FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS: COMPARISON OF SMALL, MEDIUM, AND LARGE FRAME WETHERS BACKGROUNDED ON WHEAT PASTURE

By

MATTHEW E. NICHOLS

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Thesis Approved:

H Glen Dolezal

Thesis Advisor

Clement E Ward

Gerald Fitch

Thomas C. Collins

Dean of the Graduate College

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CHAPTER 1

INTRODUCTION

Excessive carcass fatness is of major concern to the lamb feeding and slaughter industries. Beginning in 1986, the American Sheep Producers Council formed the Consumer Acceptability Task Force to provide guidelines for the production of "lean lamb". That task force identified the following guidelines for lamb carcasses to be certified as "lean lamb. They are: 1) external fat thickness of .10 to 0.25 inch, 2) leg conformation score of average Choice or higher, 3) 3.5% or less kidney and pelvic fat, 4) minimum carcass quality grade of low Choice, and 5) no evidence of ram characteristics. However, this certification program did not gain widespread popularity and thus excessive fattening of lambs continued due to a pricing system that rewarded the production of fat rather than of lean carcasses.

In 1992 the USDA instituted mandatory yield and quality grading procedures for the lamb industry. Accompanying this mandate was a change in the way yield grades for lamb carcasses are determined. Under the new system, a single carcass trait, external fat thickness is used to assign yield grades. Mandatory yield grading should help promote the production of leaner (yield grades 1 and 2) lamb carcasses.

In order to produce carcasses trim enough to meet specifications for yield grades 1 and 2, it is imperative for lamb feeders to identify and manage for the inherent biological variation in growth and maturing patterns among feeder lambs. A lamb market basket survey of six U.S. cities conducted by Harris et al. (1991) reported that while excessive external fat was not present on retail cuts, there was excessive seam fat indicating extensive trimming of fat had occurred prior to presentation at the retail level. They concluded there was a dire need for the lamb industry to develop ways to produce and market leaner lamb. Previous research (Baird, 1989) has shown that frame size of feeder lambs can indicate when a feeder lamb reaches a predetermined level of fatness. However, there is no work documenting the effect backgrounding has upon the weights various frame sizes of lambs reach a certain fat level. The present study was conducted to determine at the weight and number of days in the feedlot required for lambs of small, medium, and large frame size to reach external fat thickness of 0.25 and 0.64 cm.

CHAPTER II

REVIEW OF LITERATURE

Frame Size Influence

In cattle, mature size appears to be positively associated with the weight at which fattening begins (Berg and Butterfield, 1976). In the sheep species, there is a need for more research documenting the effect of frame size upon growth and carcass characteristics. Baird (1989) reported that mature size in sheep was positively correlated with the weight at which the onset of fattening begins. Other available research indicates that sheep of various mature size are similar in composition at maturity, but differ in composition at a weight constant endpoint (Baird, 1989; Butterfield et al., 1983). But in research with cattle, frame size has been shown to be indicative of an animal's potential mature size. The proportion of muscle, fat, and bone at slaughter is influenced by potential mature size. Tatum et al. (1986) found that immature frame (skeletal) size does provide an indication of an animal's mature size and has potential effects upon growth rate and weight at which an animal reaches a certain level of carcass fatness. Their results also show that cattle of larger frame sizes are heavier, when slaughtered at a fat constant endpoint, than small framed cattle. This same study compared cattle of various mature weights and found that at similar weights, larger genotypes were younger, leaner, and less mature. This observation held true in work with lambs by McCann and Craddock (1986) where they slaughtered small and large framed lambs at 50.0, 59.1, and 68.2 kg of live weight to determine what effect frame size had on growth and carcass composition. Their research concluded small framed lambs were fatter at each slaughter weight than large framed lambs. Furthermore, Baird (1989) concluded feeder lamb frame size was indicative of the weight range in which lambs attained a certain external fat thickness as well as the rate at which the lambs deposited fat. Baird (1989) reported increased frame size was associated with a slower rate of fattening and increased slaughter weight or lower values for fat thickness at common slaughter weights.

