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THE EFFECT OF BODY WEIGHT, HIP HEIGHT AND SUBCUTANEOUS FAT THICKNESS ON WINTER AND SPRING-SUMMER PASTURE PERFORMANCE AND SUBSEQUENT FEEDLOT PERFORMANCE OF BEEF STEERS

A Thesis
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Thomas Dale Bryson

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ABSTRACT

Fall weaned steers (112), of Hereford, Angus, or Hereford X Angus breeding, plus 75 steers of mixed breeding (British X or British X Continental) were utilized to investigate the effects of fall body measurements on winter weight change, spring/summer grazing performance, and subsequent feedlot performance. The steers were wintered on either permanent pasture (fescue and/or orchardgrass plus clover) or winter annual pastures (rye, ryegrass, plus clover) and were afterwards allowed grazing periods ranging from 94 to 167 days. Following the pasture phase, cattle were assigned to slaughter groups and serially slaughtered following 0, 28, 56, 84 or 112 days on a full feed ration consisting of whole-shelled corn plus 36% protein supplement (Tend-R-Leen®).

Analysis of variance and multiple regression analyses were conducted to determine factors that had significant effects on grazing data and carcass traits. Steers that performed best under grazing situations were those described as lighter in weight and taller at the hips. Those managed for greater winter gains were heavier at the end of spring/summer grazing. Measures of carcass production (feedlot average daily gain, carcass weight [CARWT] and rib eye area) were positively associated with purchase weight (PURWT), initial hip height (INHH), and days on feed. Measures of carcass fatness and quality (external carcass fat, quality grade [QG], yield grade [YG] and kidney, heart and pelvic fat) were generally increased with increases in

PURWT, initial fat (INFAT) and weight gain during grazing treatments and were negatively associated with INHH.

Prediction equations for three variables (CARWT, QG, YG) were simultaneously solved to determine values for PURWT, INHH, and INFAT that would meet the following limitations: (1) CARWT = 700 lbs.; (2) QG = low choice; and (3) YG = 2.5. At Martin, the "ideal" steer at weaning weighed 771.71 lbs., measured 44.95 inches at the hips and carried 4.07 mm of external finish. The most desirable carcass limitations for Crossville cattle (of British breeding) were the following: (1) CARWT = 650 lbs.; (2) QG = low choice; and (3) YG = 2.5. Weanling cattle that would satisfy these limitations weighed 665.78 lbs., measured 38.65 inches at the hips and carried 3.69 mm of external finish. These cattle averaged gaining .77 lb./hd./day and .86 lb./hd./day at Martin and Crossville, respectively.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

It has been noted that the U.S. beef industry is presently in a maturing phase of its growth. Feeders, once faced with cheap and abundant grains, are now searching for cheaper alternatives for drylot finishing. Cow-calf producers, once faced with appreciating land values and cheap inputs, have been inundated with soaring production costs, chiefly due to escalating petroleum-based products. Individual segments of the industry (cow-calf, stocker-grazer, packer, etc.) often reap net profits at the expense of other phases.

Packing industry reports indicate approximately 80% of all beef produced is marketed as boxed beef. For these higher quality products, the industry imposed limitations dictate that carcasses should weigh 600-750 lbs. USDA reports estimate approximately 93% of all slaughter cattle are processed through federally inspected plants; approximately 68% of all steers and heifers slaughterd are subjected to USDA quality grades. Of the cattle receiving quality grades, some 95% are choice-prime cattle. Thus, some 60% of all fed cattle produce choice quality beef.

Although a standard product is desired by packer and consumer, producers are faced with many alternatives in management and cattle types available. Tennessee on-farm cow-calf numbers exceed 1.1 million head. Roughly 35-40 thousand beef type calves are marketed annually through organized feeder calf sales, in Tennessee alone. Quality varies somewhat, and price ranges may be as much as $15-20 per hundredweight.

Calves marketed through Tennessee feeder calf sales traditionally go to western stocker-grazer operations, where they gain approximately 200-250 pounds and are then finished on high levels of concentrate. Tennessee producers are increasingly realizing the profit potential in backgrounding. Introduction of improved fescues, adaptable ryegrasses, and more attractive legumes has intensified interest in utilizing locally grown forages more fully.

Thus, this increased interest in backgrounding coupled with the wide diversity of cattle available led to this investigation. Its objectives were: (1) to appraise the effect of size (weight) on weight change during wintering and spring/summer grazing; (2) to investigate the effect of wintering weight change on spring/summer grazing; and (3) to evaluate the effect of frame size (hip height) and condition (fat thickness) on weight change during wintering and while grazing spring/summer pastures.

CHAPTER II

REVIEW OF LITERATURE

Fluctuations in the U.S. cattle market have led many producers to question practices that were once indisputable. The possibility of increased profits has captivated the interest of many. Efforts to determine optimum production practices have once again focused attention on differences in type, within breed and across breed. The continued release of improved grasses and legumes has stimulated Southern producers to think on topics such as proper forage management, proper animal management, finishing cattle on high-forage diets and the efficient use of compensatory growth.

Many researchers have reported a negative relationship between gains made in two successive periods (Kincaid et al., 1945, 1947; Connell et al., 1948; Kidwell, 1954; Heinemann and Van Keuren, 1956; Simone et al., 1961; and Carroll et al., 1963). Kincaid et al. (1945) reported that calves weighing 86 pounds heavier after winter treatment, gained 46 pounds less when placed on spring/summer grasses. Heinemann and Van Keuren (1956) reported a correlation coefficient of $r = -.64$ between gains made during winter and gains made during summer. Carroll et al. (1963), utilizing barley straw and sudan hay as the base diet, reported a correlation coefficient of $r = -.73$ between winter gains and summer gains. Connell et al. (1948) reported that steers given no supplemental feed during the winter phase maintained an approximate 30% advantage in average daily gain when placed on native grasses.

One of several factors, or a combination of several, may be involved in the reduced growth and the resulting compensatory growth of cattle on a low plane of nutrition. Bohman (1955) reported that calves fed earlier cut, higher protein hay during the wintering period gained significantly more (.92 lb./d. vs. .29 lb./d.). However, when later placed on grass, calves fed later maturity hay compensated by having higher average daily gains (ADG); by the end of the grazing period, cattle fed early-cut hay still weighed more, though the difference was very small. Later, they (Bohman and Torrell, 1956, and Bohman et al., 1959) reported that supplementing late cut hay with either cottonseed meal or pelleted alfalfa tended to mask the difference seen in ADG. Connell et al. (1948) reported that supplementing a sorghum fodder/silage based diet with one pound cottonseed meal per head per day increased winter gains from .49 lb./d. to 1.24 lbs./d. Nonsupplemented cattle then compensated with higher ADG when placed on pasture (1.18 lbs./d. vs. .91 lb./d.). Simone et al. (1961) reported similar findings.

Calves on energy deficient diets have been shown to produce similar results (Winchester and Howe, 1955). Supplementing with additional protein will in most cases supply additional energy as well. Perry et al. (1971) reported compensatory gains of cattle fed graded levels of protein and energy supplements ranging from zero to ad Libitum, while on pasture. Supplementing with .5 pound animal fat per head per day had no significant effect on winter gains (Bohman et al., 1959). However, cattle supplemented with fat during the winter made faster gains on pasture, regardless of protein source (cottonseed meal or alfalfa pellets).

In addition to the effects of compensatory gains, winter gains of cattle as weanlings and yearlings are positively associated, if winter treatments are held constant (Kidwell, 1954). This concept lead to the conclusion that a definite set of genes controls the adaptability of animals to winter or range conditions.

Although cattle will gain faster during the realimentation period, no advantage has been seen in total gains. In fact, cattle managed to gain modest amounts during the wintering phase are heavier when taken off grass (Sheets, 1922; Kincaid et al., 1945, 1947; Connell et al., 1948; Bohman, 1955; Bohman and Torrell, 1956; Heinemann and Van Keuren, 1956; Bohman et al., 1959; Simone et al., 1961; and Carroll et al., 1963). Kincaid et al. (1945) reported that for each pound of winter gain, total (annual) gain increased by .42 pound.

These observations led to two possible explanations for the relationship between gains made in different periods (Koger and Knox, 1951). In general, gains of different periods are positively related. Larger framed cattle, with heavier logical slaughter weights will, of necessity, gain more during any, in fact, all production periods. Secondly, however, because of specific genetic limitations, extreme weight changes (positive or negative) will be corrected for during the following period. Certain environmental conditions, expressed in one period and then removed, will allow for compensation of over and under growth made during the first period.

Winter gains had no effect on feedlot performance when cattle were grazed 155 days following wintering and prior to finishing (Heinemann and Van Keuren, 1956). Perry et al. (1971), however, reported ADG to be increased and total kg concentrate required to produce a constant weight decreased with lowered winter gain, when cattle are placed directly off wintering into the finishing lot. However, when slaughtered at constant quality grade, cattle gaining less during wintering, continued to gain slower and were less efficient than cattle gaining more during the wintering phase (Nelson et al., 1980). Winchester and Howe (1955) and Meyer et al. (1965) reported that equal amounts of energy were required to produce carcasses of equal caloric value, regardless of whether growth was interrupted or continuous.

Meyer et al. (1965) reported that fat percentage (intramuscular and subcutaneous) was directly related to energy intake. Cattle on higher energy rations during wintering, when placed on grass, carried more backfat. Energy and protein restriction resulted in slower bone development, lack of lean development and loss of external finish; loss of intramuscular fat was insignificant (Carroll et al., 1963). Guilbert et al. (1944) and Fox et al. (1972) reported that cattle on restricted diets will continue skeletal growth for a period, but gains will eventually drop to zero. Once placed on feed, different patterns of growth are seen between cattle allowed continuous or interrupted growth patterns (Fox et al., 1972). Steers allowed compensatory growth responses gained more protein and less fat during the initial feeding period. Later, composition of their gains turned to higher percentage fat, less protein. Intramuscular fat was higher in cattle given supplemental feed during the winter phase (Simone et al., 1961; and Carroll et al., 1963).

Lawrence and Pearce (1964) offered a possible explanation for the performance increase of cattle whose growth has been interrupted. One, these cattle seem to have larger appetites. Perry et al. (1971) reported that, though supplemented cattle gained 19 to 36 pounds more while on grass, feedlot consumption was similar for all treatments; thus intake per unit body weight was increased. Second, cattle during realimentation period experience higher digestibility and/or utilization of nutrients (Lawrence and Pearce, 1964, and Fox et al., 1972). This, in part, is due to compositional changes; restricted animals, with higher muscle:fat ratios require feed of less caloric value for maintenance.

