by water and withdrawn after three days. From day 3 until day 42 (6 weeks) the pigs received no wormer but were then again wormed with levamisole in the drinking water. Neomix water medication was used during the first seven days and then withdrawn. The treatments/rations for Trial II were 16% crude protein, corn and soybean oil meal based and are included in Table 3.

All pigs in both trials remained in the finishing barn and were fed until reaching an approximate market weight of 230 pounds. There were a number of health monitoring procedures carried out by the experiment leaders and the Department of Rural Practice of the College of Veterinary Medicine. One pig per pen was bled and the sera stored to evaluate for pseudorabies virus (PRV) and other viral infections. In Trial II, the same pigs were rebled at the end of the trial to repeat the appropriate hematologic, serologic and parasitologic examinations. Fecal samples were collected initially and at 42 days in both trials to evaluate for the presence of parasites. Visual examinations were made periodically to check for the presence of external parasites. There was a postmortem performed on all dead pigs and a member of the Department of Rural Practice was present

TABLE 3. Treatment/Rations for Feeder Pigs in Trial II

Ingredient	B	BA-CU	BA-K	BN	BN-CU
No. 2 Yellow Corn	802.0	801.0	789.0	795.5	794.5
Soybean Oil Meal (48%)	120.5	120.5	123.5	122.0	122.0
Hog Premix 100[a]	75.0	75.0	75.0	75.0	75.0
ASP-250	2.5	2.5	2.5	-	-
Neoterramycin	-	-	-	7.5	7.5
250 ppm Copper Sulfate	-	1.0	-	-	1.0
Potassium Acetate	-	-	10.0	-	-
Total Pounds	1000	1000	1000	1000	1000

[a]Provided a guaranteed analysis per pound of 25% (min) crude protein, 2% (min) crude fat, 2% (max) crude fiber, 70,000 USP units of Vitamin A, 12,000 USP units of Vitamin D3, 185 USP units of Vitamin E, 50 mg of riboflavin, 100 mg of pantothenic acid, 250 mg of niacin, 200 mcg of Vitamin B12 supplement, 3,875 mg of choline, 20 mg of Vitamin K, .12% manganese, .22% iron, .03% copper, .0015% cobalt, .005% iodine, .15% zinc, 12% (min) calcium, 6.5% (min) phosphorus, .0002% selenium, and 10% salt.

to inspect hogs at slaughter for evaluation of snouts, lungs, liver, etc. to determine organisms and disease present and the effectiveness of the health management program.

Individual pig weights for all pigs of each trial were taken upon allotment and at 1, 3, 6 and 10 weeks after beginning the experiment and prior to loading for market. Feed efficiency and average daily gain were calculated for each weight period and at the end of the experiments.

Upon arrival at the experiment station, all pigs of both trials were photographed in a calibrated cage having 2 inch by 4 inch squares. Measurements taken from the photographs included shoulder to tailhead, elbow to flank, floor to elbow, height as measured on a perpendicular line through the flank to the top of the animal and a girth measurement (Figure 1). These measurements were to help determine body length, body height, and to visually and permanently verify body type. The same procedure and measurements were carried out at the end of each trial to make comparisons of each pigs feeder grade and present market grade.

Pigs were sonorayed for backfat thickness at the beginning and at 6 and 10 weeks and prior to loading for market in both trials.

One pig per pen (40 per trial) was slaughtered and carcass data collected on each pig through the University of Tennessee meats laboratory. The remaining pigs were slaughtered and carcass data collected on these pigs through Lay's Packing Company. Carcass length, backfat thickness and degree of muscling were the measurements taken at slaughter.

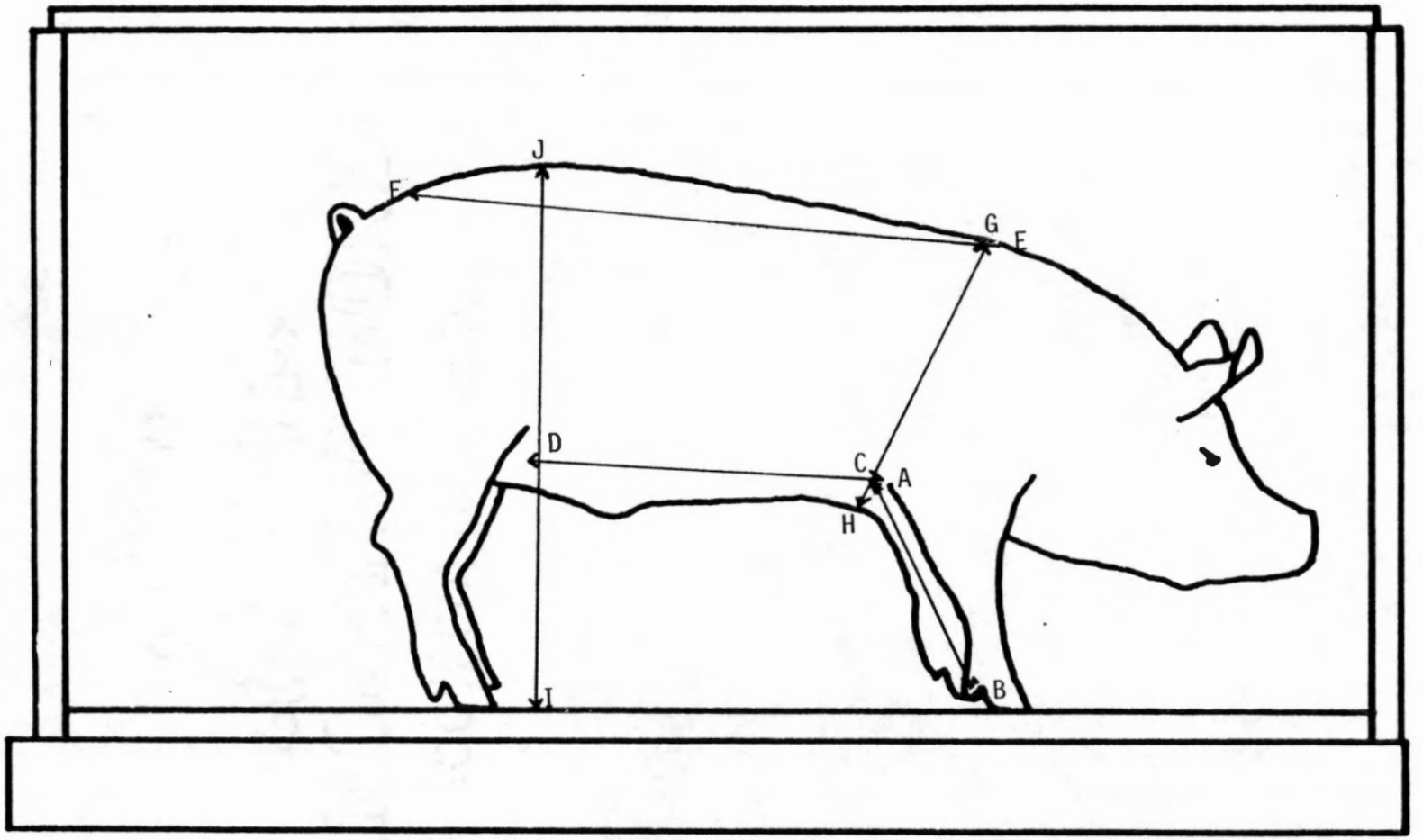


FIGURE 1. Measurements taken from photograph. A-B, elbow to floor; C-D, elbow to flank; E-F, point of shoulder to tailhead, G-H girth depth; I-J, height as measured on a perpendicular line to the top of the hog through the flank.

All sonoray backfat measurements, taken during the trial and those at slaughter, were an average of the standard three locations taken on each pig, over the first rib, the last rib, and the last lumbar vertebra.

2. FACILITIES

The feeding barn is a double wing structure designed specifically for feeder pig research. It has 40 pens, 16 on one wing and 24 on the other, that are 10 feet long and 6 feet wide with 4 feet of 4 inch concrete slats at the back of the pens. The slat openings were one-half inch in each pen. Automatic nipple waterers were located on the right lower portion of each pen. Two separate water lines were available to each pen for use of water medication and anthelmintic. A two-holed, 250 pound capacity Smidley feeder was placed in each pen near the front left side of the pen.

The front portion of the pens was solid concrete with a 2% slope toward the rear concrete slats. The panels between the pens were 1 inch by 5 inch oak boards on the front half of the pens with 3/4 inch diameter galvanized metal pipe used on the back half of each pen. These partitions were 36 inches high. A 3 inch opening existed between the pipe partition which allowed air to circulate. An overhead sprinkler system was available for use during the warmer months to prevent the pigs from becoming overheated. The system was designed to run for 10 minutes every hour whenever the temperature exceeded 75 degrees Fahrenheit.

During weigh periods, the pigs were taken to a 4 feet wide by 5 feet long scale area to be weighed and then returned to their respective pens. There was a 3 feet 10 inch wide aisle separating pens on each side of the barn to allow easy access to the pens for feeding and for movement of the pigs. There were five one horsepower Daytona radial blade wheel blowers to remove gases from the pit areas and release them outside of the facility. The outer wall area was 60% curtained with screens to help keep birds out. During warmer times, the curtains could be lowered or raised to adjust for temperature. They also played an important role in natural ventilation for the facility.

The barn was heated by four propane gas heaters, two located on each side. These were of particular value during the winter months in trying to maintain a temperature to prevent water lines from freezing.

Two calibrated cages were designed during the two trials to photograph the pigs for measurements when brought into the facility and when they reached their destined market weight. The first one designed was to photograph the feeder pig. This cage was 2 feet off the floor and 5 feet long with a partition to divide the crate into 2 and 3 foot sections. The cage was 1 foot wide and 2 feet high with the rear portion being solid plywood which was painted yellow for photographic purposes. The front portion of the cage was covered with 2 inch by 4 inch wire for the ease of taking measurements from the photograph.

The other crate was designed to photograph the pigs after reaching their respective market weights. It was 3½ inches off the floor and 5 feet 6 inches long. The cage was 18 inches wide and 36 inches high. It also had a solid plywood rear partition which was painted orange for photographs. The front of the cage had the 2 inch by 4 inch wire to aid in taking the measurements from the photograph (Figure 2).