Baird (1989) reported frame size was not a statistically significant variable affecting rate of growth of lambs on a finishing diet. They found no differences in the growth curves of small, medium, or large frame lambs during a 56 d finishing period. Results by Makarechin et al. (1978), however, showed Suffolk sired lambs had a higher average daily gain then their smaller framed, Dorset sired counterparts. Tatum et al. (1986) reported cattle with larger potential mature size gained more rapidly than those with smaller mature sizes.

Research by McClelland and Russell (1972) found differences in mature weight explained breed differences in body composition when comparing lambs slaughtered at the same weight. Sheep of large framed breed types are heavier at slaughter (Cameron and Drury, 1985). Kempster et al. (1987) reported that those breeds with heavier mature weights required more days on feed to reach a fat constant endpoint. The carcass weight at which different sire breed crosses reach a certain subcutaneous fat level is determined by adult body size.

Baird (1989) reported no difference in the rate of change in quality grade between frame sizes as lambs became heavier. However large, medium, and small frame lambs all had different values for quality grade when compared at common slaughter weights. In research comparing frame sizes in cattle though, Smith et al. (1990) reported a higher percentage of U.S. Choice carcasses from smaller framed steers of British breeding than from Exotic cross steers.

Dressing Percentage

Until recently, dressing percentage has been an important part of the pricing system for lambs. Several studies (Kemp et al., 1970; Lambuth et al., 1970; and Lloyd et al., 1981) have documented that as carcass weight increases, so does dressing percentage. Shelton and Carpenter (1972) have shown that dressing percentage has a curvilinear relationship with carcass weight and that rate of change for dressing percentage accelerated as carcass weight increased. However, this conflicts with results by Atkins and Thompson (1979) who showed that rate of change in dressing percent decreased as slaughter weight increased. This may be because the lambs in the Atkins and Thompson trial were finished on a forage based diet and at a slower rate of gain. Another finding of the Atkins and Thompson work (1979) was that carcasses from faster growing genotypes tended to be smaller in skeletal size and had higher dressing percentages when adjusted to the same carcass weight. Those lambs also had higher fat levels at the 12th/13th ribs than the slower growing genotypes. This larger fat depth could account for the higher dressing percentage reported in the study. Baird (1989) reported a more rapid increase in dressing percentage as live weight increased, but reported no effect of frame size upon dressing percentage. Small frame lambs did tend to have slightly lower dressing percentages.

A study by Butterfield et al. (1983) showed that the head, hide, limbs, and kidneys comprised a greater proportion of the total body weight in a small strain of Merino rams versus the larger strain. The offal made up a greater proportion of the total body weight in the smaller strain of Merino rams which resulted in a lower dressing percentage. This coincides with research on cattle by Jones et al. (1980) which found that smaller framed cattle had a higher proportion of head, hide, liver, kidneys, omasum, and small intestine that large frame cattle. That same work concluded that small framed cattle had lower dressing percentages than large framed cattle when compared on an equal fat thickness basis.

Weight Effects

Increased carcass weight has been shown to affect carcass composition. Traits such as fat thickness, loin eye area, and kidney and pelvic fat all increase, but at a different rate relative to the increases in carcass weight. Fat thickness has been shown to increase as carcass weight increased (Southam and Field, 1969; Kemp et al., 1970; Lambuth et al., 1970; Shelton and Carpenter, 1972; Campion et al., 1976; Atkins and Thompson, 1979; Thompson et al., 1979; Lloyd et al., 1981, Sents et al., 1982; McCann and Craddock, 1986) and the increased carcass fat occurred along with a decrease in percent retail yield (Southam and Field, 1969 and Kemp et al, 1970). Fat thickness increased linearly with increased carcass weight in these studies. Atkins and Thompson (1979) reported that fat depth increased at a rate of 2% for each 1% increase in carcass weight. This increase in carcass weight and fat coincided with a decrease in the proportion of muscle and bone (Thompson 1979).