The overriding consideration of compensatory growth should be the economic soundness of such. According to Heinemann and Van Keuren (1956), even though cost per animal per day was roughly 1.5 times greater for supplemented cattle, cost per pound of gain was reduced more than 50%, by supplementing wintered cattle. Guilbert et al. (1944) reported that 200-300 pounds of concentrate used in winter rations will produce approximately 100 pounds additional growth, and replace 400-500 pounds concentrate required to produce similar feedlot gains. Though steers maintaining continuous growth reached slaughter weight with fewer days on feed (Young et al., 1962; Meyer et al., 1965; and Perry et al., 1971), similar to less pounds of concentrate were required to produce similar carcasses (Winchester and Howe, 1955; and Perry et al., 1971), when winter supplementation is included.

In addition to the effects of compensatory growth, researchers have long been interested in quantifying differences in management schemes and types, breeds, and weights of cattle, as they effect production parameters of beef cattle. Aberle et al. (1981) and Bowling et al. (1978) have indicated various methods may be employed to produce beef carcasses of similar qualities. Carcasses grading high good may be produced by high energy feeding periods ranging from 140 to 210 days (Aberle et al., 1981) or by extensive use of forages followed by fattening periods of 98 to 130 days (Bowling et al., 1978). Cattle of differing types and breeds may be successfully finished to near equal quality grades (Knox and Koger, 1946; Stonaker et al., 1952; Kidwell and McCormick, 1956; and Crouse et al., 1974). However, with more rigorous production and quality standards, producers' options become more limited (Cole et al., 1963; Van Stavern et al., 1970; Ferrell et al., 1978; and Young et al., 1978).

Early researchers dealt with the influence of type, within a particular breed, on performance characteristics and carcass traits (Knox and Koger, 1946; and Stonaker et al., 1952). "Rangy" type steers were determined to be faster gaining and produce heavier carcasses (Knox and Koger, 1946; and Butts et al., 1980a) that dressed significantly higher than "comprest" type steers (Knox and Koger, 1946). However, rangy steers weighed more at the onset of the trial; once gains were statistically adjusted to equivalent initial weights, gains were nearly equal. Comprest steers showed a slight advantage in carcass grade and gain as expressed as a percent of initial weight. Increasing initial weight by one pound produced added weight gains of .184 pound, regardless of type (Knox and Koger, 1946). Stonaker et al. (1952) confirmed these results and added that near equal efficiencies and proportional increases in carcass weight were associated with increases in initial weight. Composition of carcasses, expressed as percent retail cuts per pound of carcass, were very similar between conventional and compress type steers. Compress type steers finished to low choice in seven days less, but also produced carcasses averaging 163 pounds lighter.

In addition to the difference in type within a breed, extensive work (Kidwell and McCormick, 1956; Cole et al., 1963; Wyatt et al., 1977; Ferrell et al., 1978; Young et al., 1978; and Butts et al., 1980a), utilizing differing finishing systems, indicate breed to exert a significant influence on feedlot performance and carcass characteristics. Cole et al. (1963) realized similar production abilities of British or Zebu breeds, while in the feedlot. Wyatt et al. (1977) reported that the increase in preweaning growth of Charolais X Friesian steers is attributable primarily to the increase in digestible energy intake received in milk from its high milk-producing dam and not from any advantage in growth potential. Kidwell and McCormick (1956) reported that cattle of larger mature-size breeds (Holstein vs. Herefords) gained more on less feed by increasing weight of muscle and bone rather than increasing weight of fat. Cole et al. (196) also reported Holsteins to be rapid gainers and the most efficient, requiring only 776 pounds of concentrate to produce 100 pounds gain. Beef breeds of larger mature size possess advantages in gain and nearly equal to slightly improved efficiencies (Ferrell et al., 1978; and

Young et al., 1978). Emphasis on total production of edible protein, without regard to quality factors, favors larger breeds, or larger types within breeds, while emphasis on quality factors of beef would favor smaller breeds of traditionally British origin (Cole et al., 1963; Ferrell et al., 1978; and Young et al., 1978).

Efforts to accurately appraise type has created much confusion and controversy, eventually leading to visual live animal appraisals by qualified individuals (Guilbert and Gregory, 1952; Brown et al., 1956; and Crouse et al., 1974). These workers concluded that individual appraisers were unable to agree, statistically, on live animal objective or subjective measures. They also noted that individual measurements were not very effective in describing type differences. Hence, live animal objective linear measurements were initiated to remove optical illusions and provide a more accurate, repeatable method of quantifying type differences.

Objective live animal measures were used to predict individual performance and carcass composition of slaughter cattle. Kidwell (1955) reported high correlations between measures of chest width, hip height, and body weight, with carcass traits. Maino et al. (1981) reported advantages of larger mature size cattle in performance characteristics while on grass. Though differences in measures of height and heart girth tended to decrease with time, steers of larger mature size (as estimated by hip height) continued to maintain advantages in weights. Heart girth was highly correlated with body weight ($r = .896$) and was determined to be a better estimate of size than body weight (Kidwell, 1955). Butts et al. (1980a) found factors influencing carcass grade were initial fat ($p < .01$) and initial length (measured from the point of the shoulder to the pin bone) ($p < .05$). Carcass grade was negatively related to a ratio calculated between wither height and heart girth (wither height/heart girth). Kidwell (1955) reported a correlation coefficient of $r = -.441$ between wither height/heart girth and dressing percent. Further analysis revealed length of body and depth of chest to have positive effects on carcass grade. Holloway and Butts (1983) reported that calves fatter at weaning continued to grow in frame and skeletal dimensions, and gained more than thin calves. When placed on full feed, thin calves gained fat at a faster rate than calves fat at weaning. Dressing percent was positively effected by width of chest and negatively influenced by length, with heart girth, or body weight, being held constant. Brown et al. (1973) reported measurements were a good indication of past performance, but relationships between measures and performance may change with time. Durham and Knox (1953) also indicated a stronger relationship between measurements and previous performance than between measurements and subsequent performance. Brown et al. (1973) reported the possibility that the same set of genes that control weight gain in cattle also control the expression of measures taken at twelve months of age. They concluded that final weights were highly correlated with measures taken, but that body weight alone was just as suitable in describing mature size and performing ability.

Efforts have been made to determine earlier measurements that would serve as predictors of future performance. Among feeder calf measures that appear to be effective in predicting subsequent performance, initial weight appears to be important (Ruby et al., 1948; Van Stavern et al., 1970; and Butts et al., 1980a). Initial weight and dietary treatment accounted for 56% of the variation seen in gain on test. A coefficient of determination of $R^2 = .73$ was reported for carcass weight, as revealed by initial weight, dietary treatment, and their interaction (Van Stavern et al., 1970). Butts et al. (1980a) concluded that initial weight, and initial height, when adjusted to fat constant points, gave an indication of growth potential, and thus carcass weight, at a constant quality endpoint.

An estimate of growth potential and measurement of size of cannon bone was only modestly predictive for feedlot gains ($R^2 = .24$), as reported by Crouse et al. (1974). Carcass yield grade was affected by hip height, condition and preweaning growth rate. Height was also predictive for describing feedlot gains. Feeder grades were moderately effective in predicting cutability and yield grades, with correlation coefficients of $r = .36$ and $r = .23$, respectively. Feeder grades were not associated with USDA quality grades (Crouse et al., 1974), but initial fat had significant effects on time required to produce low choice carcasses as well as on carcass grade (Butts et al., 1980a). In groups of varied breeding, quantitative carcass traits were best predicted from estimates of condition, length and height. Feeder grades are associated with carcass conformation scores. Yao et al. (1953) found that width of chest was negatively associated with growth characteristics, but not significantly. Brown et al. (1973) reports genetic correlations ranging from $r = .49$ to $r = 2.15$ between width measures and test gain. These differences probably reflect the difference in selection pressure exerted on the breeds utilized (Shorthorn vs. Hereford and Angus). Height measures, characterized by Yao et al. (1953) as "nonmeat production measurements" were negatively associated with slaughter and USDA quality grades. Principle component analyses containing equal emphasis for all measures, in essence a size component, produced a correlation coefficient of r = .55 between itself and test again. Brown et al. (1973) revealed that genes responsible for early development and growth are also responsible for increased test gain. Principle components also indicated that for Herefords the most desirable shape in regard to gain and efficiency is taller, narrower and longer bulls. The opposite is true for Angus bulls (Brown et al., 1973). This could be a reflection of the relative homozygosity of the Hereford and Angus bulls used. The ability of a bull to breed true would increase the reliability of statistical inferences, and differences may be evident here.

The advantage of larger framed, later maturing bulls may be explained by a difference in composition of gains (Kidwell and McCormick, 1956; and Hiner and Bond, 1971). Growth and development of muscle and bone occurs the fastest between six and twelve months of age (Hiner and Bond, 1971). Restriction of growth for up to six months, followed by a high nutritional level, will result in fast muscle development. Restriction for up to 30 months may result in irreversible muscular retardation, and fast fat development.

Standards of conformation were designed to be indicators of desirable performance of carcass traits. For comparison of weight gains to be of interpretable significance, they must be made over similar, corresponding segments of the growth curve, if animals are of differing mature size (Kidwell, 1955).

CHAPTER III

MATERIALS AND METHODS

Cattle and facilities for this study were furnished at two locations. Inherent differences in climate, cattle, and management practices imposed necessitates discussion of the two groups as separate, yet related trials.

Crossville Steers

Cattle assimilated at the University of Tennessee Plateau Experiment Station (PES), Crossville, Tennessee, were collected from the University of Tennessee Tobacco Experiment Station (TES), Greenville, Tennessee, as well as PES. One hundred twelve steers of Hereford, Angus, or Hereford X Angus breeding were weaned in the fall of 1982. Weaning weights ranged from 315 to 665 pounds with a mean of 510 pounds.

Wintering treatments were initiated November 4, 1982, when initial measurements were taken on all calves. Measurements taken included: (1) initial weight, defined as actual weight of the calf on November 4, 1982, with no shrink or alimentation period involved; (2) initial hip height, defined as vertical height at the hips, taken while animal was restrained in a suitable chute, yet maintaining a normal stance; and (3) initial fat, estimated by the use of a Branson model 12 sonoray operated by an experienced technician. Calves were ranked according to weight and equally divided between permanent pasture and temporary pasture winter treatments. All calves allotted to temporary pasture were implanted with 36 mg. Ralgro®. A study of Ralgro effects on wintering cattle was superimposed on permanent pasture cattle. Cattle were wintered on their respective pastures plus corn silage (only when sufficient forage was not available, primarily due to snow cover) to maintain weight and stimulate gains of approximately .25 pound per day.