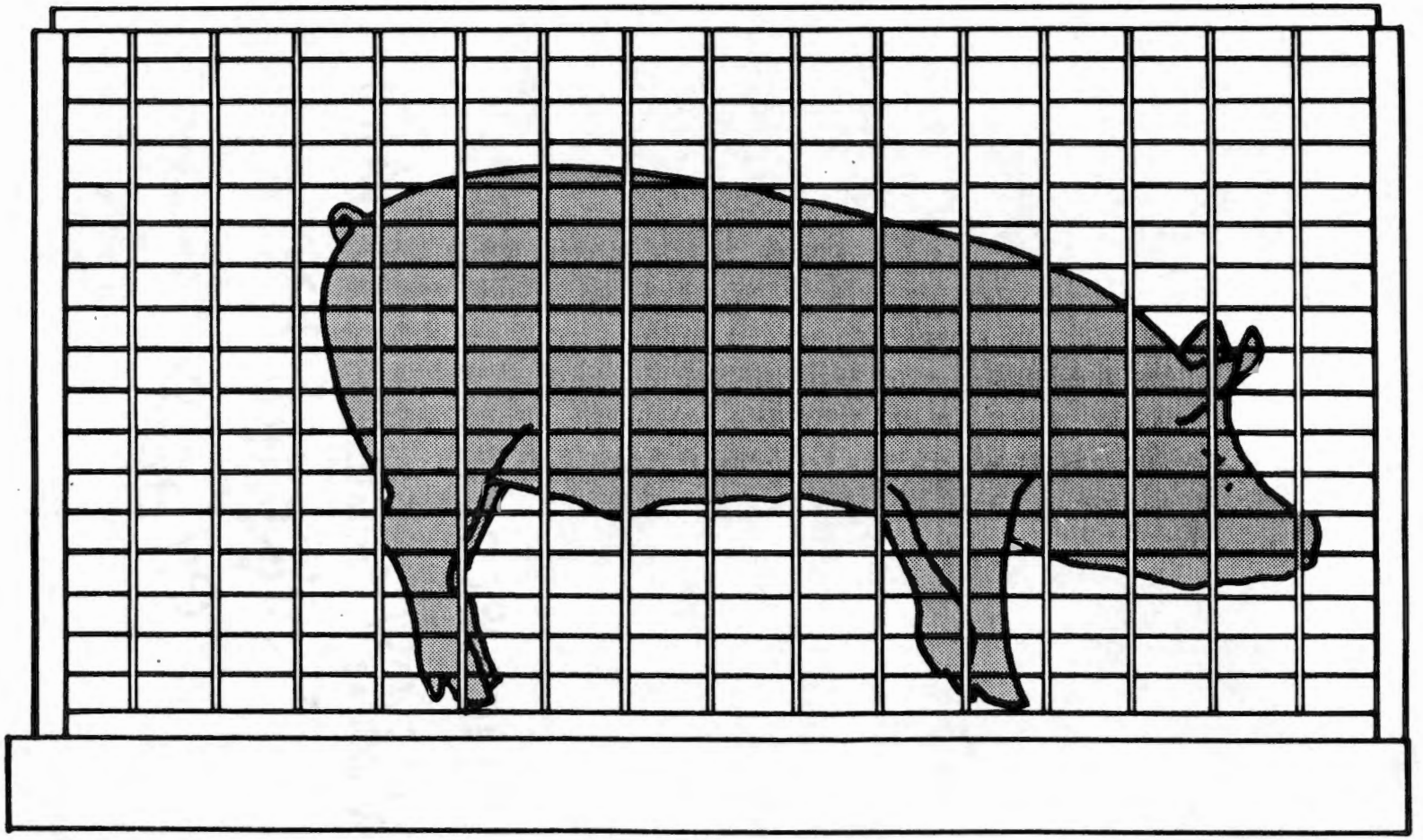


FIGURE 2. Calibrated cage for taking measurements of pigs.

CHAPTER IV

EFFECT OF THE RECEIVING DIET ON THE PERFORMANCE OF PURCHASED FEEDER PIGS

1. SUMMARY

During 1983, two trials were conducted to study the effects of receiving diets on the performance of purchased feeder pigs. Each trial involved 240 feeder pigs with Trial I performed from January until May and Trial II lasting from June until November. All pigs were purchased from Tennessee feeder pig sales in Cookeville.

These trials were superimposed over a grade-body type combination study and diets were randomly assigned to pens in each trial. The four diets in Trial I consisted of a corn-soybean meal basal diet (B) + levamisole in the water (B) + alfalfa meal + levamisole in the water (BA); (B) + oats + levamisole in the water (BO) and (B) + levamisole in the feed (BTF). There were five diets in Trial II that consisted of a 16% crude protein fortified corn-soybean meal basal diet (B) + ASP-250; (B) + ASP-250 + 250 ppm copper as copper sulfate (BA-Cu); (B) + ASP-250 + potassium as potassium acetate (BA-K); (B) + neoterramycin (BN) and (B) + neoterramycin + 250 ppm copper as copper sulfate (BN-Cu). In each trial, after three weeks, all pigs received the basal diet with neoterramycin until two weeks before marketing at which time the antibiotic was withdrawn.

In Trial I, 240 crossbred pigs of mixed sex were used with an average initial weight of 40.7 pounds. The addition of oats to the basal diet increased (P<.05) average daily gain (ADG, lbs/day) after 7 days but this difference was not maintained at 21 days nor at the end of the experiment. Average daily gain at the three periods for B, BA, BO and BTF were .96, .68, 1.20, 1.04; .88, .85, .96, .98; 1.51, 1.54, 1.58, 1.53, respectively. Feed per pound of gain (F/G) after 7 days, 21 days and at the end of the experiment for B, BA, BO and BTF were 2.56, 2.63, 1.82, 2.49; 2.61, 2.71, 2.63, 2.40; 3.25, 3.30, 3.35, 3.24, respectively. Pigs receiving the BA diet required more (P<.05) feed per pound of gain at day 21 but this difference was not observed at day 7 or at the end of the experiment. The addition of oats to the receiving diet tended to improve average daily gain when compared to the other diets but similar trends were not evident when comparing feed efficiency.

Trial II also involved 240 crossbred pigs of mixed sex that had an initial weight of 41.3 pounds. The addition of potassium to the basal diet reduced (P<.05) average daily gain (ADG, lbs/day) after 7 and 21 days of the experiment but this difference was not maintained to the end of the experiment. Average daily gain at the three periods for B, BA-Cu, BA-K, BN and BN-Cu were .73, .82, .66, .78, .83; .60, .64, .56, .65, .66; .74, .76, .74, .75, .76, respectively. Feed per pound of gain after 7 days, 21 days and at the end of the experiment for B, BA-Cu, BA-K, BN and BN-Cu were 1.54, 1.46, 1.57, 1.43, 1.48; 2.46, 2.25, 2.66, 2.33, 2.30; 3.21,

3.09, 3.21, 3.20, 3.26, respectively. Pigs receiving the BA-K ration required more (P<.05) feed per pound of gain (F/G) than did pigs receiving BA-Cu and BN-Cu during the first 21 days but this difference was not maintained to the end of the experiment. The addition of 250 ppm Cu to the receiving diet tended to improve ADG and F/G when compared to diets containing either ASP-250 Neoterramycin during the first 21 days of the experiment but not over the entire experiment. Performance of purchased feeder pigs was not affected by source of antibiotic in this experiment.

2. INTRODUCTION

The production of feeder pigs has become a major swine enterprise in Tennessee. In 1980, over 3.2 million feeder pigs were sold through graded feeder pig sales; Tennessee alone sold 855,000 graded feeder pigs. Managers and producers of feeder pigs are not only concerned with grades but with the nutrition involved during feeding periods.

The movement of feeder pigs through public markets exposes the pig to numerous diseases and other stresses (Hails, 1978). In addition, movement of pigs often involves mingling, thereby creating fighting and other social stresses. Sherritt et al. (1974) concluded that mixing of pigs, in conjunction with other stresses, adversely affected pig growth.

Fritschen and Moser (1979), however, demonstrated that limit feeding a diet containing whole oats for 10 days delayed the onset and severity of diarrhea for purchased feeder pigs.

Antibiotics effectively improve growth rate and feed efficiency in starter diets, but the response decreases as the pigs get larger (Allee, 1979). Wilson et al. (1981) reported the addition of Aureo SP-250 to the diet significantly ($P<.01$) increased daily gains where pigs had the greater floor space of 2.5 vs 1.5 square feet per pig.

Hochstetler et al. (1959) discovered a non-significant decrease in rate of gain and backfat thickness as alfalfa meal was increased in the ration.

Dunne and Leman (1975) reported the addition of copper and potassium to diets to relieve stress conditions in feeder pigs. They also reported that copper sulfate is effective as a growth promotant with an antibiotic-like effect.

The objectives of this study were to evaluate the effect of oats, alfalfa meal, antibiotics, potassium and copper in the receiving diets on the performance of purchased feeder pigs.

3. EXPERIMENTAL PROCEDURES

A total of 480 pigs were used in two trials in 1983. Two hundred and forty pigs were started in January and 240 in June. All pigs were purchased from Tennessee feeder pig sales in Cookeville and transported directly to the feeder pig research facility located on the Plateau Experiment Station in Crossville, Tennessee. All pigs were identified with plastic all-flex tags upon selection at the sale site and were randomly allotted to pens after their arrival at the experiment station within a grade-type classification.

All treatments (ration-antibiotic-wormer combinations) were available to each pig upon allotment. There were several differences between the two trials with respect to dietary treatments and rations which were stratified across grade-body type combinations. A description of the rations is presented in Tables 2 and 3, pages 24 and 26. These treatments/rations were in effect for 21 consecutive days after which they received a basal diet with Neoterramycin until 2 weeks before marketing at which time the antibiotic was withdrawn.

All pigs in both trials remained in the finishing barn and were fed until reaching an approximate market weight of 230 pounds.

The facility is a curtained-walled, double wing structure designed specifically for feeder pig research. There is a total of forty 6 foot by 10 foot pens with 4 feet of slats, pit ventilation, nipple waterers and two-hole, 250 pound capacity Smidley feeder for each pen. An overhead sprinkler system was available for use during the warmer months and propane gas heaters were available as heat sources during the colder winter months to prevent water lines from freezing.

Individual pig weights for all pigs of each trial were taken upon allotment and at 1, 3, 6 and 10 weeks after beginning the experiment and prior to loading for market. Pen feed consumption was recorded at each weigh period.

Feed efficiency and average daily gain were calculated for each weigh period and at the end of the experiments.

Statistical Analysis

The data for each trial were analyzed by the Statistical Analysis System (SAS). Average daily gains, feed efficiency and mean weights were analyzed by an analysis of variance or general linear models (GLM) and by Duncan's multiple range test which reports the means of the main effects and their statistical difference. The Duncan's test was the analysis used for reporting of the results of mean ration effects.

Preliminary analysis of the data revealed no significant nutritional treatment by grade-body type interactions indicating that the effect of nutritional treatment was similar for all grade and body types. Therefore, the following model was used to analyze the data on a pen basis (average daily gains, feed efficiency, mean weights) for the effect of treatment.

$Y_{ij} = u = t_i + e_{ij}$

Where Y_{ij} is the effect of average daily gain, feed efficiency and mean weights,

u is Mu, the overall mean,

t_i is the treatment effect,

e_{ij} represents the random error associated with each observation.

4. RESULTS AND DISCUSSION

In Trial I, there was a significant difference ($P<.05$) at week 1 between the basal diet with oats and ASP-250 and the basal

diet with alfalfa meal and ASP-250. The pigs on the oats ration gained 1.20 pounds per day versus .68 pounds per day for pigs on the alfalfa meal diet. Average daily gains (ADG) and feed efficiency (FE) for week 1 for pigs on the rations are presented in Table 4. Although no differences occurred with respect to feed efficiency, the basal diet ration with oats and ASP-250 required the least feed per pound of gain at week 1.

At day 21, the basal diet with levamisole in the feed (BTF) produced the highest average daily gain but this was not different ($P>.05$) from the basal diet with alfalfa meal (BA).

There were no significant differences on final average daily gain and feed efficiency among treatments in Trial I. The pigs fed the basal diet with oats and ASP-250 (BO) gained faster and those receiving the basal diet with levamisole in the feed (BTF) required less feed per pound of gain.