Loin eye area also increased in a linear manner as live weight increased (Shelton and Carpenter 1972, Lloyd et al., 1981; and Sents et al., 1982). However, even though loin eye area increased as carcasses became heavier, the percentage total yield of retail cuts decreased as slaughter weight increased from 36 to 54 kg in wether lambs (Lambuth et al., 1970). The decline in percentage yield of retail cuts can be attributed to an increase in total carcass fat as slaughter weight increased. Light weight wethers have been shown to yield a superior percentage of retail cuts than heavy weight wethers (Jacobs et al., 1972).

In contrast to the linear increases in fat thickness and loin eye area, kidney and pelvic fat increased quadratically as weight increased (McCann and Craddock, 1986). The percentage of kidney and pelvic fat increased more rapidly between 50 and 59.1 kg slaughter weight than it did between 59.1 and 68.2 kg. This occurrence was the same for both large and small framed lambs, but the rate of increase did differ.

Yield grade was another carcass trait that showed quadratic increases as carcass weight became heavier in a trial by Shelton and Carpenter (1972). As carcass weight increased, the rate of change for yield grades also increased. Sents et al., (1982) reported a yield grade change of 0.4 units with a 9.1 kg increase in live weight.

It has been suggested that live or carcass weight would be of greater value to predict cutability if used within biological type (frame size) and of less value over all biological types as it is currently being used (Crouse et al., 1974).

Wheat Pasture

Wheat pasture trials in which lambs are backgrounded for a period of time allowing them to grow without depositing fat are extremely limited. Noble et al. (1958 and 1959) reported gains of lambs placed onto wheat pasture at a stocking rate of 5 head per acre of 0.178 and 0.200 kg for the two years, respectively. Lambs were on wheat pasture approximately 90 d in both studies and then shipped directly to market. The 1959 study reported gains of 0.17 kg per head per day when the stocking rate was increased to 10 hd per acre.

CHAPTER III

FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS: COMPARISON OF SMALL, MEDIUM, AND LARGE FRAME WETHERS BACKGROUNDED ON WHEAT PASTURE

ABSTRACT

One hundred seventy Texas Rambouillet wethers approximately 7 to 8 months of age were selected from a group of 2000 to represent small (n=54), medium (n=57), and large (n=59) frame groups. Average weights at the start of the trial were 28.6, 32.7, and 35.9 kg for small, medium, and large frame groups, respectively. Lambs were backgrounded on wheat pasture for 105 d with weights recorded at 35 d intervals. Lambs were then weighed and serially slaughtered (approximately 10 head/frame group) at 14 d intervals during a 56 d feedlot finishing phase. Approximately 24 hr postmortem, all measures affecting USDA quality and yield grades were obtained. Frame size had no effect on wheat pasture gain, but average daily gains of small frame lambs (0.27 kg) were lower ($P<.05$) than medium or large framed lambs (0.33 and 0.33 kg, respectively) for the 56 d feedlot

period. Following wheat pasture backgrounding, all frame groups achieved 90 percent U.S. Choice quality grade after 28 d in the feedlot. At a constant slaughter weight (47.7 kg), small framed lambs had higher (P<.05) dressing percentages (51.6% versus 48.7% and 47.9%, respectively), and heavier (P<.05) hot carcass weights (24.6 compared to 23.3 and 22.8 kg, respectively) than medium or large framed groups. The small framed lambs were significantly fatter (0.48 cm) than medium (0.28 cm) or large (0.23 cm) framed lambs at 47.7 kg. Small, medium, and large framed groups all differed (P<.05) in percent kidney and pelvic fat, quality grade, and yield grade. Small, medium , and large framed lambs reached a constant fat thickness (0.38 cm) at slaughter weights of 45.9, 50.9, and 54.6 kg and hot carcass weights of 23.0, 26.1, and 27.8 kg, respectively. At a yield grade of 2.0, according to the 1982 United States standards for grades of lamb, yearling mutton, and mutton carcasses, slaughter weights were 41.9, 44.8, and 48.3 kg (hot carcass weights: 20.0, 21.5, and 23.3 kg) for small, medium, and large framed lambs, respectively. At a constant yield grade of 2.0 under the current standards, slaughter weights may be increased to 48.0 kg for small, 50.8 kg for medium, and 54.4 kg for large framed lambs (hot carcass weights: small = 22.9 kg, medium = 25.6 kg, and large = 27.5 kg). Managing for differences in frame size of lambs backgrounded on wheat pasture can prove beneficial under a mandatory yield grading and value based marketing system.