Temporary pastures included a mixture of Rye (Secale, spp.), ryegrass (Lolium perenne L.) and ladino clover (Trifolium repens L.), established approximately September 15, 1982, after conventional tillage and seedbed preparation, following corn silage harvest. Fertility and pH levels were controlled by the addition of N, P, and K as well as lime, according to UT Soil Testing Laboratory recommendations. Fall grazing was initiated November 14, 1982. Spring grazing began March 14, 1983. At this time, cattle were again weighed, measured for hip height and subcutaneous fat, reimplanted and dewormed as needed, using Tramisol® boluses. Cattle continued to graze temporary pastures until June 16, 1983, at which time weights, heights and fat measures were again recorded. At this time, calves were sorted by logical slaughter weights (weights at which steers would produce low choice carcasses) and randomly assigned to groups that were slaughtered following 0, 28, 56, 84 or 112 days on feed.

Permanent pastures included previously established stands of perennial grasses and clovers, predominantly fescue (Festuca arundinacea, Schreb.) orchardgrass (Dactylis glomerata L.) and white and red clover (Trifolium repens L. and Trifolium pratense L.), with hillside coverages of Kobe lespedeza (Lespedeza striata, Thunb.). Permanent pasture management included fertility and pH adjusting as recommended by UT Soil Testing Laboratory, rotating and topping pastures as needed to maintain young, tender, vegetative growth, and renovating by the introduction of clovers, as needed. On approximately August 15, 1982, 75-100 pounds of actual nitrogen per acre were applied and growth was allowed to accumulate until November 14, 1982, at which time fall grazing was begun. Spring grazing on permanent pastures began April 4, 1983. At this time, cattle were weighed, measured and dewormed using Tramisol® boluses. At the end of the grazing period, August 5, 1983, cattle were again weighed and measured and equally allotted to slaughter groups, within logical slaughter weights.

Near the end of the grazing treatment, an attempt was made to adjust the cattle to the finishing ration, while still on pasture. To facilitate this, the cattle were hand-fed cracked corn for approximately ten days at a rate of nearly 1% of body weight per head per day. At this time, as well, an intranasal IBR-BVD-PI^{3} complex vaccine was administered to all cattle. The cattle responded well to this treatment, as very little signs of stress were observed. Additional management practices (fly control, special medicinal treatment, deworming, etc.) were carried out on an as needed basis to ensure desirable cattle performance.

Feedlot treatments were constant for both temporary and permanent pasture cattle. An additional adjustment period of 21 days was allowed (June 17 to July 7 for temporary pasture on August 5 to August 25 for permanent pasture), during which time whole-shelled corn was initially provided at approximately 1-1.5% of body weight per day and was gradually increased until *ad libitum* intake was reached. Cattle in 0-day kill groups were slaughtered directly off grass (June 20, 1983 and August 10, 1983 for temporary and permanent pasture cattle, respectively). During the feeding period, bunks were managed to ensure *ad libitum* intake with very little refusals; Tend-R-Leen®, a commercially prepared, 36% protein supplement, with monensin, was provided at the rate of 1.1 pounds per head per day. Each 28 days following, weights, hip heights and fat measurements were taken and the corresponding group of cattle slaughtered. Slaughter cattle were transported to Lay Packing Co., Knoxville, Tennessee. Following slaughter and 48 hours postmortem chill, carcasses were evaluated by a USDA grader for quality and yield grade characteristics.

Martin Steers

Cattle assembled at the University of Tennessee, Martin Experiment Station (MES), Martin, Tennessee, were a group of 75 steers, of mixed breeding. The cattle were purchased at local sale barns, comingled, collected and transported by an area order-buyer. These steers were purchased as medium-framed, number one steers, of quality available to West Tennessee producers; weights ranged from 450 to 710 pounds. Upon arrival, November 23, 1982, calves were administered a routine receiving treatment, including an intranasal IBR-BVD-PI^3 complex vaccine, deworming and treatment was begun for shipping fever complex. Initial measurements were taken as per Crossville cattle: (1) initial weight; (2) initial hip height; and (3) initial fat. A gate cut was employed to randomly assign cattle to one of three pasture treatments. Pasture consisted of: (1) tall fescue plus ladino clover; (2) orchardgrass plus ladino clover; or (3) annual ryegrass plus ladino clover. Perennial pastures (fescue/clover and orchardgrass/clover) were established following conventional tillage and seedbed preparation; annual pasture (ryegrass/clover) was established by overseeding into a common bermudagrass sod. Cattle were equally distributed to all pasture treatments, twenty-five cattle per pasture. Similar winter treatments were employed as at the Crossville Station. However, supplemental feed was made available by hay, rather than corn silage, at a rate which would encourage further structural development, but not influence gain. On March 14, 1983, cattle were again weighed, measured and returned to their respective pastures for the initiation of spring grazing. There they remained throughout the grazing period (March 14, 1983 to July 18, 1983).

Feeding treatment was identical to that of Crossville steers. Cattle assigned to 0-day kill groups were slaughtered immediately off grass (July 21, 1983). All others were allowed a 21 day adjustment period to bring them up to full-feed. Cattle allotted to 28, 56, 84 and 112 days on feed were slaughtered August 29, 1983, September 26, 1983, October 24, 1983, and November 21, 1983, respectively. Slaughter cattle were transported to Reelfoot Packing Co., Union City, Tennessee. Following slaughter and 48 hours postmortem chill, carcasses were evaluated by a USDA grader for quality and yield grade characteristics.

Statistical Analysis

The data were analyzed according to multiple regression analysis, in order to construct prediction equations from live animal measurements (hip height, subcutaneous fat and weight) taken in the fall. Weight change during the grazing period was included as an independent variable in analysis of feedlot/carcass traits.

The first set of dependent variables were termed grazing variables. These included the following: (1) Average Winter Weight Change (AWWC), daily change in weight during the wintering period, prior to spring grazing; (2) Average Spring Weight Change (ASPGWC), daily weight change while grazing spring pastures; and (3) Average Grazing Weight Change (AGRZWC), daily weight change from the fall, through wintering and grazing period, until cattle were placed on feed (a combination of AWWC and ASPGWC). Initial models were constructed containing all initial measures as independent variables. Further models were created by deleting nonsignificant variables ($p > .10$). The final models were those that contained the fewest number of independent variables and still explained a large portion of the variation in dependent variables.

Feedlot performance and carcass traits were used as dependent variables in the second set of models. Dependent variables analyzed were carcass weight (CARWT), carcass fat (CARFAT), quality grade (QG), yield grade (YG), dressing percent (DP), rib eye area (REA), percent kidney, heart and pelvic fat (KPH) and feedlot average daily gain (ADGTOT). Independent variables of initial models included all initial measures plus AGRZWC and linear and quadratic terms for days on feed, where applicable. Final models were again chosen from those that included the fewest number of independent variables but yet explained the largest portion of variation in the dependent variables.

CHAPTER IV

RESULTS AND DISCUSSION

Grazing Data

Means of initial measurements and grazing performance, by pastures, are presented in Table 1. Steers at Crossville, averaging approximately 40 pounds heavier and placed on pasture 2 (temporary pasture), gained slightly more during wintering and approximately 25% more during spring/summer grazing. Extrapolation of data indicates near equal slaughter weights (1,010 pounds for pasture 1, permanent pasture and 1,014 pounds for pasture 2, temporary pasture), but pasture 2 cattle were significantly fatter, as evidenced by higher dressing percent (DP); other measures of fatness tend to agree, with the exception of percent kidney, heart and pelvic fat (KPH), which was virtually equal for steers from the two pastures. Martin data indicates similar winter weight changes (AWWC) of cattle on all pastures. Spring weight change (ASPGWC), likewise, was similar, except for pasture 3, fescue and clover, which showed daily gain depressions of approximately 25%. Pasture 1 cattle (ryegrass and clover) had a slight advantage in grazing data and maintained that advantage throughout carcass production. Feedlot average daily gain (ADGTOT) indicates pasture 3 (fescue and clover) cattle at Martin exhibited compensatory growth on feed, as did pasture 1 (permanent pasture) cattle from Crossville; otherwise, production parameters were similar.

TABLE 1

MEANS OF GRAZING DATA AS AFFECTED BY LOCATION AND PASTURE

	Crossville		Martin		
	Pasture 1	Pasture 2	Pasture 1	Pasture 2	Pasture 3
PURWT[a]	493.00	533.80	588.40	598.13	577.80
INHH[b]	40.88	41.34	40.54	41.00	40.44
INFAT[c]	2.55	2.63	1.88	2.13	1.96
AWWC[d]	0.35	0.31	-.05	-.13	-.09
ASPGWC[e]	1.98	2.57	1.93	2.10	1.56
AGRZWC[f]	1.18	1.41	1.00	1.05	0.78
CARWT[g]	569.77	580.91	589.79	570.96	542.00
CARFAT[h]	10.05	11.02	9.42	7.79	7.96
REA[i]	10.89	10.85	10.13	10.30	9.92
KPH[j]	1.34	1.37	1.52	1.60	1.40
QG[k]	9.93	10.13	9.75	10.00	9.92
YG[l]	2.38	2.64	2.78	2.53	2.52
DP[m]	58.75	59.69	60.00	59.63	58.23
ADGTOT[n]	3.76	3.68	3.08	2.39	3.40

[a]PURWT = purchase weight, lbs.

[b]INHH = initial hip height, inches.

[c]INFAT = initial subcutaneous backfat, mm.

[d]AWWC = average winter weight change, lbs/hd/day.

[e]ASPGWC = average spring weight change, lbs/hd/day.

[f]AGRZWC = average grazing weight change, lbs/hd/day.

[g]CARWT = hot carcass weight, lbs.

[h]CARFAT = mm fat measured at 12-13 rib interface.

[i]REA = rib eye area, inches^2.

[j]KPH = percent kidney, hear and pelvic fat.

[k]QG = quality grade, as assigned by USDA grader (Standard° = 7, Good° = 10, choice° = 13, etc).

[l]YG = yield grade.

[m]DRESSING PERCENT = hot carcass weights/slaughter weight x .96.

[n]ADGTOT = feedlot average daily gain, lbs/hd/day.

Effect of Independent Variables on AWWC. Mean squares and coefficient of determination values for models of initial grazing data are presented in Table 2 and Table 3 for Crossville steers and Martin steers, respectively. Breed and all initial variables except initial fat (INFAT) were found to be significant effecters of average winter weight change (AWWC), at Crossville. Pasture differences were not seen, probably due to the lack of fall growth on the Cumberland Plateau, and supplementation with high quality corn silage when forage was not available. All one-way interactions between initial measurements were tested; none were found to be significant ($p > .10$).