Many investigations have demonstrated that the fibrous nature of oats render them inferior to corn as an ingredient in swine diets. However, Carroll et al. (1937) reported results of an extensive study and concluded that oats could be fed to growing-finishing swine to the extent of nearly one-half the ration for 60 and 70 pound pigs without appreciably affecting growth rate. The feed required per pound of gain increased slightly as the percentage of oats increased. Similar results are found in this experiment where pigs fed the BO ration had the highest final average daily gain but required the most feed per pound of gain. The BO ration was also significantly different

TABLE 4. Average Daily Gain and Feed Efficiency by Treatment at Week 1 (Trial I)

ADG (lbs/day)	Treatment	FE	Treatment
1.20[a]	BO	1.82	BO
1.04[a,b]	BTF	2.49	BTF
.96[a,b]	B	2.56	B
.68[b]	BA	2.63	BA

[a,b]Means in the same column superscripted with different letters are significantly different (P<.05).

($P<.05$) at week 1 with pigs receiving this ration having an average daily gain of 1.20 lbs/day.

Research by Brumm et al. (1982) suggested that pigs fed a 16% crude protein receiving diet for 13 days containing 20% oats had a poorer ($P<.01$) feed efficiency than those fed a corn-soy basal diet or a diet containing 20% oats plus 5% lard. At the termination of the two trials, there were no differences in rate of gain or feed to gain between three receiving diets.

On the other hand, pigs receiving the BA ration had significantly lower ($P<.05$) average daily gains at week 1. Pigs receiving this ration also had the lowest average daily gain at day 21 and the highest feed efficiencies at week 1 and day 21 but this was not significantly different. These results are in agreement with Bohman et al. (1955) who reported that hogs receiving alfalfa meal in their rations consumed less feed daily and required more feed per unit of gain. Heitman and Meyer (1959) reported that rate of gain, feed consumption and gain per unit of feed consumed were reduced by increased levels of alfalfa meal ($P<.01$).

In Trial II, the basal diet with Neoterramycin and copper sulfate (BN-Cu) and the basal diet with ASP-250 and copper sulfate (BA-Cu) had significantly higher ($P<.05$) average daily gains than the basal diet with ASP-250 and potassium at week 1. Conversely, there were no differences with regard to feed efficiency at week 1. No significant differences were noted for feed efficiency during this period but pigs receiving the basal diet with Neoterramycin required less feed per pound of gain.

Results at day 21 were similar with pigs receiving the BN-Cu and BN rations producing significantly higher ($P<.05$) gains than those receiving BA-K. Pigs receiving the BA-Cu ration required significantly less ($P<.05$) feed per pound of gain than pigs on the B or BA-K rations.

There were no differences between treatments with regard to final average daily gain and feed efficiency. However, it is interesting to point out that the pigs receiving the BN-Cu ration had the highest average daily gain and required less feed per pound of gain than those on the other rations in Trial II. The overall means for average daily gain and feed efficiency in each trial by ration are presented in Tables 5 and 6.

The results of Trial II tend to support Dunne and Leman (1975) who reported that copper sulfate is an effective growth promotant when used at a level of 125-250 ppm. The copper rations used in Trial II contained 250 ppm and pigs receiving this diet had a tendency to perform better throughout Trial II. Performance of purchased feeder pigs was not affected by source of antibiotic in this experiment.

Conclusion

The results of this study strengthen the hypothesis that adding oats to a receiving diet for feeder pigs is beneficial. Not only does the addition of oats to a ration delay the onset of scours but no ill effects on gain were observed either. However, when using alfalfa meal in the receiving diet, we observed both reduced gains and feed efficiencies.

TABLE 5. Final Average Daily Gain and Feed Efficiency by Treatment (Trial I)

ADG (lbs/day)	Treatment	FE	Treatment
1.58	BO	3.24	BTF
1.54	BA	3.25	B
1.53	BTF	3.30	BA
1.51	B	3.35	BO

TABLE 6. Final Average Daily Gain and Feed Efficiency by Treatment (Trial II)

ADG (lbs/day)	Treatment	FE	Treatment
1.67	BA-Cu	3.09	BA-Cu
1.67	BN-Cu	3.20	BN
1.66	BN	3.21	BA-K
1.64	B	3.21	B
1.62	BA-K	3.26	BN-Cu

Copper sulfate at a level of 250 ppm was suitable for receiving diets also. Its effectiveness as a stress reducer and growth promotant are supported by this research. However, the addition of potassium acetate to diets did not improve either average daily gain or feed efficiency based on the results of this research. Although no differences were observed with respect to antibiotic, it was noted that either ASP-250 or Neoterramycin served as good growth promotants that aid in disease prevention.

CHAPTER V

EFFECT OF FEEDER PIG GRADE AND BODY TYPE ON PERFORMANCE, GROWTH PARAMETERS AND CARCASS CHARACTERISTICS

1. SUMMARY

A study was conducted to evaluate performance, growth parameters and carcass characteristics of purchased feeder pigs graded U.S. No. 1, 2 and 3. A total of 480 pigs were involved in two trials in 1983. Each trial utilized 240 pigs with Trial I conducted from January until May and Trial II lasting from June to November. Ninety U.S. No. 1, 90 U.S. No. 2 and 60 U.S. No. 3 pigs were purchased in each trial. The No. 1 and No. 2 grades were divided into three body types: Type 3--longer, taller pigs; Type 2--average for the grade; and Type 1--shorter, more compact pigs. The U.S. No. 3 grade pigs were divided into only the Type 2 and Type 1 categories. Thus, there were eight grade-type combinations. Pigs within grade and type were randomly assigned to pens throughout the building and fed as near as possible to an average pen weight of 230 pounds.

Measurements from a life size projection of each pig initially and at slaughter were obtained and carcass measurements were made at slaughter. Performance of pigs in both trials by grade and by body type were similar. Average daily gain ranged from 1.58 pounds per day for the grade 2-type 3 pigs to 1.48 pounds per day in the grade 1-type 1 pigs. The same trends were noted in feed efficiency

with grade 2-type 3 pigs being more efficient and grade 3-type 1 being least efficient. The tendency for both traits was for the longer pigs to have the best performance.

A discriminant analysis was applied to build an index that would separate the grades based on the measurements taken as feeder pigs for this study. Of the 179 pigs grading U.S. No. 1 at the sale, 106 actually had the measurements of the U.S. No. 1 grade based on the measurements taken. Ninety-two of 177 U.S. No. 2 pigs had measurements associated with the No. 2 grade, and 38 of 113 U.S. No. 3 pigs had the measurements associated with that grade. Based on the pigs in this study and the body measurements taken, height of the pig from the floor on a perpendicular line through the flank to the top of the back accounted for 23% of the variability in their grade which was more than any other measurement recorded.

There were no differences in weight between grade-body type combinations at the beginning or at the end of the study. At the beginning, type 1 pigs tended to have more backfat than type 2 or type 3. Also at the beginning, grade 3 type 1 pigs had significantly ($P<.05$) higher backfat measurements than any other grade-body combination in the study. At the end of the study, the tendency toward more backfat was more within grade regardless of type with the hogs having the most backfat being the U.S. No. 3. The grade 3 type 1 pigs and grade 2 type 1 pigs were significantly ($P<.05$) fatter at slaughter than all the other grade-body type combinations. The average carcass backfat for all hogs was 1.45 inches.

The obvious tendency in carcass length was for the type 3 pigs to be the longest, type 2 pigs the next longest and type 1 pigs the shortest. Grade 2 type 3 and grade 1 type 3 pigs were significantly ($P<.05$) longer at slaughter than the other grade-body type combinations. All grade 1 pigs had a significantly ($P<.05$) higher muscling score than the grade 2 type 1 and grade 3 type 1 pigs.

In Trial I, the percentage of lean cuts and loin eye area were obtained on a small sample of pigs. There was no difference with regard to percentage of lean cuts, however, grade 1 type 3 had significantly ($P<.05$) larger loin eye areas than grade 3 type 1 pigs.

2. INTRODUCTION

Approximately one-fifth of the market hogs slaughtered in the United States come from units finishing purchased feeder pigs (VanArsdall, 1978). In 1980, over 3.2 million feeder pigs were sold through graded feeder pig sales; Tennessee alone sold 855,000 graded feeder pigs. The purpose of the grading system is to segregate the pigs into like groups that will facilitate marketing. Current U.S.D.A. grades are intended to evaluate the logical slaughter potential and the thriftiness of the pig, with slaughter potential corresponding to the expected U.S.D.A. slaughter grade.

A limited amount of research has been performed with regard to the performance of graded feeder pigs. Thrasher et al. (1968) reported that as high as 48% of his U.S. No. 2 pigs and 35% of his U.S. No. 3 pigs graded U.S. No. 1 at slaughter. Tracy (1972)

concluded that many Tennessee feeder pigs are being placed in feeder grades below their potential slaughter grade and genetic potential at feeder pig sales due to presale management and nutrition.

There is some concern by the swine industry that current U.S.D.A. feeder pig grades do not sort feeder pigs into proper slaughter potentials. Proper identification is intended to help feeder pig producers receive maximum value for their product and also help swine feeders be more efficient in their feeding, management, and marketing programs. With these points in mind, a cooperative study between the University of Tennessee and the Tennessee Department of Agriculture was undertaken to evaluate feeder pig grades and body types. The objectives of this study were to measure the performance, feed efficiency, growth parameters and carcass characteristics of purchased feeder pigs graded U.S. No. 1, U.S. No. 2 and U.S. No. 3.

3. EXPERIMENTAL PROCEDURES

A total of 480 feeder pigs were used in two trials in 1983 at the Plateau Experiment Station in Crossville. Each trial involved 240 feeder pigs with Trial I performed from January until May and Trial II lasting from June until November. All pigs were purchased from Tennessee feeder pig sales in Cookeville. As many of the pigs as possible were purchased from the 40-49 pound weight group for uniformity.

The grades and types of pigs within grades were determined by Claude Harris, a marketing specialist with the Tennessee Department

of Agriculture. Type within grade was based on the following characteristics: type 3 was a large framed, late maturing pig with a moderate degree of muscling; type 2 was a medium framed, average maturing pig with an average degree of muscling, and type 1 was a small framed, early maturing pig with thin muscling.

The pigs were randomly allotted to pens after their arrival at the experiment station. All treatments (ration-antibiotic-wormer combinations) were available to each pig upon allotment. A description of each treatment/ration is presented in Tables 2 and 3, pages 24 and 26.

All pigs in both trials remained in the finishing barn and were fed until reaching an approximate market weight of 230 pounds. Individual pig weights for all pigs of each trial were taken upon allotment and at 1, 3, 6 and 10 weeks from the beginning of the experiment and prior to loading for market. Pen feed consumption was recorded at each weigh period. Feed efficiency and average daily gain were calculated for each weigh period and at the end of the experiment.

Upon arrival at the experiment station, all pigs of both trials were photographed in a calibrated cage having 2 inch by 4 inch squares in a grid formation. Measurements taken from the photograph included shoulder to tailhead, elbow to flank, floor to elbow, height as measured on a perpendicular line through the flank to the top of the animal and a girth measurement. These measurements were to help determine body length, body height and to visually and permanently

verify body type. The same procedure and measurements were carried out at the end of each trial to make comparisons of each pig's feeder grade and final market grade.

Pigs were sonorayed for backfat thickness at the beginning and at 6 and 10 weeks and prior to loading for market in both trials.