Key Words: Lamb, Feedlot, Carcass Traits.

INTRODUCTION

Consumer demand for foods with lower fat content have prompted the meat industry to produce and offer leaner products. Unfortunately the pricing structure in the lamb industry has historically emphasized dressing percentage which typically rewards the production of fat. The lamb segment of the industry has been slow to follow the lead of pork and beef producers in reducing the amount of needless fat on finished carcasses. With the advent of the current USDA lamb yield grade system which requires all lamb carcasses that are quality graded to also be yield graded, lamb producers may finally have a mandatory system that would provide a financial signal to produce leaner, more correctly finished carcasses.

Lamb producers and feeders in the southern U.S. have a unique opportunity to benefit from this marketing change by utilizing wheat pasture to grow lambs without depositing excess fat prior to the feedlot phase. This system also allows the marketing of lambs in the spring when prices are typically the highest. To effectively utilize this system, it is crucial that producers recognize the variation in growth patterns of feeder lambs and manage accordingly. The objective of this study was to determine the differences in feedlot performance and carcass traits of lambs representing three different frame sizes that were previously grown on wheat pasture.

MATERIALS AND METHODS

Animals. One hundred fifty five Texas-Rambouillet wether lambs were selected based on frame size from a group of 2000 to satisfy three frame size groups (small=S, medium=M, and large=L). Lambs were approximately 7 months of age. Frame size determination was based on visual assessment by two experienced evaluators. Lambs were transported to the USDA-ARS Grazinglands Research Laboratory at El Reno, OK and fed prairie and alfalfa hay for a 3 wk adjustment period. Lambs were individually identified, dewormed, and weighed prior to being placed on wheat pasture for a 105 d backgrounding period. Live weights were taken every 35 d while on wheat pasture following a 24 h shrink period to minimize fill. Lambs were sheared between d 70 and d 105 while on wheat and individual fleece weights were obtained.

At the conclusion of the 105 d period on wheat pasture, lambs were weighed and placed in the feedlot, penned by frame size (2 pens per frame size). All lambs had ad libitum access to an initial 40% concentrate (corn and soybean meal) and 60% roughage (alfalfa hay) diet. Over the period of the trial, the concentrate level was increased to

85% concentrate. Individual live animal weights were obtained every 14 d in the feedlot, again with a 24 hr shrink period to minimize fill. Feed consumption records for individual pens were recorded each weigh period and the feed intake was adjusted to a dry matter basis. Subsets of lambs (10 per frame) were serially slaughtered on each weigh date (0, 14, 28, 42, and 56 d) at a commercial facility. Three of the 10 lambs with weights nearest the pen mean were slaughtered on d 0, 28 and 56 at the Oklahoma State University Meat Laboratory to facilitate whole body composition testing.

Carcass Data. Each subset of lambs to be slaughtered was transported approximately 300 kilometers and slaughtered within 2 h of arrival at the slaughter facility. Hot carcass weights were recorded at slaughter and after the carcasses were chilled at 0°C for 24 h, chilled carcass weights and complete yield and quality grade data (USDA, 1992) were recorded. A numerical score of 1 to 5 was assigned to categorize fat color (1=yellow to 5=white) for each lamb slaughtered.

Body composition. Following collection of carcass data, the carcasses of the lambs slaughtered at the Oklahoma State facility were split and both sides were weighed. The left side was then fabricated into the major subprimal cuts (233 leg, 232 loin, flank, 204 rack, 207 shoulder, breast, and foreshank) according to the Institutional Meat Purchase Specifications (IMPS) outlined by NAMP (1988). Weights were recorded for the untrimmed subprimals and then at a s.c. fat trim level of 0.39 cm. At this point, the trimmed subprimal was separated into lean, fat, and bone. These constituents were weighed again separately. The fat and lean components from the trimmed left side subprimals were then ground, vacuum packaged, and frozen for later use in proximate analysis.