Table 3 indicates none of the initial measurements were effective in describing variation in AWWC at Martin; in fact, the entire model was very ineffective, as shown by the coefficient of determination value of $R^2 = .05$. No other combination of variables were found to be effective in describing AWWC at Martin; hence, it was concluded that winter weight change was influenced by factors other than those measured in this study. Perhaps, with this set of put-together cattle, health problems unknown to station personnel, may have influenced AWWC.

A final model for Crossville cattle and the resulting prediction equation are presented in Table 4. Though breed and pasture were not significant, they were included in this model to force the removal of that portion of the variation that could be attributed to them. Other significant variables included purchase weight (PURWT), $p < .001$ and initial hip height (INHH), $p < .001$. Partial regression coefficients indicate that while holding PURWT constant, increases in INHH, or

TABLE 2

MEAN SQUARES AND COEFFICIENT OF DETERMINATION VALUES FOR GRAZING PERFORMANCE OF CROSSVILLE STEERS USING INITIAL MEASUREMENTS AS INDEPENDENT VARIABLES

	AWWC[a]		ASPGWC[b]		AGRZWC[c]	
SOURCE	DF	MS	DF	MS	DF	MS
BREED	2	0.1194^{+}	2	0.4138**	2	0.2208****
PASTURE	1	0.0649	1	9.7739****	1	2.1926****
PURWT[d]	1	1.0437****	1	0.0875	1	0.4265****
INHH[e]	1	0.6305****	1	0.4729*	1	0.5424****
INFAT	1	0.0077	1	0.0447	1	0.0037
ERROR	104	0.0471	104	0.0873	104	0.0261
R^2		.39		.56		.57

[a]AWWC = daily winter weight change.
November 9, 1982 to March 14, 1983 for temporary pasture cattle.
November 9, 1982 to April 4, 1983 for permanent pasture cattle.

[b]ASPGWC = daily gain while on spring/summer grazing treatment.
March 14, 1983 to June 16, 1983 for temporary pasture cattle.
April 4, 1983 to August 5, 1983 for permanent pasture cattle.

[c]AGRZWC = average daily gain during entire treatment.
November 9, 1982 to June 16, 1983 for temporary pasture cattle.
November 9, 1982 to August 5, 1983 for permanent pasture cattle.

[d]PURWT = purchase weight, lbs., November 9, 1983.

[e]INHH = initial hip height, inches, November 9, 1983.

[f]INFAT = initial subcutaneous fat, mm, November 9, 1983.

****$p < .001$; ***$p < .005$; **$p < .01$; *$p < .05$; $^{+}p < .10$.

TABLE 3

MEAN SQUARES AND COEFFICIENT OF DETERMINATION VALUES FOR GRAZING PERFORMANCE OF MARTIN STEERS USING INITIAL MEASUREMENTS AS INDEPENDENT VARIABLES

	AWWC[a]		ASPGWC[b]		AGRZWC[c]	
SOURCE	DF	MS	DF	MS	DF	MS
BREED	1	0.0512	1	0.0089	1	0.0014
PASTURE	2	0.0166	2	2.0033****	2	0.5122****
PURWT[d]	1	0.0172	1	0.4942*	1	0.1923*
INHH[e]	1	0.0096	1	0.5948**	1	0.2113*
INFAT	1	0.0481	1	0.0025	1	0.0125
ERROR	67	0.0844	67	0.0943	68	0.0377
R^2		.05		.44		.37

[a]AWWC = daily winter weight change, November 23, 1982 to March 14, 1983.

[b]ASPGWC = daily gain while on spring/summer grazing treatments, March 14, 1983 to July 18, 1983.

[c]AGRZWC = average daily gain during entire period November 23, 1982 to July 18, 1983.

[d]PURWT = purchase weight, lbs., November 23, 1982.

[e]INHH = initial hip height, inches, November 23, 1982.

[f]INFAT = initial subcutaneous fat, mm, November 23, 1982.

****$p < .001$; ***$p < .005$; **$p < .01$; *$p < .05$; $^{+}p < .10$.

TABLE 4

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR AVERAGE WINTER WEIGHT CHANGE[a] OF CROSSVILLE CATTLE USING BREED, PASTURE AND THOSE INITIAL MEASUREMENTS THAT WERE SIGNIFICANT AS INDEPENDENT VARIABLES

SOURCE	DF	MS	P > F	R^2
BREED	2	0.1159	.10	.39
PASTURE	1	0.0610	.25	
PURWT[b]	1	1.0722	.001	
INHH[c]	1	0.6247	.001	
ERROR	105	0.0467		

$$\hat{Y} = -1.6732^{d} - \text{PURWT}(.0024) + \text{INHH}(.0793)$$

[a]AWWC = daily winter weight change,
November 9, 1982 to March 14, 1983 for temporary pasture cattle.
November 9, 1982 to April 4, 1983 for permanent pasture cattle.

[b]PURWT = weight at weaning, lbs.

[c]INHH = hip height at weaning, inches.

[d]Intercept has been adjusted to mean of breed and pasture.

mature frame size, produced higher daily gains during the wintering phase; holding INHH constant and decreasing PURWT, an indication of fleshing condition, likewise produces higher winter gains. These data may, as well, indicate a difference in age. Cattle which have attained taller hip heights while remaining at lighter weights may be perceived as cattle that have undergone periods of nutritional restriction, are older, more able to utilize larger amounts of forage, and capable of compensatory growth.

Effect of Independent Variables on ASPGWC. Table 2 and Table 3 present the initial models for average spring weight change (ASPGWC) of Crossville cattle and Martin cattle, respectively. Breed, pasture, and INHH had significant relationships with ASPGWC at Crossville; levels of significance were $p < .01$, $p < .001$, and $p < .05$, respectively. Significant factors at Martin were pasture ($p < .001$), PURWT ($p < .01$), and INHH ($p < .01$). Subsequent models were created deleting initial fat (INFAT) and adding a term for total winter weight change (WWC) and the interaction between pasture and PURWT.

Final models for ASPGWC and regression equations are presented in Table 5. Pasture, PURWT and INHH are common to both data sets as having significant relationships with ASPGWC. Total winter weight change (WWC) had a significant effect at Crossville ($p < .05$). The lack of significance of WWC at Martin leads one to question the accuracy of winter weights taken at the Martin station. Differences in fill, influenced by distance of cattle from scales, ease of handling, and other factors may be evidenced here. The interaction between pasture and

TABLE 5

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR AVERAGE SPRING WEIGHT CHANGE[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND THOSE INITIAL MEASUREMENTS THAT WERE SIGNIFICANT AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.4607	.005	.60	1	0.0087	.76	.44
PASTURE	1	0.8958	.001		2	2.0043	.001	
PURWT[b]	1	0.5442	.01		1	0.6210	.01	
INHH[c]	1	0.7772	.005		1	0.6271	.01	
WWC[d]	1	0.4312	.05					
PURWT x PAST[e]	1	0.2892	.10					
ERROR	103	0.0810			68	0.0929		
	$\hat{Y} = -.4469^f$ - PURWT[b] (.0027) + INHH[c] (.0946) - WWC[d] (.0027)				$\hat{Y} = -.6599^g$ - PURWT[b] (.0021) + INHH[c] (.0928)			

[a]ASPGWC = daily gain while on spring/summer grazing treatments,
Crossville: March 14, 1983 to June 16, 1983 for temporary pasture cattle.
April 4, 1983 to August 5, 1983 for permanent pasture cattle.
Martin: March 14, 1983 to July 18, 1983 for all cattle.

[b]PURWT = purchase weight, lbs.

[c]INHH = initial hip height, inches.

[d]WWC = total winter weight change (November 9, 1982 to initiation of grazing).

[e]PURWT x PAST = interaction between pasture and purchase weight.

[f]Intercept has been adjusted to mean of breed, pasture, and PURWT x PAST.

[g]Intercept has been adjusted to mean of breed and pasture.

PURWT at Crossville may be simply an indication of the failure to equally divide the weights of all cattle among both pastures. The heavier cattle (533 lbs. vs. 493 lbs.) were allotted to pasture 2, temporary pasture. The partial regression coefficient for PURWT indicates that fall weaned cattle weighing fifty pounds less had an advantage in spring/summer gains of approximately .10 lb./day. Holding weight constant and increasing INHH will likewise increase ASPGWC. On the Crossville cattle, where cattle were allowed nutrition to express more gaining ability in the winter, increases on AWWC resulted in decreases in ASPGWC. Again, the larger mature sized cattle held an advantage in ASPGWC, especially if those cattle were allowed a compensatory growth factor.

Effect of Independent Variables on AGRZWC. The initial models, Table 2 and Table 3, for Crossville cattle and Martin cattle, respectively, reveal that pasture, PURWT and INHH were effective in describing daily weight gain from the fall, through the wintering phase, and including spring/summer grazing (AGRZWC) at both locations. Initial fat (INFAT) was relatively unimportant and was thus deleted from the models.

Final models, created by adding WWC, and the resulting prediction equations are presented in Table 6. These models explained 66% and 58% of the variation in AGRZWC at Crossville and Martin, respectively. Breed, as was the case in all previous Martin models, was not significantly related to AGRZWC. This may be due to the inherent inaccuracies of assigning breed classifications to cattle at Martin. These cattle

TABLE 6

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR AVERAGE GRAZING WEIGHT CHANGE[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND THOSE INITIAL MEASUREMENTS THAT WERE SIGNIFICANT AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.1357	.005	.66	1	0.0009	.86	.58
PASTURE	1	2.2704	.001		2	0.5511	.001	
PURWT[b]	1	0.0827	.05		1	0.1899	.01	
INHH[c]	1	0.1796	.005		1	0.1853	.01	
WWC[d]	1	0.5836	.001		1	0.8398	.001	
ERROR	104	0.0205			68	0.0258		
	$\hat{Y} = -.2822^{e} - \text{PURWT}^{b}\ (.0007) + \text{INHH}^{c}\ (.0455) - \text{WWC}^{d}\ (.0031)$				$\hat{Y} = -.3804^{e} - \text{PURWT}^{b}\ (.0012) + \text{INHH}^{c}\ (.0505) + \text{WWC}^{d}\ (.0017)$			

[a]AGRZWC = daily grazing weight change, from initiation of project until cattle placed in feedlots,

Crossville: November 9, 1982 to June 16, 1983 for temporary pasture cattle.
November 9, 1982 to August 5, 1983 for permanent pasture cattle.

Martin: November 23, 1982 to July 18, 1983 for all cattle.