One pig per pen (40 per trial) was slaughtered and carcass data collected on each pig through the University of Tennessee meats laboratory. Only in Trial I were the additional data of percent lean cuts and loin eye area collected. The remaining pigs in each trial were slaughtered and carcass data collected on these pigs through Lay's Packing Company. Carcass length, backfat thickness, degree of muscling and grade were the measurements taken at slaughter.

All backfat measurements, sonoray and at slaughter, were an average of the standard three locations taken on each pig, over the first rib, the last rib and the last lumbar vertebra.

The research facility is a curtained walled, double wing structure designed specifically for feeder pig research. There is a total of forty 6 foot by 10 foot pens with 4 feet of slats, pit ventilation, nipple waterers and a two-hole, 250 pound capacity Smidley feeder for each pen. An overhead sprinkler system was available for use during the warmer months and propane gas heaters were available as heat sources during the colder winter months to prevent water lines from freezing.

Statistical Analysis

The data from this experiment were analyzed by the Statistical Analysis System (SAS). Average daily gains, feed efficiency and mean weights were analyzed by an analysis of variance or general linear models (GLM) and by Duncan's multiple range test which reports the means of the main effects and their statistical difference. The Duncan's test was the analysis used for reporting the results of the models shown below. The carcass, backfat and growth parameter data were also analyzed in the same manner.

The following model was used to analyze the data on a pen basis for the effect of grade and body type on average daily gain, feed efficiency and mean weights.

$$Yij = u + gi + eij$$

Where Yij is the effect of average daily gain, feed efficiency and mean weights,

u is Mu, the overall mean,

gi is the grade-body type effect,

eij represents the random error associated with each observation.

The same model was used to analyze the effect of grade and body type on carcass length, muscling and backfat thickness.

Where Yij is the effect of carcass length, muscling score and backfat thickness,

u is Mu, the overall mean,

gi is the grade-body type effect,

eij represents the random error associated with each observation.

The same model was also used to determine the effect of grade and body type on the live measurements taken on each pig initially and at the end of the trials.

Where Yij is the effect of shoulder to tailhead, elbow to flank, floor to elbow, highest point on the pig through the flank and girth measurements,

u is Mu, the overall mean,

gi is the grade-body type effect,

eij represents the random error associated with each observation.

4. RESULTS AND DISCUSSION

The average starting weight, final weight and days on test ranked by grade and body type are presented in Tables 7, 8, and 9. There were some differences with regard to starting weight between trials, however, this was mainly due to the lack of availability of pigs within weight group when purchased. When the two trials were combined, there was no difference in average starting weight, final weight or the number of days on test.

There were no significant differences with regard to average daily gain and feed efficiency when the trials were combined. This is in agreement with Thrasher et al. (1968) who indicated there was no difference in the rates of gain or feed efficiency of pigs graded as feeders. However, there were some differences between trials. Results from Trial I indicated that grade 2 type 3 and grade 1 type 2 pigs had a higher ($P<.05$) average daily gain than all other

TABLE 7. Average Starting Weight, Final Weight and Days on Test Ranked by Grade and Type (Trial I)

Weight I (lbs)	Grade-Type	Final Weight (lbs)	Grade-Type	Days on Test	Grade-Type
42.7[a]	1-3	228.9	3-1	112.1	1-2
42.4[a,b]	1-2	228.0	2-3	112.0	1-3
42.1[a,b]	2-2	225.3	1-1	116.0	2-2
41.7[b]	2-3	223.2	2-2	116.7	2-3
41.6[b]	3-1	222.9	1-2	117.6	1-1
39.9[c]	2-1	221.9	2-1	120.4	3-1
39.9[c]	1-1	221.7	3-2	123.2	3-2
36.0[d]	3-2	219.5	1-3	126.0	2-1

[a,b,c,d]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 8. Average Starting Weight, Final Weight and Days on Test Ranked by Grade and Type (Trial II)

Weight I (lbs)	Grade-Type	Final Weight (lbs)	Grade-Type	Days on Test	Grade-Type
42.8[a]	1-3	239.1	2-1	110.1	2-2
42.5[a,b]	3-2	232.9	1-1	111.2	3-2
42.2[b,c]	2-3	230.9	2-3	112.0	1-1
41.8[c]	1-2	229.9	2-2	112.1	1-2
40.8[d]	3-1	227.5	3-2	113.0	3-1
40.7[d]	1-1	226.5	1-2	116.8	2-3
40.7[d]	2-2	224.8	1-3	122.5	2-1
40.0[e]	2-1	224.4	3-1	126.0	1-3

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 9. Average Starting Weight, Final Weight and Days on Test Ranked by Grade and Type (Trial I and Trial II)

Weight (lbs)	Grade-Type	Final Weight (lbs)	Grade-Type	Days on Test	Grade-Type
41.8	1-3	233.4	2-1	112.1	1-2
41.7	1-2	229.4	3-2	113.1	2-2
41.5	2-2	228.6	2-3	114.8	1-1
40.5	3-1	225.9	1-1	116.7	3-1
40.4	1-1	225.9	2-2	116.7	2-3
39.9	2-3	224.4	1-2	117.2	3-2
39.8	3-2	223.3	3-1	119.0	1-3
39.6	2-1	221.6	1-3	124.3	2-1

grade and body type combinations. The differences among grade and body types were not as evident with regard to feed efficiency, however, grade 2 type 3 had the lowest feed efficiency of all pigs tested. The grade 2 type 3 pigs were longer, taller than all others as indicated by measurements taken which would make them likely candidates to out perform the other grade and body type combinations. The expectation of grade 1 pigs being the larger was not observed but the grade 3 pigs were the shorter, more compact pigs according to the measurements taken.

Results from Trial II were similar in that grade 2 type 3 and grade 2 type 2 pigs had the highest average daily gain. The grade 1 type 3 pigs required the least feed per pound of gain as would be expected. In Trial II, the grade 3 type 1 pigs had the lowest average daily gain and the highest feed efficiency among the grade-body type combination which would be expected.

The results for both trials and for the trials combined are presented in Tables 10, 11 and 12. When reviewing the results of the trials combined, there are some interesting observations to point out. The grade 2 type 3 pigs had the highest average daily gain and required the least feed per pound of gain. As stated earlier, their growth ability is indicated in the various measurements taken of the pigs by photograph and at slaughter (Tables 13 and 14). The grade 3 pigs ranked in the middle of the groups with regard to average daily gain indicating that with proper management and nutrition these pigs are capable of performing well. However,

TABLE 10. Average Daily Gain and Feed Efficiency Ranked by Grade and Type of Feeder Pig (Trial I)

ADG (lbs/day)	Grade-Type	FE	Grade-Type
1.62[a]	2-3	3.19[a]	2-3
1.59[a,b]	1-2	3.22[a]	3-2
1.56[b,c]	3-1	3.23[a,b]	2-2
1.56[b,c]	1-1	3.24[a,b]	3-1
1.53[c,d]	2-2	3.25[a,b]	1-2
1.50[d]	3-2	3.31[b,c]	1-3
1.48[d]	1-3	3.34[c]	1-1
1.40[e]	2-1	3.37[c]	2-1

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 11. Average Daily Gain and Feed Efficiency Ranked by Grade and Type of Feeder Pig (Trial II)

ADG (lbs/day)	Grade-Type	FE	Grade-Type
1.72[a]	2-3	3.01[a]	1-3
1.72[a]	2-2	3.06[a,b]	1-2
1.70[a,b]	1-2	3.06[a,b]	3-2
1.67[a,b,c]	2-1	3.12[b]	2-2
1.67[b,c]	1-3	3.15[b]	2-3
1.64[c]	3-2	3.26[c]	1-1
1.57[d]	1-1	3.29[c]	2-1
1.45[e]	3-1	3.60[d]	3-1

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 12. Average Daily Gain and Feed Efficiency Ranked by Grade and Type of Feeder Pig (Trial I and Trial II)

ADG (lbs/day)	Grade-Type	FE	Grade-Type
1.58	2-3	3.22	2-3
1.56	1-2	3.24	1-2
1.54	1-3	3.26	3-2
1.54	3-2	3.27	1-3
1.54	3-1	3.28	1-1
1.52	2-2	3.29	2-1
1.48	2-1	3.30	2-2
1.48	1-1	3.31	3-1

TABLE 13. Height Through the Flank and Length From Shoulder to Tail of Feeder Pigs by Grade and Type

Flank Ht. (inches)	G-T	Shoulder to Tail (inches)	G-T
16.83[a]	2-3	17.55[a]	2-3
16.78[a]	3-2	17.51[a]	3-2
16.61[a]	1-3	17.46[a]	1-3
16.22[b]	1-2	17.32[a]	2-2
16.14[b,c]	2-2	17.22[a,b]	1-2
15.91[c,d]	2-1	16.91[b,c]	2-1
15.75[d]	3-1	16.71[c]	1-1
15.66[d]	1-1	16.53[c]	3-1

[a,b,c,d]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 14. Front Leg Length and Girth Depth of Feeder Pigs by Grade and Type

Leg Length (inches)	G-T	Girth Depth (inch)	G-T
8.58[a]	2-3	7.80[a]	3-2
8.53[a]	1-3	7.67[a,b]	1-1
8.36[a,b]	3-2	7.66[a,b]	2-2
8.29[a,b]	2-1	7.65[a,b]	3-1
8.20[a,b,c,]	2-2	7.63[a,b]	2-1
8.11[b,c]	1-2	7.62[a,b]	1-2
8.07[b,c]	1-1	7.61[a,b]	2-3
7.83[c]	3-1	7.53[b]	1-3

[a,b,c]Means in the same column superscripted with different letters are significantly different (P<.05).

as would be expected, the grade 3 type 1 pigs required the most feed per pound of gain of all grades and body types.

The length measurements taken by photograph at marketing were compared with the actual carcass length and the results are very similar. Both the photograph and carcass measurements (Table 15) indicated that grade 2 type 3 pigs were the longest and the grade 3 type 1 pigs the shortest, as would be expected.

Grade 2 type 3 pigs initially had the greatest height as measured from the floor through the flank to the top of their back. Also at the beginning, they had the longer of both length measurements taken, putting grade 2 type 3 pigs in a rather unusual position throughout the trials. Their long, lean look initially which may have expressed thin muscling did not portray a true picture. They were better performers as well as having the higher length and height measurements at the conclusion of the trials.

The grade 3 type 2 pigs exhibited the most girth depth initially with the grade 3 type 1 pigs having the most girth depth at the end of the experiment. This could be a deceiving characteristic of grade 3 pigs as depth may be viewed as shorter, more compact pigs by graders. This may partially explain why grade 3 pigs have a tendency to grade higher at slaughter along with management, nutrition, etc. The rank of feeder pigs based on body measurements at the beginning of the study is presented in Table 16.