Proximate Analysis. Proximate analysis of the lean and fat tissue was performed in triplicate following procedures described by AOAC (1984). Each sample was immersed in liquid nitrogen and subsequently powdered in a Waring[R] commercial blendor. Three grams of the powdered sample were placed on ashless filter paper, dried at 100°C for 24 h, desiccated for 1 h and reweighed to determine moisture. Following moisture determination, each sample was placed in a soxhlet for 24 h for ether extraction of lipid followed by drying at 100°C for 12 h. Each sample was then desiccated and reweighed to calculate lipid content.

Statistical Analyses. Differences in means were tested for significance using analysis of variance procedures. Wheat pasture and feedlot performance parameters were analyzed using frame size as a fixed main effect. All slaughter and carcass traits were adjusted via polynomial regression equations to the mean initial weight within frame size. The adjusted traits were used to calculate least squares means at four different slaughter end points (constant weight, fatness, quality grade, and yield grade) using polynomial regression equations for each frame group. Percent U.S. Choice by frame group over feeding time was calculated using non linear regression. Means were tested using Tukey's honest lsd procedure.

RESULTS AND DISCUSSION

Wheat Pasture. Wheat pasture average daily gain (ADG) stratified by frame size is presented in Table 1. While differences (P<.05) in gain existed between frame groups for the first and second 35 d periods, no differences were noted for the entire period (0 to 105 d). During the first 35 d period, a polyarthritis outbreak was diagnosed and all lambs were placed in a drylot for a 9 d treatment period (with chlortetracycline) which severely altered gains (small=0.017, medium=0.022, and large 0.003 kg/hd/d). During the last 35 d of the wheat pasture phase, forage availability was severely limited which would explain why the gains observed (0.065, 0.070, 0.063 kg/hd/d for small, medium, and large framed lambs, respectively) were lower than previous work by Noble et al. (1958) who reported gains around 0.18 kg/hd/d.

Feedlot Performance. Feedlot ADG differed (P<.05) between frame groups but the pattern was not consistent across periods (Table 2). Small framed lambs had greater (P<.05) ADG (0.393 kg/hd/d) than medium framed lambs (0.370 kg/hd/d) during the first 14 d in the feedlot, however during the last two periods (0 to 42 and 0 to 56 d) the small framed lambs had the lowest (P<.05) ADG (0.268 and 0.272 kg/hd/d). These observations indicate that small framed lambs plateaud in growth whereas medium and large framed groups maintained gains throughout the 56 d feedlot phase. All frame groups had lower gains than were reported by Baird (1989) for the feedlot phase. No differences (P>.05) were noted between frame groups for feed efficiency.

Carcass Traits. Carcass traits were examined at several different economically important slaughter endpoints to maximize the information gained from the serial slaughter design. The endpoints chosen for comparison were: 1) constant slaughter weight (47.7 kg), 2) constant subcutaneous fat thickness (0.38 cm), and 3) constant USDA quality grade (low choice). Multiple endpoint comparisons provide greater insight for interpreting growth and developmental differences in carcass traits. Since development is largely age and weight dependent, a weight constant endpoint reflects carcass composition and quality in relation to degree of maturity. Among lambs of diverse types, a weight constant endpoint maximizes differences between early and late maturing types. Fat constant comparisons (constant fat thickness and constant quality grade) contrast differences between lambs at similar stages of development and provide useful marketing implications.