[b]PURWT = purchase weight, lbs.

[c]INHH = initial hip height, inches.

[d]WWC = total winter weight change, pounds.

[e]Intercept has been adjusted to mean of breed and pasture.

were of unknown origin; cattle were subjectively assigned to one of two breed groups: (1) British cross; or (2) British X Continental cross. This system leads to a great deal of variation within each classification, perhaps explaining its lack of significance with other variables. Multiple regression coefficients (Table 6) illustrate that gains from fall, through spring/summer grazing period may be increased by either increasing daily gains during the wintering period, or by purchasing cattle that either weigh less or are taller at the hips. The regression coefficients of b = .0031 and b = .0017 for WWC indicates that to increase total gains by .10 lb./day, winter weight gain must be increased by 32 to 58 pounds, depending on location.

Carcass Data

A summary of carcass characteristics as influenced by days on feed and location is presented in Table 7. The linear response of carcass traits with days on feed is in agreement with that of Greene (1982) and Sullivan (1983). Sullivan (1983) found that a grade of high good could be attained in 112 days on feed, using Hereford cattle, 66 days using Angus; here the average of Angus and Hereford at Crossville, reached average grades of high good in 73 days, with yield grades of 2.66. Feedlot daily gain (ADGTOT) suggests that Crossville cattle may have experienced some compensatory gains the first 28 days on feed, while Martin cattle apparently were slower in getting acclimated to the feedlot ration. Both groups showed slight reductions in ADGTOT after 84 days on feed, as expected, when composition of gains turned to more fat, less muscle and bone.

TABLE 7

MEANS OF CARCASS CHARACTERISTICS AND FEEDLOT PERFORMANCE AS AFFECTED BY DAYS ON FEED AND LOCATION

	LOCATION									
	CROSSVILLE Days on Feed					MARTIN Days on Feed				
	0	28	56	84	112	0	28	56	84	112
CARWT[a]	427.33	525.00	570.50	654.88	717.06	425.21	477.67	573.73	660.00	698.86
CARFAT[b]	6.22	8.56	9.33	13.44	15.88	2.71	5.27	7.47	11.60	14.93
REA[c]	9.08	10.75	10.98	11.70	11.99	8.74	8.95	10.40	11.13	11.34
KPH[d]	0.81	1.25	1.28	1.69	1.79	1.00	1.60	1.07	1.32	2.57
QC[e]	7.67	9.44	10.44	11.38	11.35	8.21	8.33	10.67	10.87	11.36
YG[f]	2.02	2.09	2.37	2.89	3.32	1.87	2.32	2.47	2.85	3.55
DP[g]	55.35	57.54	59.95	59.75	63.92	54.04	57.65	59.31	62.07	63.20
ADGTOT[h]		4.79	3.15	3.85	3.06		1.74	3.49	3.53	3.13

[a]CARWT = hot carcass weight, lbs.

[b]CARFAT = mm fat measured at 12-13th rib interface.

[c]REA = rib eye area, inches^2.

[d]KPH = percent kidney, heart, and pelvic fat.

[e]QG = quality grade assigned a numerical value: Standard° = 7, Good ° = 10, Choice ° = 13, etc.

[f]YG = yield grade, as calculated by USDA grader.

[g]Dressing percent = hot carcass weight/slaughter weight x .96.

[h]ADGTOT = feedlot average daily gain, lbs./hd./day.

<u>Effect of Independent Variables on CARWT</u>. Mean squares and coefficient of determination values for the initial models of carcass traits and feedlot performance are presented in Table 8 and Table 9 for Crossville cattle and Martin cattle, respectively. Purchase weight (PURWT) had a highly significant ($p < .001$) relationship with carcass weight (CARWT), at both locations. Initial hip height (INHH) was a significant effecter of CARWT at the Martin station only, $p < .005$. Initial fat (INFAT) did not affect CARWT and was subsequently removed from the models. As would be expected, AGRZWC exerted a significant influence on CARWT ($p < .001$). Kill group (KG) had a significant relationship with CARWT ($p < .001$) at both locations.

The lack of significance of INHH at Crossville and the high level of significance of AGRZWC suggests a possible redundancy of the two terms. This is further supported by the relationship between INHH and AGRZWC ($p < .005$). Since AGRZWC is the more descriptive term, including both the relative performing ability of the individual and management level imposed, it was left in the model.

For the final model, KG was changed from a class variable, with four degrees of freedom, to days on feed (DOF), and used as covariate, one degree of freedom, and thus inferences can be made over the entire range of feeding period. Analyses of variance and prediction equations for CARWT are presented in Table 10. These final models accounted for 93% and 95% of the variation in CARWT. Partial regression coefficients for PURWT of $b = .77$ and $b = .63$ for Crossville cattle and Martin cattle, respectively, are in agreement with Greene (1982), whose reported

TABLE 8

MEAN SQUARES AND COEFFICIENT OF DETERMINATION VALUES FOR FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF CROSSVILLE STEERS USING INITIAL MEASUREMENTS AND GRAZING WEIGHT CHANGE AS INDEPENDENT VARIABLES

	CARCASS WEIGHT (lbs.)		CARCASS FAT (mm.)		QUALITY GRADE[f]		YIELD GRADE		DRESSING PERCENT[g]		RIB EYE AREA ($in.^2$)		% KPH[h]		ADGTOT[i]	
SOURCE	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS
BREED	2	6463.5794***	2	13.2079	2	12.1532****	2	0.0915	2	0.0001	2	0.8947	2	0.4038⁺	2	6.1391***
PASTURE	1	8832.1062***	1	1.6649	1	0.6826	1	0.5412	1	0.0004	1	3.1218*	1	0.0218	1	0.0163
KILL GROUP[a]	4	194496.4802****	4	260.4035****	4	42.9300****	4	5.3299****	4	0.0171****	4	20.2267****	4	2.6432****	4	8.3857****
PURWT[b]	1	50575.2128****	1	2.9593	1	0.0048	1	0.3028	1	0.0001	1	18.9822****	1	0.0004	1	1.9762
INHH[c]	1	722.5246	1	4.5221	1	1.6004	1	0.3326	1	0.0001	1	1.1519	1	0.0026	1	0.0308
INFAT[d]	1	215.5817	1	57.7439*	1	0.4917	1	0.8727*	1	0.0001	1	1.7765	1	0.0365	1	1.1386
AGRZWC[e]	1	43059.4226****	1	7.3519	1	0.1184	1	0.0324	1	0.0001	1	7.2307***	1	0.1460	1	0.0027
ERROR	75	978.4441	75	12.7956	1	1.3081	75	0.2325	75	0.005	75	0.7797	75	0.1478	75	0.9469
R^2		.94		.55		.68		.58		.67		.70		.52		.54

[a]KILL GROUP 1 = 0 days on feed, KILL GROUP 2 = 28 days on feed, KILL GROUP 3 = 56 days on feed, KILL GROUP 4 = 84 days on feed, KILL GROUP 5 = 112 days on feed.

[b]PURWT = initial weight, November 4, 1982.

[c]INHH = initial hip height, November 4, 1982.

[d]INFAT = initial fat thickness (12-13 rib), November 4, 1982.

[e]AGRZWC = average daily gain during grazing treatment,
November 4, 1982 to June 16, 1983 for temporary pasture cattle.
November 4, 1982 to August 5, 1983 for permanent pasture cattle.

[f]Quality grade assigned a numerical value: Standard° = 7, Good° = 10, Choice° = 13, etc.

[g]Dressing percent = hot carcass weight/slaughter weight x .96.

[h]Percent kidney, heart, and pelvic fat subjectively assigned by a USDA grader.

[i]ADGTOT = feedlot average daily gain, lbs./hd./day.

****$p < .001$; ***$p < .005$; **$p < .01$; *$p < .05$; ⁺$p < .10$.

TABLE 9

MEAN SQUARES AND COEFFICIENT OF DETERMINATION VALUES FOR FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF MARTIN STEERS USING INITIAL MEASUREMENTS AND GRAZING WEIGHT CHANGE AS INDEPENDENT VARIABLES

	CARCASS WEIGHT (lbs.)		CARCASS FAT (mm.)		QUALITY GRADE[f]		YIELD GRADE		DRESSING PERCENT[g]		RIB EYE AREA ($in.^2$)		% KPH[h]		ADGTOT[i]	
SOURCE	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS	DF	MS
BREED	1	427.2560	1	1.0023	1	0.6046	1	0.0001	1	0.0011*	1	0.5051	1	0.0601	1	3.4152*
PASTURE	2	3058.6267**	2	11.3963	2	0.3444	2	0.2963	2	0.0011*	2	0.1026	2	0.4975*	2	3.2803**
KILL GROUP[a]	4	187743.6025****	4	322.7434****	4	29.1545****	4	5.3782****	4	0.0180****	4	20.2040****	4	5.6121****	4	5.9755****
PURWT[b]	1	40722.7548****	1	67.1186**	1	1.0302	1	0.8755**	1	0.0010*	1	4.6131**	1	0.1818	1	0.0532
INHH[c]	1	2597.9704***	1	50.9274**	1	1.1924	1	0.6715*	1	0.0006	1	0.7753***	1	0.0439	1	8.4454****
INFAT[d]	1	51.2484	1	25.9166^{+}	1	1.1710	1	0.4751^{+}	1	0.0002	1	0.0120	1	0.1059	1	2.7162*
ACRZWC[e]	1	37175.2727****	1	0.6298	1	0.2132	1	0.0007	1	0.0001	1	4.1206	1	0.3493^{+}	1	1.1036
ERROR	61	592.8923	61	8.5879	61	0.8598	61	0.1336	61	0.0003	61	0.7028	61	0.1172	61	0.5783
R^2		.96		.75		.73		.76		.83		.71		.78		.67

[a]KILL GROUP 1 = 0 days on feed, KILL GROUP 2 = 28 days on feed, KILL GROUP 3 = 56 days on feed, KILL GROUP 4 = 84 days on feed, KILL GROUP 5 = 112 days on feed.

[b]PURWT = initial weight, November 23, 1982.

[c]INHH = initial hip height, November 23, 1982.

[d]INFAT = initial subcutaneous fat, mm, measured on November 23, 1982.

[e]ACRZWC = average daily gain during entire treatment November 23, 1982 to July 18, 1983.

[f]Quality grade assigned a numerical value: Standard° = 7, Good° = 10, Choice° = 13, etc.

[g]Dressing percent = hot carcass weight ÷ slaughter weight x .96.

[h]Percent kidney, heart, and pelvic fat subjectively assigned by a USDA grader.

[i]ADGTOT = feedlot average daily gain, lbs./hd./day.