An index for measurements of pigs within these trials was developed to predict feeder pig grade based on the actual measurements

TABLE 15. Length Measurements Taken by Photograph and at Slaughter Ranked by Grade and Type (Trial I and Trial II)

Photograph					
Shoulder to Tail (inches)	Grade-Type	Elbow Flank (inches)	Grade-Type	Carcass Length (inches)	Grade-Type
30.8[a]	2-3	13.7[a]	2-3	32.4[a]	2-3
30.6[a]	1-3	13.5[a,b]	1-3	32.1[a,b]	1-3
30.5[a,b]	3-2	13.3[b,c]	3-2	31.8[b,c]	2-2
30.3[a,b,c]	2-2	13.2[b,c,c]	1-2	31.8[b,c]	3-2
30.0[b,c,d]	2-1	13.1[c,d]	2-2	31.5[c,d]	1-2
29.8[c,d]	1-2	13.0[d,e]	2-1	31.2[d]	1-1
29.8[c,d]	1-1	13.0[d,e]	1-1	31.2[d]	2-1
29.3[d]	3-1	12.7[e]	3-1	30.4[e]	3-1

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 16. Rank of Feeder Pigs by Grade and Type Based on Body Measurements

Flank Height (Inches)	Shoulder to Tail Length (Inches)	Weight (lbs)	Girth Depth (Inches)	Leg Length (Inches)
2-3[a]	2-3[a]	1-3	3-2[a]	2-3[a]
3-2[a]	3-2[a]	1-2	1-1[a,b]	1-3[a]
1-3[a]	1-3[a]	2-2	2-2[a,b]	3-2[a,b]
1-2[b]	2-2[a]	3-1	3-1[a,b]	2-1[a,b]
2-2[b,c]	1-2[a,b]	1-1	2-1[a,b]	2-2[a,b,c]
2-1[c,d]	2-1[b,c]	2-3	1-2[a,b]	1-2[b,c]
3-1[d]	1-1[c]	3-2	2-3[a,b]	1-1[b,c]
1-1[d]	3-1[c]	2-1	1-3[b]	3-1[c]

[a,b,c,d]Means in the same column superscripted with different letters are significantly different ($P<.05$).

taken as feeder pigs. This information is presented in Table 17. The majority of pigs fell within their respective grades with the exception of the grade 3 pigs which tended to grade upward considerably. This strongly supports the work of Tracy (1972) who reported that only 5% of the pigs in his study graded a U.S. No. 4 which is comparable to U.S. No. 3 in this study.

Results were very similar also for the predicted feeder pig grade versus the actual slaughter grade as presented in Table 18. The major difference again is among the grade 3 pigs which have actually graded higher at slaughter. This continues to support the work of Thrasher et al. (1965, 1968) and Tracy (1972).

The actual feeder pig grade versus the predicted grade-body type based on live measurements is presented in Table 19.

Carcass length by grade and body type was similar for both trials and for the trials combined as presented in Table 20. The combined trials indicated that the grade 2 type 3 pigs were the longest at slaughter and that the grade 3 type 1 pigs were the shortest. The grade 2 type 3 pigs appear longer and leaner as pigs but were probably placed in grade 2 because of muscling. As would be expected, the grade 3 type 1 pigs should be the shorter, more compact pigs at slaughter as well.

In Trial I, grade 1 type 3 pigs had the largest loin eye areas and grade 3 type 1 pigs had the smaller loins as would be expected. There were no differences with regard to the percentage of lean cuts with grade 1 type 3 pigs having the higher percentage and grade 3

TABLE 17. A Comparison of Actual Feeder Pig Grade Vs Predicted Live Measurements (Trial I and Trial II)

Feeder Pig Grade-Type	Predicted Grade-Type Based on Live Measurements								
	1-3	1-2	1-1	2-3	2-2	2-1	3-2	3-1	Total
1-3	11	7	5	7	3	0	3	0	36
1-2	8	23	15	17	16	3	4	3	89
1-1	5	4	28	2	8	2	1	4	54
2-3	4	2	1	26	4	3	5	0	45
2-2	3	11	15	9	26	5	6	3	78
2-1	4	9	10	8	5	6	2	10	54
3-2	11	5	2	11	6	2	18	4	59
3-1	2	7	12	6	7	4	1	14	53
TOTAL	48	58	88	86	75	25	40	38	468
PERCENT	10.26	14.53	18.80	18.38	16.03	5.34	8.55	8.12	100.00

TABLE 18. Comparison of Predicted Feeder Pig Grade (PFG) and Actual Slaughter Grade (SG)

Actual Feeder Pig Grade	Percent of Pigs with Predicted Feeder Grade (PFG) and Actual Slaughter Grade (SG)		
	PFG - SG	PFG - SG	PFG - SG
1	59 - 53	32 - 38	8 - 9
2	33 - 43	52 - 47	15 - 20
3	35 - 37	32 - 48	34 - 15

TABLE 19. Actual Grade Vs Predicted Grade Based on Measurements Taken as Feeder Pigs

Actual Feeder Pig Grade	Predicted Feeder Pig Grade		
	1	2	3
1 (N = 179)	106 (59%)	58 (32%)	15 (8%)
2 (N = 177)	59 (33%)	92 (52%)	26 (15%)
3 (N = 113)	39 (35%)	39 (32%)	38 (34%)

TABLE 20. Carcass Length Ranked by Grade and Type

Trial I		Trial II		Trials Combined	
Carcass Length (Inches)	Grade-Type	Carcass Length (Inches)	Grade-Type	Carcass Length (Inches)	Grade-Type
32.1[a]	2-3	32.6[a]	2-3	32.4[a]	2-3
31.9[a,b]	1-3	32.4[a,b]	3-2	32.1[a,b]	1-3
31.6[a,b,c]	1-2	32.3[a,b]	1-3	31.8[b,c]	2-2
31.5[b,c]	2-2	32.1[a,b]	2-2	31.8[b,c]	3-2
31.3[c,d]	1-1	31.7[b,c]	2-1	31.5[c,d]	1-2
31.2[c,d]	3-1	31.4[c,d]	1-2	31.2[d]	1-1
30.7[d,e]	2-1	31.1[d,e]	1-1	31.2[d]	2-1
30.3[e]	3-2	30.7[e]	3-1	30.4[e]	3-1

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

type 2 pigs have the lowest percentage of lean cuts. There should not be a great deal of confidence placed on these measurements due to the low number of pigs sampled.

There were some differences with regard to final backfat measurements taken at slaughter. As one would expect, grade 3 type 1 pigs had the most backfat at slaughter and grade 1 type 3 had the least. These results are similar to those reported by Barth et al. (1970), U.S.D.A. (1971) and Tracy (1972) which described lean-type or U.S. No. 1 pigs as being the leanest at slaughter with fat-type or U.S. No. 3 pigs having the most fat at slaughter.

It is also important to point out that 17 pigs in Trial I and 23 pigs in Trial II could not be reflected in the carcass data. A small portion of these pigs died while on test and an even larger number were lost during the slaughter process at the packing house.

The actual feeder pig grade versus the carcass grade for both trials and the trials combined are presented in Table 21. The overall effect suggests that type 1 pigs of all grades have the greatest tendency to grade lower at slaughter as should be expected. The majority of pigs fall into their respective grade at slaughter with the exception of grade 3 pigs. For both trials combined 85% of the grade 3 pigs graded either grade 1 or 2 at slaughter. This once again suggests that many of these pigs may be mismanaged prior to feeder pig sales. The genetic potential of many herds is not recognized due to poor management. The incorporation of balanced rations, antibiotics and controlling both internal and external

TABLE 21. Feeder Pig Grade Vs Carcass Grade

Trial I				Trial II				Trials Combined			
Feeder Pig Grade	Percent of Pigs Grading at Slaughter 1	2	3	Feeder Pig Grade	Percent of Pigs Grading at Slaughter 1	2	3	Feeder Pig Grade	Percent of Pigs Grading at Slaughter 1	2	3
1 (N=86)	71	27	2	1 (N=86)	35	49	16	1 (N=172)	53	38	9
2 (N=82)	45	45	10	2 (N=83)	40	49	11	2 (N=165)	43	47	10
3 (N=55)	45	44	11	3 (N=48)	29	52	19	3 (N-103)	37	48	15

parasites can greatly increase the potential and profits in many herds. This is also supported by the work of Thrasher et al. (1965, 1968) and Tracy (1972) who also reported that pigs in lower grades with proper management and nutrition have a tendency to grade higher at slaughter.

Conclusion

The results of this study indicated that many Tennessee feeder pigs are being placed in feeder grades below their potential at feeder pig sales due to poor pre-sale management and nutrition. The response of the U.S. No. 3 pigs demonstrated that Tennessee producers have an opportunity, through improved management and nutritional practices, to have a greater percentage of their pigs graded higher as feeders.

Many feeders are graded in groups and many of the measurements used in this study may be used to classify pigs according to grade and body types.

A grading system utilizing body types within grades might more accurately classify pigs to adjust for differences with regard to performance, measurements and carcass data. On the other hand, a grading system that classifies pigs only by body type could very easily be beneficial to graders as well. Many of the data within this research reflects a difference primarily between body types regardless of grade.

CHAPTER IV

DIFFERENCES IN BACKFAT AMONG GRADE AND BODY TYPE COMBINATIONS OF PURCHASED FEEDER PIGS

1. SUMMARY

Two trials were conducted in 1983 to evaluate the differences in backfat of purchased feeder pigs graded U.S. No. 1, 2, and 3. Each trial involved 240 feeder pigs with Trial I occurring from January until May and Trial II lasting from June until November. All pigs were purchased from Tennessee feeder pig sales.

Ninety U.S. No. 1, 90 U.S. No. 2 and 60 U.S. No. 3 pigs were purchased in each trial. The No. 1 and No. 2 grades were divided into three body types: type 3--longer, taller pigs; type 2--average for the grade; and type 1--shorter, more compact pigs. The U.S. No. 3 grade pigs were divided into only the type 2 and type 1 categories. Thus, there were eight grade-body type combinations. Five pens of six pigs per pen of each grade and type were randomly assigned to pens throughout the building and fed to an average pen weight of 230 pounds.

Ultrasonic backfat measurements of pigs were taken initially and at 6 weeks, 10 weeks and prior to loading for market. Carcass backfat was also obtained at slaughter.

There were no differences in weight between grade-body type combinations at the beginning or at the end of the study.

At the beginning, type 1 pigs tended to have more backfat than type 2 or 3. At the end, the tendency toward more backfat was more within grade regardless of type with hogs having the most backfat being the No. 3 pigs which would be expected. It should also be noted that the average carcass backfat for all hogs was 1.45 inches.

One of the more interesting points about backfat in this study is the beginning and final backfat of the grade 2 type 3 pigs. They were the leaner pigs at the beginning and were nearly the leanest at the end. Also, the grade 3 type 1 pigs had the most backfat both times. On the other hand, grade 1 type 3 pigs were at or near the bottom in ranking both times.

There were some differences that existed between each individual trial. In Trial I, grade 1 type 1 pigs had the most backfat initially but by the end of the trial, the grade 3 type 1 pigs as would be expected had accumulated the most backfat.

The grade 3 type 1 pigs were the fattest initially in Trial II and continued the trend throughout the experiment. At the end of Trial II, all type 1 pigs were significantly ($P<.05$) fatter than all other pigs on test.

A simple correlation of final ultrasonic measurement versus actual carcass backfat reflects a .84 correlation in Trial I and a .69 correlation in Trial II. The correlation for both trials was .74. The correlations for fat by ultrasound and carcass were the average measurements of three sites, over the shoulder, the last rib and the last lumbar vertebra. The coefficient of determination

or r^2 for both trials based on the simple correlation indicates that backfat accounts for 55% of the variability among the grades.

The one site with the highest correlation was over the last lumbar vertebra (.78). This would account for 61% of the variability among grades due to backfat over the last lumbar vertebra and indicates that using one highly correlated site may be more realistic than using all three sites. The least desirable single site measurement ultrasonically was over the shoulder.