Differences in carcass traits between frame groups were largely a function of the weight or degree of maturity of the lambs at the time of slaughter. Frame-related differences were greatest when comparisons were made at a constant slaughter weight (Table 4). At a constant slaughter weight, fat related traits (actual fat thickness, ACFT; adjusted fat thickness, ADFT) contrasted early versus late maturing frame groups. At a slaughter weight of 47.7 kg, early maturing, small framed lambs produced the heaviest carcasses (small=24.6, medium=23.3, and large=22.8 kg). They were also the fattest both externally (ADFT=0.46, 0.28, and 0.23 cm for small, medium, and large frame groups respectively) and internally (kidney and pelvic fat, small=2.19%, medium=1.52%, large=1.20%) with the highest dressing percent (small=51.6%, medium=48.7%, and large=47.9%). Although these carcasses had the highest quality grade (QG=average choice), they were the lowest in cutability (yield grade=2.23). Conversely, the later maturing, large framed lambs produced the leanest, highest cutability (yield grade=1.54), but lowest QG carcasses (low choice).

Lambs differing in frame size were compared at fat constant related endpoints (Tables 5 and 6). At a constant ADFT (0.38 cm), large framed lambs had heavier ($P<.05$) slaughter (SLWT) and hot carcass (HCW) weights (54.7 and 27.8 kg) than the medium or small frame lambs (51.0 and 46.0 kg SLWT, and 26.1 and 23.0 kg HCW repectively). They also had larger ($P<.05$) ribeye areas (14.65 cm^2) than their smaller framed counterparts (13.87 cm^2). At a constant quality grade (QG) the greatest differences between frame groups were again in (SLWT), (HCW), and ribeye area. Small framed lambs had the lightest ($P<.05$) SLWT (41.0 kg versus 42.1 and 46.1 kg for medium and large framed lambs). Large framed lambs had heavier ($P<.05$) HCW (21.9 kg) than either small(19.4 kg) or medium (19.9 kg) framed lambs. These data along with Figure 1, which graphically illustrates rate of fattening, based on quadratic equations (Appendix A) computed to plot fat thickness across slaughter weight for each frame size, indicate large framed lambs must be fed to heavier slaughter weights to achieve a comparable level of fatness to smaller framed lambs. Likewise, small framed lambs should be slaughtered at lighter weights to prevent overfattening. This is the same trend observed by Baird (1989) for lambs placed directly into the feedlot, but results here indicate by backgrounding, lambs reach a fat thickness of 0.44 cm at heavier weights (small=48.00 kg versus 47.27 kg, medium=53.00 versus 50.45 kg, and large=57.00 versus 55.45 kg) within frames. There was no sigificant difference associated with fat color. However, regardless of frame, there was a numerical tendency for fat to become whiter as days on feed increased.

Carcass Composition. Linear regression equations were computed to plot changes in the body composition variables of muscle to bone ratio, percent fat free lean, percent lean, percent bone, and percent fat over days in the feedlot(Appendix A). Figures 2 through 6 display these relationships. Changes in muscle to bone ratio displayed in Figure 2, indicate that small framed lambs tend to have a faster increase (0.0178 units) than medium (0.0117 units) or larged frame lambs (0.0134 units). Percent fat free lean in the carcass, calculated as the total amount of separable lean in the carcass minus the amount of lipid in the separable lean, is presented in Figure 3. Medium framed lambs had a slightly lower percentage fat free lean over the entire 56 d finishing period than small or large framed lambs, however the small framed lambs tended to have a more rapid decrease (-0.1446 %) per day on feed than the medium (-0.1251 %) or large framed (-0.1046 %) lambs. On the date the trial began, 105 d prior to placement into the feedlot, the large framed lambs had a lower (P<.05) percent fat free lean (least squares means = 48.23 %) than did their small (60.41 %) or medium (55.95 %) framed counterparts (Table 7). Medium framed lambs had exhibited the most rapid decrease (-0.0677 % per day) in percent lean during the 56 d finishing phase (Figure 4). They had the lowest percent decline in percent bone (Figure 5), however there was very little difference between frames in this trait (small=-0.1423 % , medium=-0.1097 %, and large=-0.1224 %). Small and large framed lambs had less change per day in percent fat (small= 0.1337 % and large= 0.1290 %) than the medium framed lambs (0.1774 %).