$****p < .001$; $***p < .005$; $**p < .01$; $*p < .05$; $^{+}p < .10$.

TABLE 10

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR CARWT[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	5532.2234	.01	.93	1	7.7411	.91	.95
PASTURE	1	12776.1333	.001		2	2755.3143	.05	
PURWT[b]	1	124292.3738	.001		1	48920.7636	.001	
INHH[c]					1	3475.7629	.05	
AGRZWC[d]	1	62768.1827	.001		1	33508.3554	.001	
DOF[e]	1	771876.8371	.001		1	757802.6518	.001	
ERROR	80	1021.2358			65	695.4271		

Crossville: $\hat{Y} = -175.2471^{f} + PURWT^{b}\ (.7728) + AGRZWC^{d}\ (152.7442) + DOF^{e}(2.4008)$

Martin: $\hat{Y} = -356.0871^{f} + PURWT^{b}\ (.6257) + INHH^{c}\ (7.2611) + AGRZWC^{d}\ (118.6148) + DOF^{e}\ (2.6539)$

[a]CARWT = carcass weight, lbs.

[b]PURWT = purchase weight, lbs.

[c]INHH = initial hip height, inches.

[d]AGRZWC = daily gain, fall to feedlot.

[e]DOF = days on feed.

[f]Intercept has been adjusted to mean of breed and pasture.

regression coefficient between PURWT and CARWT was b = .61. The partial coefficient reported here indicates that taller, heavier cattle at weaning, managed to gain more during grazing, and allowed longer finishing periods produced heavier carcasses.

Effect of Independent Variables on CARFAT. Kill group (KG) significantly affected carcass fat (CARFAT), as measured at the 12-13 rib, at both locations (Table 8 and Table 9). Initial fat (INFAT) showed a strong tendency to influence CARFAT (level of significance ranges from $p < .05$ at Crossville to $p < .10$ at Martin). Purchase weight (PURWT) and INHH were significant effecters, as well, at Martin. Subsequent models were constructed that included feedlot average daily gain (ADGTOT); it was determined to be effective at Crossville only.

Average grazing weight change (AGRZWC) did not affect CARFAT. Purchase weight (PURWT) and INHH, significant effecters of CARFAT, were also significant effectors of AGRZWC. Once PURWT and INHH were entered into the model, and that portion of the variation assigned to each, AGRZWC dropped in its level of significance.

Final models and prediction equations for CARFAT are presented in Table 11. Days on feed (DOF) is the only factor common to both data sets; its regression coefficient (b = .1089 for Crossville and b = .1104 for Martin) indicate that approximately ten days are required for each additional mm of fat cover. Regression coefficient of b = 1.0407 for ADGTOT, at Crossville, indicates that cattle which are able to express more rapid gains on the same type of feed inputs produced carcasses with greater outside fat cover. The Martin data

TABLE 11

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR CARFAT[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.2769	.98	.45	1	0.3346	.84	.75
PASTURE	1	33.7027	.13		2	9.9947	.30	
PURWT[b]					1	84.7795	.01	
INHH[c]					1	72.4420	.01	
INFAT[d]					1	24.2057	.10	
ADGTOT[e]	1	82.5419	.05					
DOF[f]	1	636.4668	.001		1	1328.0780	.001	
ERROR	63	14.2824			65			
	$\hat{Y}$ = .2419[g] + ADGTOT[e] (1.0407) + DOF[f] (.1089)				$\hat{Y}$ = 25.5345[g] + PURWT[b] (.0271) - INHH[c] (1.6133) + INFAT[d] (.9669) + DOF[f] (.1104)			

[a]CARFAT = carcass fat measured in mm at 12-13th rib interface.

[b]PURWT = purchase weight, lbs.

[c]INHH = initial hip height, inches.

[d]INFAT = initial subcutaneous fat thickness, mm.

[e]ADGTOT = feedlot average daily gain, lbs./hd./day.

[f]DOF = days on feed.

[g]Intercept has been adjusted to mean of breed and pasture.

indicates that cattle heavier in the fall produced carcasses with more external fat. Each fifty pound increase in PURWT increased CARFAT by one millimeter. The positive coefficient for INFAT indicates that those cattle which were fatter at weaning produced carcasses with greater amounts of fat cover. This suggests that cattle with the ability to fatten early, on relatively high nutrition (dam's milk plus pasture), also possess the ability to deposit larger amounts of external fat while on relatively high nutrition (whole-shelled corn) in the feedlot. The negative regression coefficient between CARFAT and INHH suggests that cattle of larger mature size may not have been allowed adequate finishing periods, for their carcasses had less fat than shorter cattle.

Effect of Independent Variables on Quality Grade. Table 8 and Table 9 present the mean squares and coefficient of determination values for the initial models of quality grade (QG). Though reasonable amounts of variation are explained (68-73%), only two variables expressed significant relationships with QG. Kill group (KG) significantly influenced QG at both locations. Breed was an effective predictor at Crossville.

Additional models were constructed that included ADGTOT and DOF replaced KG. Both were found to be significant. The inclusion of ADGTOT resulted in approximately 10% reduction in coefficient of determination values. This was the result of excluding the 0-day kill group, for which there were no ADGTOT figures, thus reducing the total amount of variation, as well as reducing the error degrees of freedom.

Analyses of variance and prediction equations are presented for the final models in Table 12. Positive coefficients of partial regression for DOF indicate that by increasing length of feeding, QG increases. Near equal magnitude and differing signs of coefficients of partial regression of ADGTOT on QG, for the two locations, stimulate one's curiosity and warrants further discussion. These regression coefficients are partial; the effect of other variables, namely DOF, have been held constant. At Martin, with such a wide range of breeds represented, PURWT and ADGTOT may be indicative of a general growth factor of individuals. Cattle heavier at weaning and those which have the ability to express rapid gains would be expected to produce carcasses of higher quality than slow gaining individuals. A more accurate prediction of quality may be the daily gain at the time of slaughter, rather than simply time on feed, or gain on feed. At Crossville, however, where the cattle were of much more similar breeding, ADGTOT was negatively associated with QG. This may be a reflection of composition of gains; as length of feeding period increased, gains will be made of more fat, less bone and muscle, and result in depressed daily gains. Crossville data may also be overly influenced by the compensatory growth cattle experienced the first 28 days on feed. Also, differences may be magnified by the method of calculating ADGTOT. This figure represents the average daily gain for the entire feeding period. A calculation of daily gain nearer the time of slaughter would be expected to produce markedly different results and may be a more accurate estimate of carcass quality.

TABLE 12

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR QUALITY GRADE[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	19.3243	.001	.49	1	0.2865	.60	.59
PASTURE	1	0.3879	.59		2	1.7635	.20	
PURWT[b]					1	3.4156	.10	
ADGTOT[c]	1	4.7381	.10		1	6.3710	.05	
DOF[d]	1	18.0902	.001		1	35.4374	.001	
ERROR	63	1.3247			52	1.0563		
	$\hat{Y} = 9.8815^e - \text{ADGTOT}^c\ (.2493) + \text{DOF}^d\ (.0184)$				$\hat{Y} = 4.5641^e + \text{PURWT}^b\ (.0049) + \text{ADGTOT}^c\ (.3318) + \text{DOF}^d\ (.0275)$			

[a]Quality Grade assigned a numerical value: Standard° = 7, Good° = 10, Choice° = 13, etc.

[b]PURWT = purchase weight, lbs.

[c]ADGTOT = feedlot average daily gain, lbs./hd./day.

[d]DOF = days on feed.

[e]Intercept has been adjusted to mean of breed and pasture.

Effect of Independent Variables on Yield Grade. Kill group (KG) and INFAT had significant effects on yield grade (YG) of cattle at both locations (Table 8 and Table 9). Other factors influencing YG at Martin were PURWT ($p < .001$) and INHH ($p < .01$). Sequential sums of squares indicated a possible duplication between terms of INHH and AGRZWC, at Crossville. Removal of AGRZWC did not affect the significance of INHH, so both were deemed nonsignificant as related to YG. Kill group was again changed to DOF and inserted into the models. Using Crossville data, the quadratic effect of DOF, (DOF^2), was more useful than DOF, in describing the effect of time on carcass yield grade. However, at Martin, the linear form of days on feed (DOF) was adequate.

Analyses of variance and prediction equations for the final models are presented in Table 13. The Crossville data indicate that calves fatter in the fall produced carcasses with higher yield grades. However, the range of values for INFAT (1-5 mm) would affect YG by a factor of less than .75 of a yield grade. The coefficient of partial regression for DOF^2 of $b = .0001$ indicates that the response of YG to DOF would be very minimal for an extended period of time, following which more rapid increases in YG would be seen. One hundred days on feed would be required to increase yield grade by a full grade, as seen by the partial regression coefficient of $b = .0136$ for DOF regressed on YG. Feeders concerned with maintaining low YG values, may lower YG by purchasing either taller or lighter cattle, and finishing them for shorter periods of time. These coefficients seem to describe a taller,

TABLE 13

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR YIELD GRADE FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.0849	.69	.56	1	0.0132	.76	.72
PASTURE	1	1.3147	.05		2	0.5933	.14	
PURWT[a]					1	1.8070	.001	
INHH[b]					1	1.2092	.005	
INFAT[c]	1	0.8477	.10					
DOF[d]					1	20.5848	.001	
DOF^{2}[e]	1	21.0140	.001					
ERROR		0.2252			66	0.1439		

Crossville: $\hat{Y} = 1.6810^{f} + \text{INFAT}^{c}\,(.1342) + \text{DOF}^{2e}\,(.0001)$

Martin: $\hat{Y} = 4.9592^{f} + \text{PURWT}^{a}\,(.0036) - \text{INHH}^{b}\,(.1290) + \text{DOF}^{d}\,(.0136)$

[a]PURWT = purchase weight, lbs.

[b]INHH = initial hip height, inches.

[c]INFAT = initial subcutaneous fat thickness, mm.

[d]DOF = days on feed.

[e]DOF^2 = days on feed, squared.

[f]Intercept has been adjusted to mean of breed and pasture.

lighter animal as being one that will produce a carcass with a higher percent of lean per pound of carcass weight.

<u>Effect of Independent Variables on Dressing Percent</u>. Table 8 and Table 9 present the initial models for dressing percent (DP) of cattle at Crossville and Martin, respectively. The only significant variable common to both locations was KG. At Martin, PURWT significantly ($p < .05$) affected DP. The models were relatively effective in partitioning the variation ($R^2 = .62$ and $R^2 = .83$ for Crossville and Martin, respectively), but no other initial variables were found to be significant. Average grazing weight change (AGRZWC) had no effect on DP: it was replaced by ADGTOT.