2. INTRODUCTION

The purpose of the feeder pig grading system is to segregate the pigs into like groups that will facilitate marketing. Current U.S.D.A. grades are intended to evaluate the logical slaughter potential and the thriftiness of the pigs, with slaughter potential corresponding to the expected U.S.D.A. slaughter grade.

One of the major factors in evaluating the slaughter of swine is the amount of backfat the animal possesses. Currently, trends toward more backfat are being observed by the industry.

Tracy (1972) reported that the average backfat probe for the three feeder grade groups, U.S. No. 1-2, U.S. No. 3 and U.S. No. 4 were 1.30, 1.33, and 1.53 inches, respectively. The leaner, U.S. No. 1 through U.S. No. 3 pigs were more efficient feed converters than the U.S. No. 4 pigs having more backfat.

There is some concern by swine industry people that current U.S.D.A. feeder pig grades do not sort feeder pigs into proper

slaughter potentials. Proper identification is intended to help feeder pig producers receive maximum value for their product and also help swine feeders be more efficient in their feeding, management and marketing programs.

Little research is available with regard to backfat measurements between grades of feeder pigs. With these points in mind, the objectives of this study were to measure ultrasonically at 1, 6, 10 weeks and prior to loading for market and at slaughter the backfat thickness of purchased feeder pigs of different grades over the shoulder, the last rib and the last lumbar vertebra.

3. EXPERIMENTAL PROCEDURES

Two trials were conducted in 1983 at the Plateau Experiment Station in Crossville involving a total of 480 feeder pigs. Each trial involved 240 feeder pigs with Trial I occurring from January until May and Trial II lasting from June until November. All pigs were purchased from Tennessee feeder pig sales in Cookeville. As many of the pigs as possible were purchased from the 40-49 pound weight group for uniformity.

The grades and types of pigs within grades were determined by Claude Harris, marketing specialist with the Tennessee Department of Agriculture. Type within grade was based on the following characteristics: type 3 was a large framed, late maturing pig with a moderate degree of muscling; type 2 was a medium framed, average maturing pig with an average degree of muscling and type 1 was a small framed, early maturing pig with thin muscling.

Six pigs within grade-type combination were randomly allotted to each of five pens after their arrival at the experiment station. All treatments (ration-antibiotic-wormer combinations) were available to each pig upon allotment. A description of each treatment/ration is presented in Tables 2 and 3, pages 24 and 26.

All pigs in both trials remained in the finishing barn and were fed until reaching an approximate market weight of 230 pounds. Individual pig weights for all pigs of each trial were taken upon allotment and at 1, 3, 6 and 10 weeks from the beginning and prior to loading for market. Pen feed consumption was recorded at each weigh period. Feed efficiency and average daily gain were calculated for each weigh period and at the end of the experiment.

Pigs were sonorayed for backfat thickness at the beginning and at 6 and 10 weeks and prior to loading for market in both trials.

One pig per pen (40 per trial) was slaughtered and carcass data collected on each pig through the University of Tennessee meats laboratory. Only in Trial I were the additional data of percent lean cuts and loin eye area collected. The remaining pigs in each trial were slaughtered and carcass data collected on these pigs through Lay's Packing Company. Carcass length, backfat thickness and degree of muscling were the measurements taken at slaughter.

All backfat measurements, sonoray and at slaughter, were an average of the standard three locations taken on each pig, over the first rib, the last rib and the last lumbar vertebra.

The research facility is a curtain walled, double wing structure designed specifically for feeder pig research. There is

a total of forty 6 foot by 10 foot pens with 4 feet of slats, pit ventilation, nipple waterers and a two-hole, 250 pound capacity Smidley feeder for each pen. An overhead sprinkler system was available for use during the warmer months and propane gas heaters were available as heat sources during the colder winter months to prevent water lines from freezing.

Statistical Analysis

The data from this experiment were analyzed by the Statistical Analysis System (SAS). The backfat measurements taken ultrasonically and at slaughter were analyzed by an analysis of variance or general linear models (GLM) and by Duncan's multiple range test which reports the means of the main effects and their statistical difference. The Duncan's test was the analysis used for reporting the results of the model shown below.

A preliminary analysis revealed no significant difference by trial. A simple correlation procedure was employed to correlate the sonoray measurements with the actual carcass measurements.

The following model was used to analyze the data consisting of various backfat measurements.

$Yij = u + gi + eij$

Where Yij is the effect of the initial, 6 week, 10 week and final ultrasonic backfat measurement,

u is Mu, the overall mean,

gi is the grade-body type effect,

eij represents the random error associated with each observation.

4. RESULTS AND DISCUSSION

The mean sonoray measurements by grades and body type of feeder pig for both trials are presented in Tables 22 and 23. Initially the grade 3 type 1 pigs had significantly ($P<.05$) more backfat than all other grade and body type combinations as would be expected with grade 2 type 3 pigs being the leanest. Grade 3 type 1 pigs had the most backfat at market weight with grade 1 type 3 pigs having significantly less ($P<.05$) fat than all other grade and body type combinations. These results would be expected as grade 3 type 1 pigs are fatter pigs with the grade 1 type 3 expected as the leaner type pigs. These results are comparable to those of Tracy (1972) who reported that the average backfat probe for U.S. No. 1-2 pigs being less than that of U.S. No. 3 and U.S. No. 4 graded feeder pigs.

A simple correlation procedure revealed a difference in correlation of .84 versus .69 between the ultrasonic measurement and actual carcass measurement of Trial I and Trial II, respectively. This wide range of difference could be largely attributable to the difference in operators of the sonoray between the two trials. The correlation for the trials combined was .74.

The coefficient of determination or r^2 for both trials based on the simple correlation indicates that backfat accounted for 55% of the variability among the grades.

Correlations within site revealed that the last lumbar vertebra had the highest correlation between the three sites measured

TABLE 22. Sonoray Measurements by Grade and Type of Feeder Pig (Trial I)

Initial (Inches)	Grade-Type	6 Weeks (Inches)	Grade-Type	10 Weeks (Inches)	Grade-Type	Final (Inches)	Grade-Type
.18	1-1	.37	1-1	.79[a]	3-2	1.07	3-1
.17	1-2	.36	2-2	.78[a]	2-1	1.02	2-1
.17	2-1	.35	2-1	.77[a]	3-1	.99	3-2
.17	3-2	.35	1-2	.76[a]	1-2	.93	1-1
.17	2-2	.35	3-1	.75[a,b]	1-1	.92	2-3
.17	3-1	.34	3-2	.73[a,b]	2-2	.91	2-2
.16	2-3	.33	1-3	.70[a,b]	2-3	.90	1-2
.16	1-3	.31	2-3	.63[b]	1-3	.77	1-3

[a,b]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE 23. Sonoray Measurements by Grade and Type of Feeder Pig (Trial II)

Initial (Inches)	Grade-Type	6 Weeks (Inches)	Grade-Type	10 Weeks (Inches)	Grade-Type	Final (Inches)	Grade-Type
.21[a]	3-1	.40[a]	2-2	.81[a]	3-1	1.14[a]	3-1
.17[b]	2-1	.39[a,b]	2-3	.79[a]	1-1	1.09[a,b]	1-1
.16[b]	1-3	.39[a,b,c]	2-1	.78[a]	1-2	1.03[b]	2-1
.16[b]	1-1	.39[a,b,c]	1-1	.78[a]	2-2	.94[c]	2-2
.16[b]	1-2	.38[a,b,c]	1-2	.77[a,b]	2-1	.92[c,d]	1-2
.16[b]	3-2	.37[a,b,c]	3-1	.75[a,b]	2-3	.91[c,d]	2-3
.15[b,c]	2-2	.36[b,c]	3-2	.73[a,b]	1-3	.88[c,d]	1-3
.14[c]	2-3	.35[c]	1-3	.69[b]	3-2	.84[d]	3-2

[a,b,c,d]Means in the same column superscripted with different letters are significantly different ($P<.05$).

(Table 24). This indicates that a single measurement over the last lumbar vertebra may be the most beneficial and accurate measurement taken by ultrasound when compared to the actual carcass data. The least desirable single site measurement ultrasonically was over the shoulder.

There were several differences throughout the study with regard to backfat thickness according to the location of the measurement. As would be expected, the shoulder measurement revealed the largest concentrations of fat deposit of the pigs. The results of these measurements are as one would expect and are presented in Table 25.

Grade 1 pigs had the most backfat initially over the shoulder but at the final ultrasonic measurement grade 3 pigs had significantly more ($P<.05$) fat than either grade 1 or 2 pigs. This was in agreement with the actual carcass measurement which revealed that grade 3 pigs had 2.01 inches of backfat over the shoulder.

Grade 3 pigs had significantly more ($P<.05$) fat initially over the last rib and maintained such a pattern, having the most fat (.83 inches) at the final ultrasonic measurement. Grade 3 pigs had more fat ($P<.05$) on the carcass measurement as would be expected.

Ultrasonic measurements over the last lumbar vertebra also revealed that grade 3 pigs had significantly more ($P<.05$) fat than either grade 1 or 2 pigs. Once again, this pattern was maintained until the final ultrasonic measurement which revealed grade 3 pigs had the most fat (.90 inches) and grade 1 had the least (.83 inches)

TABLE 24. Correlations Between Sonoray and Carcass Backfat Within Site

	Shoulder	Loin	Last Lumbar Vertebra
Trial I	.33	.62	.80
Trial II	.11	.38	.74
Trials Combined	.25	.56	.78

Correlation significance level - ($P<.01$).

TABLE 25. Backfat Measurements by Site and Feeder Pig Grade (Trials Combined)

	Sonoray*								Carcass*	
Site	Initial	Grade	6 Weeks	Grade	10 Weeks	Grade	Final	Grade	Final	Grade
Shoulder	.26[a]	1	.56	1	1.04	2	1.30[a]	3	2.01[a]	3
	.25[a,b]	3	.56	2	1.04	1	1.21[b]	2	1.96[a,b]	2
	.24[b]	2	.53	3	1.03	3	1.20[b]	1	1.90[b]	1
Loin	.14[a]	3	.25	2	.31	2	.83	3	1.26[a]	3
	.11[b]	2	.24	3	.31	3	.79	2	1.19[b]	2
	.11[b]	1	.24	1	.31	1	.79	1	1.15[b]	1
Lumbar Vertebra	.14[a]	3	.31	3	.65	3	.90[a]	3	1.32[a]	3
	.13[b]	2	.31	2	.63	2	.86[a,b]	2	1.25[b]	2
	.13[b]	1	.31	1	.62	1	.83[b]	1	1.21[b]	1

[a,b]Means in the same column superscripted with different letters are significantly different ($P<.05$).

*All backfat measurements are presented in inches.

as would be expected. Pigs in grade 3 also had significantly more ($P<.05$) fat according to carcass measurements with grade 1 having the least.

Conclusions

The trend toward more backfat is in line with other observations in the industry and should definitely be investigated further. This is in agreement with the National Hog Farmer (1983) which reported that two-thirds of all barrows tested in the 1983 National Barrow Show were disqualified for failing to meet the minimum standard of at least 4.75 square inches of loin eye area and for exceeding 1.30 inches of backfat at 230 pounds.

Grade 3 pigs, as would be expected, exhibited the most fat of all pigs. However, type 1 pigs which are the shorter, more compact pigs within each grade exhibited a tendency to express more fat as evident by these trials.

Many times pigs grade up at slaughter as the result of proper management and nutrition following their purchase. Most of the pigs that grade down at slaughter are probably a product of the grouping or packaging aspect that accompanies grading at feeder pig sales. There is, however, much more information that is needed to help improve the feeder pig grading system.