These trends would indicate that the medium frame lambs had a propensity to have less lean and more fat, on a percentage basis, than their small or large frame counterparts. However, because actual fat thicknesses of greater than 0.762 cm were never achieved by any lambs in the trial, caution must be exercised when interpreting these data. Further, the small subset of lambs allotted for body composition testing (3 lambs per frame) may bias the results. Large framed lambs however, do appear to be leaner as days in the feedlot increase.

IMPLICATIONS

Frame size has been shown to allow for projections of weight required for a lamb to achieve an identified level of carcass fatness. Acknowledging and managing for differences in frame size of lambs backgrounded on wheat pasture and then placed in a feedlot should prove economically beneficial to producers in the Southern Great Plains region. Likewise, such management strategies should prove more economically efficient now that mandatory yield grading is a reality.

TABLE 1. WHEAT PASTURE AVERAGE DAILY GAIN (KG/D) STRATIFIED BY FRAME SIZE.

	Frame size		
Days	Small	Medium	Large
0 to 35	0.017[ab]±0.042	0.022[a] ±0.040	0.003[b]±0.040
0 to 70	0.087[b] ±0.024	0.092[ab]±0.022	0.100[a]±0.022
0 to 105	0.065 ±0.018	0.070 ±0.018	0.063 ±0.015
35 to 70	0.156[b] ±0.008	0.161[b] ±0.008	0.196[a]±0.008
70 to 105	0.025[a] ±0.007	0.018[a] ±0.007	-0.010[c]±0.007

a,b Means in the same row with a different superscript are different(P<.05).

TABLE 2. FEEDLOT AVERAGE DAILY GAIN (KG/D) STRATIFIED BY FRAME SIZE.

	Frame size		
Days	Small	Medium	Large
0 to 14	0.393[a]±0.090	0.370[b]±0.088	0.382[ab]±0.088
0 to 28	0.375 ±0.068	0.391 ±0.066	0.400 ±0.066
0 to 42	0.268[b]±0.066	0.310[a]±0.062	0.327[a] ±0.062
0 to 56	0.272[b]±0.070	0.328[a]±0.068	0.331[a] ±0.064
14 to 28	0.372[b]±0.023	0.440[a]±0.022	0.415[ab]±0.022
28 to 42	0.063[b]±0.029	0.159[a]±0.027	0.208[a] ±0.027
42 to 56	0.286 ±0.034	0.350 ±0.033	0.378 ±0.031

[a,b] Means in the same row with a different superscript are different($P<.05$).

TABLE 3. FEEDLOT FEED EFFICIENCY (FEED/GAIN) STRATIFIED BY FRAME SIZE.

Days	Frame size		
	Small	Medium	Large
0 to 14	5.22[a]	5.56	5.01
0 to 28	5.47	5.40	5.27
0 to 42	6.02	5.55	5.70
0 to 56	6.06	5.67	5.88

[a] Means were not different (P>.05).

TABLE 4. SLAUGHTER AND CARCASS TRAITS STRATIFIED BY FRAME SIZE AT A CONSTANT SLAUGHTER WEIGHT (47.7 KG).

	Frame size			
Trait	Small	Medium	Large	Residual SD[f]
Days fed	55.0	30.0	19.0	--
Slaughter wt. (kg)	47.7	47.7	47.7	--
Hot carcass wt. (kg)	24.6[c]	23.3[d]	22.8[d]	1.285
Dressing percent	51.6[c]	48.7[d]	47.9[d]	1.880
Actual fat thickness(cm)	0.46[c]	0.28[d]	0.18[e]	0.084
Adjusted fat thickness(cm)	0.46[c]	0.28[d]	0.23[d]	0.081
Kidney and Pelvic fat(%)	2.19[c]	1.52[d]	1.20[e]	0.4154
Ribeye Area(cm^2)	14.19[c]	13.23[d]	12.77[d]	0.053
Yield grade[a]	2.23[c]	1.82[d]	1.54[e]	0.401
Quality grade[b]	11.1[c]	10.5[d]	10.2[e]	0.552
% Choice	98.9	98.7	95.9	
SE coefficient[f]	1.209	1.001	1.043	

a USDA, 1992.

b $Choice^-$=10, $Choice^o$=11, $Choice^+$=12; USDA, 1982.

c,d,e Means in the same row with a different superscript are different(P<.05).

f Standard error of a least squares mean can be determined by multiplying the SE coefficient X standard deviation of a trait, e.g., SE of Hot carcass wt. for Small framed = 1.209 X 1.285 = 1.554.