Final models constructed with breed, pasture, PURWT, ADGTOT, DOF, and DOF^2 (where applicable) are presented in Table 14. The positive regression coefficients for DOF and DOF^2 indicate that as cattle were fed longer periods of time, fat deposition increased proportionally. The negative relationship between ADGTOT and DP may be influenced by the composition of gains and mature frame size. Cattle of similar PURWT that gained more on test may have been larger-framed cattle. Their gains may have been higher in muscle:fat ratio, thus lowering DP.

<u>Effect of Independent Variables on Rib Eye Area</u>. Mean squares and coefficient of determination values for the initial models of rib eye area (REA) with initial measurements and AGRZWC are presented in Table 8 and Table 9 for Crossville and Martin cattle, respectively. Purchase weight (PURWT) and KG significantly affected REA at both

TABLE 14

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR DRESSING PERCENT[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.0007	.31	.53	1	0.0004	.20	.69
PASTURE	1	0.0006	.31		2	0.0003	.35	
PURWT[b]					1	0.0012	.05	
ADGTOT[c]	1	0.0039	.01		1	0.0008	.10	
DOF[d]					1	0.0252	.001	
DOF^{2e}	1	0.0191	.001					
ERROR	63	0.0005			52	0.0003		
	$\hat{Y}$ = .6023[f] - ADGTOT[c] (.0070) + DOF^{2e} (.000004)				$\hat{Y}$ = .5121[f] + PURWT[b] (.000093) - ADGTOT[c] (.0037) + DOF[d] (.0007)			

[a]Dressing Percent = hot carcass weight/slaughter weight x .96.

[b]PURWT = purchase weight, lbs.

[c]ADGTOT = feedlot average daily gain, lbs./hd./day.

[d]DOF = days on feed.

[e]DOF^2 = days on feed, squared.

[f]Intercept has been adjusted to mean of breed and pasture.

locations. Initial hip height (INHH) significantly affected REA at Martin; however, sequential sums of squares and further models indicated that INHH and AGRZWC were describing the same variation. A further model added AGRZWC, being the more meaningful, easier measurement to record. Kill group (KG) was changed to DOF; Crossville data were described by both linear and quadratic forms of DOF, while Martin data was sufficiently described by the linear term only.

Analyses of variance and the resulting prediction equations for the final models of REA are presented in Table 15. The two data sets are in very close agreement in describing REA. Positive coefficients of partial regression for PURWT, DOF, and AGRZWC indicate that carcasses with larger REA can be produced either by purchasing heavier cattle in the fall, increasing length of finishing time, or by managing backgrounded cattle in such a way as to allow more gain from fall until placed in finishing lot. The relatively small coefficients for DOF^2 of $b = -.0002$ and DOF of $b = .0492$ indicate that REA increases at an almost linear rate, nearly unaffected by DOF^2. At 246 days on feed, REA would no longer respond to increases in DOF. These increases in REA are not based on a constant carcass weight, and thus are interpreted as absolute increases, not as increases in REA as a percent of total carcass weight.

Effect of Independent Variables on KPH. All models constructed to evaluate percent kidney, heart and pelvic fat (KPH) were relatively ineffective. Table 8, p. 35, and Table 9, p. 36, present the initial models for Crossville and Martin data, respectively. Kill group (KG)

TABLE 15

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR RIB EYE AREA ($In.^2$) FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.6796	.44	.67	1	0.0099	.90	.67
PASTURE	1	2.0316	.12		2	0.2957	.67	
PURWT[a]	1	25.5558	.001		1	14.9113	.001	
AGRZWC[b]	1	6.0856	.01		1	4.7846	.01	
DOF[c]	1	26.2038	.001		1	79.0027	.001	
DOF^{2d}	1	8.1299	.005					
ERROR	79	0.8238			66	0.7402		
	$\hat{Y}$ = 1.2576[e] + PURWT[a] (.0111) + AGRZWC[b] (1.5192) + DOF[c] (.0492) - DOF^{2d} (.0002)				$\hat{Y}$ = 2.2677[e] + PURWT[a] (.0086) + AGRZWC[b] (1.3500) + DOF[c] (.0271)			

[a]PURWT = purchase weight, lbs.

[b]AGRZWC = daily gain, fall to feedlot, lbs./hd.day.

[c]DOF = days on feed.

[d]DOF^2 = days on feed, squared.

[e]Intercept has been adjusted to mean of breed and pasture.

was a highly significant effecter of KPH at both locations. Among initial measurements, none were found to have significant relationships with KPH. Initial measurements were removed one at a time, testing significance of the remaining variables; none were significant. No interactions were found to influence KPH.

A final model was constructed which included ADGTOT and DOF. Both were influential in determining KPH, at both locations. Mean squares and coefficient of determination values plus prediction equations for KPH are presented in Table 16. The positive value for DOF indicates that as time of feeding increases, KPH increases as well. Differing coefficients of partial regression for ADGTOT may be suggesting differences confounded within breed. At Crossville, cattle with similar breeding realized increases in KPH with increased daily gain, as expected. However, at Martin, the regression coefficient of b = -.2261 may indicate that faster gaining cattle, within breed or across breed, had greater genetic capabilities to produce more muscle and bone than internal fat (KPH). The difference may also be attributed to the presence of compensatory growth in Crossville cattle. This may be masking the true effect of ADGTOT. It would appear that some unknown environmental force was seen in the Martin cattle, distorting the true values of certain variables, namely, ADGTOT. The coefficients of determination values of R^2 = .35 and R^2 = .43 for Crossville and Martin cattle, respectively, emphasize the fact that inferences based on these data are, at best, of limited value, an suggests perhaps, the variation in KPH is due to the relative inability of the grader to accurately assess KPH, since it is a subjective estimate.

TABLE 16

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR PERCENT KPH[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	0.0320	.81	.35	1	0.4407	.21	.43
PASTURE	1	0.0023	.90		2	0.0073	.97	
ADGTOT[b]	1	0.8850	.05		1	3.0947	.001	
DOF[c]	1	4.2903	.001		1	10.1658	.001	
ERROR	63	0.1519			52	0.2771		
	$\hat{Y} = .4643^{d} + \text{ADGTOT}^{b}\ (.1078) + \text{DOF}^{c}\ (.0089)$				$\hat{Y} = 1.2390^{d} - \text{ADGTOT}^{b}\ (.2261) + \text{DOF}^{c}\ (.0147)$			

[a]Percent KPH subjectively assigned by USDA grader.

[b]ADGTOT = feedlot average daily gain, lbs./hd./day.

[c]DOF = days on feed.

[d]Intercept has been adjusted to mean of breed and pasture.

Effect of Independent Variables on ADGTOT. Mean squares and coefficient of determination values for the initial models of feedlot average daily gain (ADGTOT) are presented in Table 8, p. 35, and Table 9, p. 36, for Crossville and Martin cattle, respectively. Kill group (KG) was the main effecter of ADGTOT at both locations. At Martin, other significant factors included INHH ($p < .001$) and INFAT ($p < .05$). Weight change from the fall through spring/summer grazing (AGRZWC) had no influence on ADGTOT; however, at Martin, ASPGWC was a factor of significance ($p < .01$).

Final models, using significant variables and breed and pasture as independent variables are presented in Table 17. The positive coefficient of PURWT at Crossville denotes that increased fall weaning weight increased feedlot daily gains. The positive regression coefficient for INHH indicates that cattle of presumably larger mature size gained faster in the feedlot. The difference in sign of regression coefficients for DOF of the two locations may represent the difference in compensatory growth seen at Crossville, and the long length of time required for the Martin cattle to get acclimated to the feedlot ration. The coefficient of regression of $b = 0.3436$ for INFAT suggests that cattle with more fat in the fall may be smaller framed cattle; with the length of feeding held constant, cattle of smaller frame, already fatter, tended to decline in rate of gain during the feeding period.

TABLE 17

ANALYSIS OF VARIANCE AND PREDICTION EQUATIONS FOR ADGTOT[a] FROM CATTLE OF TWO LOCATIONS USING BREED, PASTURE AND OTHER SIGNIFICANT VARIABLES AS INDEPENDENT VARIABLES

	LOCATION							
	CROSSVILLE				MARTIN			
SOURCE	DF	MS	P > F	R^2	DF	MS	P > F	R^2
BREED	2	5.2218	.01	.41	1	2.4565	.10	.54
PASTURE	1	0.0708	.80		2	1.9603	.10	
PURWT[b]	1	5.6512	.05					
INHH[c]					1	16.6413	.001	
INFAT[d]					1	2.8283	.10	
DOF[e]	1	22.2374	.001		1	8.8592	.001	
ASPGWC[f]					1	4.7831	.01	
ERROR	63	1.1200			52	0.7739		
	$\hat{Y}$ = 1.5900[g] + PURWT[b] (.0059) - DOF[e] (.0182)				$\hat{Y}$ = 14.8892[g] + INHH[c] (.4737) - INFAT[d] (.3436) + DOF[e] -(.0129) - ASPGWC[f] (.9492)			

[a]ADGTOT = feedlot average daily gain, lbs./hd./day.

[b]PURWT = purchase weight, lbs.

[c]INHH = initial hip height, inches.

[d]INFAT = initial subcutaneous fat thickness, mm.

[e]DOF = days on feed.

[f]ASPGWC = daily gain while on spring/summer grazing treatments, March 4, 1983 to July 18, 1983 for Martin cattle.

[g]Intercept has been adjusted to mean of breed and pasture.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objectives of this study were threefold: (1) to appraise the effect of feeder calf body weight on weight change during wintering and spring/summer grazing; (2) to investigate the effect of compensatory weight change; and (3) to evaluate the effects of subcutaneous fat thickness and hip height on weight changes during winter and spring/summer grazing, as well as carcass traits.

Cattle were utilized at the Plateau Experiment Station (PES) and the Martin Experiment Station (MES). PES cattle were of Hereford, Angus, or Hereford X Angus breeding. MES cattle were of mixed breeding (British X and British X Continental). Each group was wintered, grazed on spring/summer pastures, and finally placed in drylot feeding pens. Cattle were finished on whole-shelled corn plus Tend-R-Leen®, and were serially slaughtered after finishing periods of 0, 28, 56, 84 or 112 days on full feed.