One method for improvement of grading procedures might be the inclusion of body types in the grading system to group pigs within grade. This would then allow pigs of type 1 origin to be

associated or expected as the fatter pigs within each grade. Once again, type alone could be used to classify pigs because type 1 pigs were the fattest, type 2 next fattest and type 3 were the leanest, regardless of grade. It is possible pigs could be sorted by backfat measurements which would essentially classify them by type according to the data presented. One major opposition to grading in this manner is that it ignores the other factors considered in grading such as muscling, length, etc.

CHAPTER VII

SUMMARY

Data were collected from two trials involving 480 pigs in 1983 at the Plateau Experiment Station in Crossville. Trial I occurred from January until May with Trial II lasting from June until November. The purpose of the trials was to determine the influence of grade and body type on the performance of purchased feeder pigs. All pigs were purchased from Tennessee feeder pig sales.

Ninety U.S. No. 1, 90 U.S. No. 2 and 60 U.S. No. 3 were purchased in each trial. The No. 1 and No. 2 grades were divided into three body types: type 3--longer, taller pigs; type 2--average for the grade; and type 1--shorter, more compact pigs. The U.S. No. 3 grade pigs were divided into only the type 2 and type 1 categories. Thus, there were eight grade-body type combinations. All pigs were randomly assigned to pens and fed to an average pen weight of 230 pounds.

There were four diets in Trial I which consisted of a corn-soybean meal basal diet combined with either alfalfa meal, oats, ASP-250 or neoterramycin, and either levamisole wormer in the feed or in the water. There were five diets in Trial II that consisted of a 16% crude protein fortified corn-soybean meal basal diet with either ASP-250, copper sulfate, potassium acetate or neoterramycin in combinations with the rations.

In Trial I, the addition of oats to the basal diet increased ($P<.05$) average daily gain after 7 days but this difference was not maintained at 21 days nor at the end of the experiment. Pigs receiving the diet containing alfalfa meal required more feed ($P<.05$) per pound of gain at day 21 but this difference was not observed at day 7 or at the end of the experiment. The addition of oats to the receiving diet tended to improve average daily gain when compared to the other diets but similar trends were not evident when comparing feed efficiency.

In Trial II, the addition of potassium to the basal diet reduced ($P<.05$) average daily gain (ADG) after 7 and 21 days of the experiment but this difference was not maintained to the end of the experiment. Pigs receiving the basal diet plus ASP-250 and potassium required more ($P<.05$) feed per pound of gain (F/G) than did pigs receiving copper during the first 21 days but this difference was not maintained to the end of the experiment. The addition of 250 ppm Cu to the receiving diet tended to improve ADG and F/G when compared to diets containing either ASP-250 or Neoterramycin during the first 21 days of the experiment but not over the entire experiment.

Measurements from a life size projection of each pig initially and at slaughter were obtained and carcass measurements were made at slaughter. Performance of pigs in both trials by grade and body type were similar. Average daily gain ranged from 1.58 pounds per day for the grade 2 type 3 pigs to 1.48 pounds per day for the grade 1 type 1 pigs. The same trends were noted in feed efficiency

with grade 2 type 3 pigs being most efficient and grade 3 type 1 pigs being least efficient.

The results of a discriminant analysis to index the pigs based on the measurements taken as feeders showed that 106 of 179 pigs grading U.S. No. 1 had the measurements of a No. 1 pig based on the measurements taken. Ninety-two of 177 U.S. No. 2 pigs had the measurements associated with the No. 2 grade, and 38 of 113 U.S. No. 3 pigs had the measurements associated with that grade. Based on the pigs in this study and the body measurements taken, height of the pig from the floor on a perpendicular line through the flank to the top of the animal accounted for 23% of the variability in their grade which was more than any other measurement recorded.

At the beginning, type 1 pigs tended to have more backfat than type 2 or type 3. Also at the beginning, grade 3 type 1 pigs had significantly higher ($P<.05$) backfat measurements than any other grade-body type combination in the study. The grade 3 type 1 pigs and the grade 2 type 1 pigs were significantly ($P<.05$) fatter than all other grade-body type combinations. The average backfat for all hogs was 1.45 inches.

Grade 2 type 3 and grade 1 type 3 pigs were significantly longer ($P<.05$) at slaughter than all the other grade-body type combinations. All grade 1 pigs had a significantly higher ($P<.05$) muscling score than the grade 2 type 1 and grade 3 type 1 pigs. There was no difference with regard to the percentage of lean cuts

in Trial I, however, grade 1 type 3 had significantly larger ($P<.05$) loin eye areas than grade 3 type 1 pigs.

Ultrasonic backfat measurements of pigs were taken initially and at 6 weeks, 10 weeks and prior to loading for market. At the beginning, type 1 pigs tended to have more backfat than type 2 or 3. At the end, the tendency toward more backfat was more within grade regardless of type.

The grade 2 type 3 pigs were the leaner pigs at the beginning and were nearly the leanest at the end of the experiment. Also, the grade 3 type 1 pigs had the most backfat both times and grade 1 type 3 pigs were nearly the leanest both times. At the end of the experiment in Trial II, all type 1 pigs were significantly ($P<.05$) fatter than all other pigs on the test.

A simple correlation of final ultrasonic measurement versus actual carcass backfat reflects a .84 correlation in Trial I and a .69 correlation in Trial II. The correlation for both trials was .74. The correlation for fat by ultrasound and carcass were the average measurement of three sites, over the shoulder, the last rib and at the last lumbar vertebra. The coefficient of determination or r^2 for both trials based on the simple correlation indicated that backfat accounted for 55% of the variability among the grades.

The one site with the highest correlation of sonoray measurements was over the last lumbar vertebra (.78). This would account for 61% of the variability among grades due to backfat over the last lumbar vertebra.

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APPENDIX

TABLE A-1. Average Daily Gain and Feed Efficiency by Treatment (Trial I)

Week 1				Day 21				Final			
ADG (lbs/day)	TRT	FE	TRT	ADG (lbs/day)	TRT	FE	TRT	ADG (lbs/day)	TRT	FE	TRT
1.20[a]	BO	1.82	BO	.98	BTF	2.40[a]	BTF	1.58	BO	3.24	BTF
1.04[a,b]	BTF	2.49	BTF	.96	BO	2.61[a,b]	B	1.54	BA	3.25	B
.96[a,b]	B	2.56	B	.88	B	2.63[a,b]	BO	1.53	BTF	3.30	BA
.68[b]	BA	2.63	BA	.85	BA	2.71[b]	BA	1.51	B	3.35	BO

[a,b]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-2. Average Daily Gain and Feed Efficiency by Treatment (Trial II)

Week 1				Day 21				Final			
ADG (lbs/day)	TRT	FE	TRT	ADG (lbs/day)	TRT	FE	TRT	ADG (lbs/day)	TRT	FE	TRT
1.83[a]	BN-Cu	1.43	BN	1.45[a]	BN-Cu	2.25[a]	BA-Cu	1.67	BA-Cu	3.09	BA-Cu
1.80[a]	BA-Cu	1.46	BA-Cu	1.43[a]	BN	2.30[a,b]	BN-Cu	1.67	BN-Cu	3.20	BN
1.72[a,b]	BN	1.48	BN-Cu	1.41[a,b]	BA-Cu	2.33[a,b]	BN	1.66	BN	3.21	BA-K
1.61[a,b]	B	1.54	B	1.31[a,b]	B	2.46[b]	B	1.64	B	3.21	B
1.46[b]	BA-K	1.57	BA-K	1.23[b]	BA-K	2.67[b]	BA-K	1.62	BA-K	3.26	BN-Cu

[a,b]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-3. Length Measurements Taken From Photograph and at Slaughter Ranked by Grade and Type (Trial I)

Shoulder To Tail (Inches)	Grade-Type	Elbow-Flank (Inches)	Grade-Type	Carcass Length (Inches)	Grade-Type
31.40[a]	2-3	13.77[a]	2-3	32.12[a]	2-3
30.87[a,b]	1-3	13.29[b]	1-3	31.93[a,b]	1-3
30.68[a,b,c]	2-1	13.03[b,c]	1-2	31.56[a,b,c]	1-2
30.66[a,b,c]	2-2	12.84[c,d]	1-1	31.52[b,c]	2-2
30.57[a,b,c]	1-2	12.83[c,d]	3-1	31.25[c,d]	1-1
30.33[b,c]	3-1	12.77[c,d]	2-2	31.18[c,d]	3-1
29.81[c,d]	1-1	12.58[c,d]	2-1	30.69[d,e]	2-1
29.24[d]	3-2	12.55[d]	3-2	30.26[e]	3-2

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-4. Length Measurements Taken From Photograph and at Slaughter Ranked by Grade and Type (Trial II)

Photograph					
Shoulder To Tail (Inches)	Grade-Type	Elbow-Flank (Inches)	Grade-Type	Carcass Length (Inches)	Grade-Type
30.71[a]	3-2	13.83[a]	3-2	32.60[a]	2-3
30.36[a,b]	2-3	13.77[a,b]	1-3	32.35[a,b]	3-2
30.34[a,b]	1-3	13.65[a,b]	2-3	32.31[a,b]	1-3
29.83[a,b,c]	2-2	13.55[a,b]	2-2	32.09[a,b]	2-2
29.75[b,c]	1-1	13.41[a,b,c]	2-1	31.73[b,c]	2-1
29.31[c]	3-1	13.35[b,c]	1-2	31.35[c,d]	1-2
29.13[c]	1-2	13.09[c,d]	1-1	31.09[d,e]	1-1
29.03[c]	2-1	12.76[d]	3-1	30.65[e]	3-1

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-5. Length Measurements Taken From Photograph and at Slaughter Ranked by Grade and Type (Trial I and Trial II)

Photograph					
Shoulder To Tail (Inches)	Grade-Type	Elbow-Flank (Inches)	Grade-Type	Carcass Length (Inches)	Grade-Type
30.75[a]	2-3	13.70[a]	2-3	32.39[a]	2-3
30.61[a]	1-3	13.53[a,b]	1-3	32.13[a,b]	1-3
30.52[a,b]	3-2	13.32[b,c]	3-2	31.81[b,c]	2-2
30.28[a,b,c]	2-2	13.21[b,c,d]	1-2	31.75[b,c]	3-2
29.97[b,c,d]	2-1	13.13[c,d]	2-2	31.45[c,d]	1-2
29.79[c,d]	1-2	12.96[d,e]	2-1	31.19[d]	1-1
29.78[c,d]	1-1	12.95[d,e]	1-1	31.71[d]	2-1
29.27[d]	3-1	12.66[e]	3-1	30.44[e]	3-1

[a,b,c,d,e]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-6. Loin Eye Area and Percentage of Lean Cuts by Grade and Type (Trial I)

Loin Eye Area (Square Inches)	Grade-Type	Percent Lean Cuts	Grade-Type
5.33[a]	1-3	72.70	1-2
4.65[a,b]	1-2	71.96	3-1
4.64[a,b]	3-2	71.10	2-3
4.50[a,b]	2-1	71.00	3-1
4.41[a,b]	1-1	70.70	2-2
4.38[a,b]	2-3	70.44	2-1
4.23[a,b]	2-2	68.40	1-1
4.14[b]	3-1	67.86	3-2

[a,b]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-7. Feeder Pig Grade Vs Carcass Grade (Trial I and Trial II

Feeder Pig Grade	Percent of Pigs Grading at Slaughter		
	1	2	3
1 (N = 172)	53%	38%	9%
2 (N = 165)	43%	47%	10%
3 (N = 103)	37%	48%	15%
TOTAL (N = 440)			

TABLE A-8. Feeder Pig Grade and Type Vs Carcass Grade (Trial I)

Feeder Pig Grade-Type	Percent of Pigs Grading at Slaughter		
	1	2	3
1-3 (N = 17)	71%	29%	0
1-2 (N = 40)	74%	25%	0
1-1 (N = 29)	66%	28%	6%
2-3 (N = 18)	33%	61%	6%
2-2 (N = 39)	51%	41%	8%
2-1 (N = 25)	44%	48%	8%
3-2 (N = 20)	50%	50%	0
3-1 (N = 35)	43%	40%	17%

TABLE A-9. Feeder Pig Grade and Type Vs Carcass Grade (Trial II)

Feeder Grade-Type	Percent of Pigs Grading at Slaughter		
	1	2	3
1-3 (N = 18)	50%	44%	6%
1-2 (N = 47)	36%	51%	13%
1-1 (N = 21)	19%	48%	33%
2-3 (N = 29)	34%	55%	11%
2-2 (N = 33)	49%	45%	6%
2-1 (N = 21)	33%	48%	19%
3-2 (N = 25)	52%	40%	8%
3-1 (N = 23)	4%	65%	31%

TABLE A-10. Feeder Pig Grade and Type Vs Carcass Grade (Trial I and Trial II)

Feeder Pig Grade-Type	Percent of Pigs Grading at Slaughter		
	1	2	3
1-3 (N = 35)	60%	37%	3%
1-2 (N = 87)	56%	38%	6%
1-1 (N = 50)	43%	38%	19%
2-3 (N = 47)	34%	58%	8%
2-2 (N = 72)	50%	43%	7%
2-1 (N = 46)	39%	48%	13%
3-2 (N = 45)	51%	45%	4%
3-1 (N = 58)	24%	53%	23%

TABLE A-11. Backfat Measurements by Site and Feeder Pig Grade (Trial I)

Site	Sonoray*								Carcass*	
	Initial	Grade	6 Weeks	Grade	10 Weeks	Grade	Final	Grade	Final	Grade
Shoulder	.28[a]	1	.54	1	1.03	3	1.35[a]	3	1.98[a]	3
	.27[a,b]	2	.52	2	1.01	2	1.25[b]	2	1.92[a]	2
	.25[b]	3	.52	3	.99	1	1.21[b]	1	1.83[b]	1
Loin	.12	1	.23	3	.32	1	.81[a]	3	1.19[a]	3
	.11	2	.22	2	.32	2	.73[b]	2	1.11[b]	2
	.11	3	.22	1	.31	3	.66[c]	1	1.02[c]	1
Lumbar Vertebra	.14	3	.61	3	.71	3	.92[a]	3	1.28[a]	3
	.13	2	.56	2	.66	2	.86[a,b]	2	1.20[a]	2
	.13	1	.55	1	.64	1	.78[b]	1	1.09[b]	1

[a,b,c]Means in the same column superscripted with different letters are significantly different ($P<.05$).

*All backfat measurements are presented in inches.

TABLE A-12. Backfat Measurements by Site and Feeder Pig Grade (Trial II)

Site	Sonoray*						Carcass*	
	Initial	Grade	6 Weeks	Grade	10 Weeks	Grade	Final	Grade	Final	Grade
Shoulder	.25[a]	3	.60[a]	2	1.09[a]	1	1.24	3	2.04	3
	.24[a]	1	.59[a]	1	1.07[a,b]	2	1.19	1	2.00	2
	.22[b]	2	.55[b]	3	1.02[b]	3	1.17	2	1.97	1
Loin	.15[a]	3	.28[a]	2	.65	2	.86	3	1.33	3
	.11[b]	2	.26[b]	3	.64	1	.85	2	1.27	2
	.11[b]	1	.25[b]	1	.63	3	.82	1	1.27	1
Lumbar Vertebra	.15[a]	3	.65	2	.60	1	.88	3	1.36	3
	.13[b]	1	.64	1	.60	3	.88	1	1.33	1
	.12[b]	2	.63	3	.59	2	.86	2	1.29	2

[a,b]Means in the same column superscripted with different letters are significantly different ($P<.05$).

*All backfat measurements are presented in inches.

TABLE A-13. Sonoray Measurements by Grade and Type of Feeder Pig (Trial I and Trial II)

Initial (Inches)	Grade-Type	6 Weeks (Inches)	Grade-Type	10 Weeks (Inches)	Grade-Type	Final (Inches)	Grade-Type
.19[a]	3-1	.38[a]	2-2	.79[a]	3-1	1.08[a]	3-1
.17[b]	2-1	.38[a]	1-1	.78[a]	2-1	.95[b]	2-1
.17[b]	1-1	.37[a,b]	2-1	.77[a]	1-2	.93[b]	2-3
.17[b]	1-2	.37[a,b]	1-2	.77[a]	1-1	.91[b]	2-2
.16[b]	3-2	.37[a,b]	3-1	.76[a]	2-2	.91[b]	1-1
.16[b,c]	2-2	.36[a,b]	2-3	.74[a,b]	3-2	.90[b]	1-2
.16[b,c]	1-3	.35[a,b]	3-2	.73[a,b]	2-3	.87[b]	3-2
.15[c]	2-3	.34[b]	1-3	.68[b]	1-3	.83[b]	1-3

[a,b,c]Means in the same column superscripted with different letters are significantly different ($P<.05$).

TABLE A-14. Beginning and Final Sonoray Measurements by Grade and Type of Feeder Pig

Beginning BF (Inches)	Grade-Type	Final BF (Inches)	Grade-Type
.19[a]	3-1	1.10[a]	3-1
.17[b]	2-1	1.02[b]	2-1
.17[b]	1-1	1.00[b]	1-1
.17[b]	1-2	.93[c]	2-2
.16[b]	3-2	.92[c]	3-2
.16[b,c]	2-2	.92[c]	2-3
.16[b,c]	1-3	.91[c]	1-2
.15[c]	2-3	.83[d]	1-3

[a,b,c,d]Means in the same column superscripted with different letters are significantly different (P<.05).

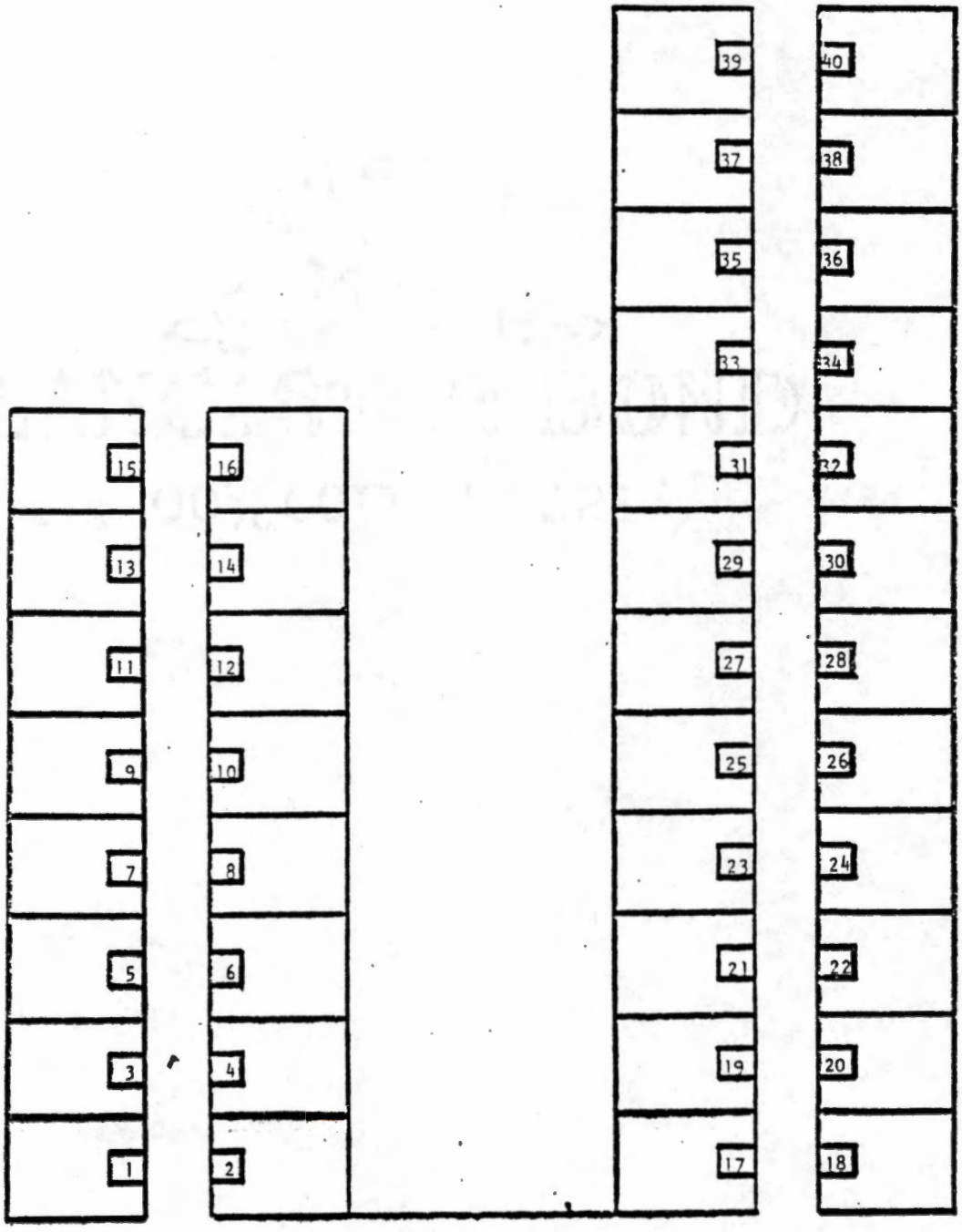


FIGURE A-1 Feeder pig barn plan, Plateau Experiment Station, Crossville, Tennessee.

VITA

Earl D. Brooks, II was born January 11, 1956 in Pineville, Kentucky to Mr. and Mrs. Earl D. Brooks. He was reared in Claiborne County, Tennessee and attended Ellen Myers School in Harrogate, Tennessee. He was graduated from Powell Valley High School in Speedwell, Tennessee in May of 1974.

In September of 1974, he entered The University of Tennessee, Knoxville and received a Bachelor of Science degree in Animal Science in June of 1977. During his undergraduate studies he became a member of the U.T. Block and Bridle Club, Farmhouse fraternity and was on the 1976 U.T. Livestock Judging Team.

Following graduation, he entered the Graduate School of The University of Tennessee, Knoxville serving as swine and sheep herdsman at U.T. Blount Farm. He received the Master of Science degree in Animal Science in August 1979.

In September 1981, he entered The University of Tennessee, Knoxville to work on the Ph.D. degree in Animal Science. He held an assistant professorship at Lincoln Memorial University during his study at The University of Tennessee, Knoxville. He is a member of Phi Kappa Phi, American Society of Animal Science, Tennessee Academy of Science, National Association of Colleges and Teachers of Agriculture and the Council for Agricultural Science and Technology.