Analysis of variance and multiple regression analyses were conducted to determine factors that had significant effects on grazing data and carcass traits. Steers that performed best under grazing situations were those described as lighter weight and taller at the hips. Those managed for greater winter gains were heavier at the end of spring/summer grazing. Measures of carcass production (ADGTOT, CARWT, REA) were positively affected by PURWT, INHH and DOF. Measures of carcass fatness and carcass quality (CARFAT, QG, YG, DP and KPH) were generally increased with increases in PURWT, INFAT and weight gain during grazing treatments, and were negatively associated with INHH. Based on the results of this trial, a steer that would perform best under backgrounding situations may not produce the best carcass. From a total industry standpoint, the best package may be to use lighter weight, older, larger-framed cattle for backgrounding and alter finishing procedures to better suit them, or alter forage systems, through continued development of improved species, to allow heavier cattle to be used in backgrounding situations, followed by conventional feeding treatments.

LIST OF REFERENCES

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Aberle, E. D., E. S. Reeves, M. D. Judge, R. E. Hunsley and T. W. Perry. 1981. Palatability and muscle characteristics of cattle with controlled weight gain: Time on high energy diet. J. Anim. Sci. 52:757.

Bohman, V. R. 1955. Compensatory growth of beef cattle: The effect of hay maturity. J. Anim. Sci. 14:249.

Bohman, V. R., M. A. Wade and C. Torrell. 1959. Effect of animal fat and protein supplements on range beef cattle. J. Anim. Sci. 18:567.

Bohman, V. R. and C. Torrell. 1956. Compensatory growth of beef cattle: The effect of protein supplements. J. Anim. Sci. 15:1089.

Bowling, R. A., J. K. Riggs, G. C. Smith, Z. L. Carpenter, R. L. Reddish and O. D. Butler. 1978. Production, carcass, and palatability characteristics of steers produced by different management systems. J. Anim. Sci. 46:333.

Brown, C. J., E. J. Warrick, H. J. Smith, W. W. Green and H. A. Stewart. 1956. Relationships between conformation scores and live animal measurements of beef cattle. J. Anim. Sci. 15:911.

Brown, C. J., J. E. Brown and W. T. Butts. 1974. Evaluating relationships among immature measures of size, shape and performance of beef bulls. IV. Regression models for predicting measures of size and shape. J. Anim. Sci. 38:12.

Brown, J. E., C. J. Brown and W. T. Butts. 1972. A discussion of the genetic aspects of weight, mature weight and rate of maturing in Hereford and Angus cattle. J. Anim. Sci. 34:525.

Brown, J. E., C. J. Brown and W. T. Butts. 1973. Evaluating relationships among immature measures of size, shape and performance of beef bulls. III. The relationship between postweaning test performance and size and shape at twelve months. J. Anim. Sci. 37:11.

Butts, W. T., Jr., W. R. Backus, E. R. Lidvall, J. A. Corrick and R. F. Montgomery. 1980a. Relationships among definable characteristics of feeder calves, subsequent performance and carcass traits. I. Objective measurements. J. Anim. Sci. 51:1297.

Butts, W. T., Jr., E. R. Lidvall, W. R. Backus and J. A. Corrick. 1980b. Relationships among definable characteristics of feeder calves, subsequent performance and carcass traits. II. Subjective scores. J. Anim. Sci. 51:1306.

Carroll, F. D., J. D. Ellsworth and D. Koger. 1963. Compensatory carcass growth in steers following protein and energy restriction. J. Anim. Sci. 22:197.

Clanton, D. C., L. E. Jones and M. E. England. 1983. Effect of rate and time of gain after weaning on the development of replacement heifers. J. Anim. Sci. 56:280.

Cole, J. W., C. B. Ramsey, C. S. Hobbs and R. S. Temple. 1963. Effects of type and breed of British, Zebu and dairy cattle on production, palatability and composition. I. Rate of gain, feed efficiency and factors affecting market value. J. Anim. Sci. 22:702.

Connell, W. E., S. S. Wheeler and R. C. Tom. 1948. The effect of winter supplementation on subsequent gains of beef steers on grass and in the fattening lot. J. Anim. Sci. 7:430.

Crouse, J. D., M. E. Dikeman, D. M. Allen and C. E. Murphy. 1974. Prediction of feeder calf performance and subsequent carcass characteristics. J. Anim. Sci. 38:256.

Cundiff, L. V., D. Chambers, D. F. Stephens and R. L. Willham. 1964. Genetic analysis of some growth and carcass traits in beef cattle. J. Anim. Sci. 23:1133.

Durham, R. M. and J. H. Knox. 1953. Correlations between grades and gains of Hereford cattle at different stages of growth and between grades at different times. J. Anim. Sci. 12:771.

Ferrell, C. L. and J. D. Crouse. 1978. Feed utilization by various types of steers. J. Anim. Sci. 47:1167.

Ferrell, C. L., R. H. Kohlmeier, J. D. Crouse and H. Glimp. 1978. Influence of dietary energy, protein and biological type of steer upon rate of gain and carcass characteristics. J. Anim. Sci. 46:255.

Fox, D. G., R. R. Johnson, R. L. Preston, T. R. Dockerty and E. W. Klosterman. 1972. Protein and energy utilization during compensatory growth in beef cattle. J. Anim. Sci. 34:310.

Greene, B. B. 1982. Fattening patterns in yearling steers serially slaughtered after grazing spring-summer cool season pasture. M. S. Thesis, The University of Tennessee, Knoxville.

Guilbert, H. R., G. H. Hart, K. A. Wagnon and H. Goss. 1944. The importance of continuous growth in beef cattle. Calif. Expt. Sta. Bull. 688.

Guilbert, H. R. and P. W. Gregory. 1952. Some factors of growth and development of Hereford cattle. J. Anim. Sci. 11:3.

Heinemann, W. R. and R. W. Van Keuren. 1956. The effect of wintering plane of nutrition on subsequent gains of beef yearling steers on irrigated pastures. J. Anim. Sci. 15:1097.

Hiner, R. L. and J. Bond. 1971. Growth of muscle and fat in steers from 6 to 36 months of age. J. Anim. Sci. 32:225.

Holloway, J. W. and W. T. Butts, Jr. 1983. Influence of preweaning nutrition on growth of Angus calves provided a postweaning nutrition system resulting in discontinuous growth. J. Anim. Sci. 56:1407.

Kidwell, J. F. 1954. Some growth relations in range cattle. J. Anim. Sci. 13:54.

Kidwell, J. F. 1955. A study of the relation between body conformation and carcass quality in fat calves. J. Anim. Sci. 14:233.

Kidwell, J. F. and J. A. McCormick. 1956. The influence of size and type on growth and development of cattle. J. Anim. Sci. 15:109.

Kincaid, C. M., G. W. Litton and R. E. Hunt. 1945. Some factors that influence the production of steers from pasture. J. Anim. Sci. 4:164.

Kincaid, C. M., G. W. Litton and R. E. Hunt. 1947. Age, winter gain and grazing methods as factors in steer production from pasture. J. Anim. Sci. 6:494 (Abstr.).

Knox, J. H. and M. Koger. 1946. A comparison of gains and carcasses produced by three types of feeder steers. J. Anim. Sci. 5:331.

Koger, M. and J. H. Knox. 1951. The correlation between gains made at different periods by cattle. J. Anim. Sci. 10:760.

Lawrence, T. L. J. and J. Pearce. 1964. Some affects of wintering yearling beef cattle on different planes of nutrition. II. Slaughter data and carcass evaluation. J. Agri. Sci. 63:23.

McCampbell, C. W. 1922. The effect of winter rations on summer pasture gains of cattle. Proc. Soc. Anim. Prod. 22:77.

Maino, J. J., A. C. Litton and J. S. Brinks. 1981. Postweaning growth and carcass characteristics of various frame size steers on forage systems. J. Anim. Sci. 52:232.

Meyer, J. H., J. L. Hull, W. H. Weitkamp and S. Bonilla. 1965. Compensatory growth responses of fattening steers following various low energy intake regimes on hay or irrigated pasture. J. Anim. Sci. 24:29.

Nelson, L. A., K. S. Hendrix, R. P. Lemenager and D. C. Petritz. 1980. Comparison of the effects of hay and corn silage growing diets on performance and economic returns of different steer types. J. Anim. Sci. 51:544.

Perry, T. W., D. A. Huber, G. O. Mott, C. L. Rhykerd and R. W. Taylor. 1971. Effect of level of pasture supplementation on pasture, drylot and total performance of beef cattle. I. Spring pasture. J. Anim. Sci. 32:744.

Ridenour, K. W., H. E. Kiesling, G. P. Lofgreen and D. M. Stiffler. 1982. Feedlot performance and carcass characteristics of beef steers grown and finished under different nutrition and management programs. J. Anim. Sci. 54:1115.

Ruby, E. S., C. T. Blunn, E. M. Brouse and M. L. Baker. 1948. Relation of initial weight and subsequent gains of weanling cattle. J. Anim. Sci. 7:279.

Sheets, E. W. 1922. The effect of winter rations on subsequent pasture gains of 2-year-old steers. Proc. Am. Soc. Anim. Prod. 22:64.

Simone, M., F. D. Carroll, C. O. Chichester and J. R. Whitaker. 1961. Quality factors of beef as affected by delayed growth due to protein deficiency. J. Anim. Sci. 20:353.

Stonaker, H. H., M. H. Hazaleus and S. S. Wheeler. 1952. Feedlot and carcass characteristics of individually fed comprest and conventional type Hereford steers. J. Anim. Sci. 11:17.

Sullivan, C. L. 1983. Fattening patterns of yearling steers finished on grain after growth on spring-summer pasture. M. S. Thesis, The University of Tennessee, Knoxville.

Van Stavern, J. W., D. G. Davenport, M. B. Wise and E. R. Barrick. 1970. Prediction of steer performance from initial body weight and digestible energy intake. J. Anim. Sci. 31:1210.

Winchester, C. F. and P. E. Howe. 1955. Relative effects of continuous and interrupted growth on beef steers. USDA Tech. Bull. No. 108.

Wyatt, R. D., M. B. Gould, J. V. Whiteman and R. Totusek. 1977. Effect of milk level and biological type on calf growth and performance. J. Anim. Sci. 45:1138.

Yao, T. S., W. M. Dawson and A. C. Cook. 1953. Relationships between meat production characters and body measurements in beef and milking Shorthorn steers. J. Anim. Sci. 12:775.

Young, L. D., L. V. Cundiff, J. D. Crouse, G. M. Smith and K. E. Gregory. 1978. Characterization of biological types of cattle. VIII. Postweaning growth and carcass traits of three-way cross steers. J. Anim. Sci. 46:1178.

Young, L. G., G. A. Branaman and R. J. Deans. 1962. Influence of rate of grain feeding on gain and carcass characteristics of calves. J. Anim. Sci. 21:621.

VITA

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