TABLE 5. SLAUGHTER AND CARCASS TRAITS STRATIFIED BY FRAME SIZE AT A CONSTANT ADJUSTED FAT THICKNESS (0.38 CM).

	Frame size			
Trait	Small	Medium	Large	Residual SD[e]
Days fed	41.0	42.0	41.0	--
Slaughter wt. (kg)	46.0[d]	51.0[c]	54.7[b]	2.182
Hot carcass wt. (kg)	23.0[d]	26.1[c]	27.8[b]	1.289
Dressing percent	50.1	50.6	50.8	1.880
Actual fat thickness(cm)	0.33	0.37	0.36	0.084
Adjusted fat thickness(cm)	0.38	0.38	0.38	--
Kidney and Pelvic fat(%)	1.87	1.98	1.95	0.415
Ribeye Area(cm^2)	13.87[c]	14.32[b]	14.65[b]	0.511
Quality grade[a]	10.8	10.9	11.0	0.552
% Choice	98.2	100.0	100.0	--
SE coefficient[e]	1.053	1.059	1.049	

a Choice$^-$=10, Choice^o=11, Choice$^+$=12; USDA, 1982.

b,c,d Means in the same row with a different superscript are different(P<.05).

e Standard error of a least squares mean can be determined by multiplying the SE coefficient X standard deviation of a trait, e.g., SE of Hot carcass wt. for Small framed = 1.053 X 1.289 = 1.357.

TABLE 6. SLAUGHTER AND CARCASS TRAITS STRATIFIED BY FRAME SIZE AT A CONSTANT QUALITY GRADE (LOW CHOICE).

	Frame size			
Trait	Small	Medium	Large	Residual SD[f]
Days fed	20.0	13.0	15.0	--
Slaughter wt. (kg)	41.0[e]	42.1[d]	46.1[c]	2.182
Hot carcass wt. (kg)	19.4[d]	19.9[d]	21.9[c]	1.289
Dressing percent	47.2	47.4	47.5	1.880
Actual fat thickness(cm)	0.18[c]	0.13[d]	0.15[cd]	0.084
Adjusted fat thickness(cm)	0.23	0.20	0.20	0.081
Kidney and Pelvic fat(%)	1.30	1.10	1.10	0.415
Ribeye Area(cm^2)	11.94	11.74	12.52	0.511
Quality grade[b]	10.0	10.0	10.0	10.0
% Choice	89.6	91.0	92.4	--
SE coefficient[e]	1.019	1.068	1.048	

a USDA, 1992.

b Choice$^-$=10, Choice^o=11, Choice$^+$=12; USDA, 1982.

c,d,e Means in the same row with a different superscript are different($P<.05$).

f Standard error of a least squares mean can be determined by multiplying the SE coefficient X standard deviation of a trait, e.g., SE of Hot carcass wt. for Small framed = 1.019 X 1.289 = 1.314.

TABLE 7. LEAST SQUARES MEANS FOR BODY COMPOSITION TRAITS AT TIME OF PLACEMENT ONTO WHEAT PASTURE STRATIFIED BY FRAME SIZE.

	Frame size		
Trait	Small	Medium	Large
Muscle/Bone ratio	2.42	2.64	2.19
Percent fat free lean	60.41[a]	55.95[a]	48.23[b]
Percent lean	68.68	69.80	63.13
Percent bone	28.49	27.00	33.06
Percent fat	2.82	3.20	3.81

[a,b] Means in the same row with a different superscript are different($P<.05$).

FIGURE 1. RATE OF FAT DEPOSITION BY SLAUGHTER WEIGHT STRATIFIED BY FRAME SIZE.

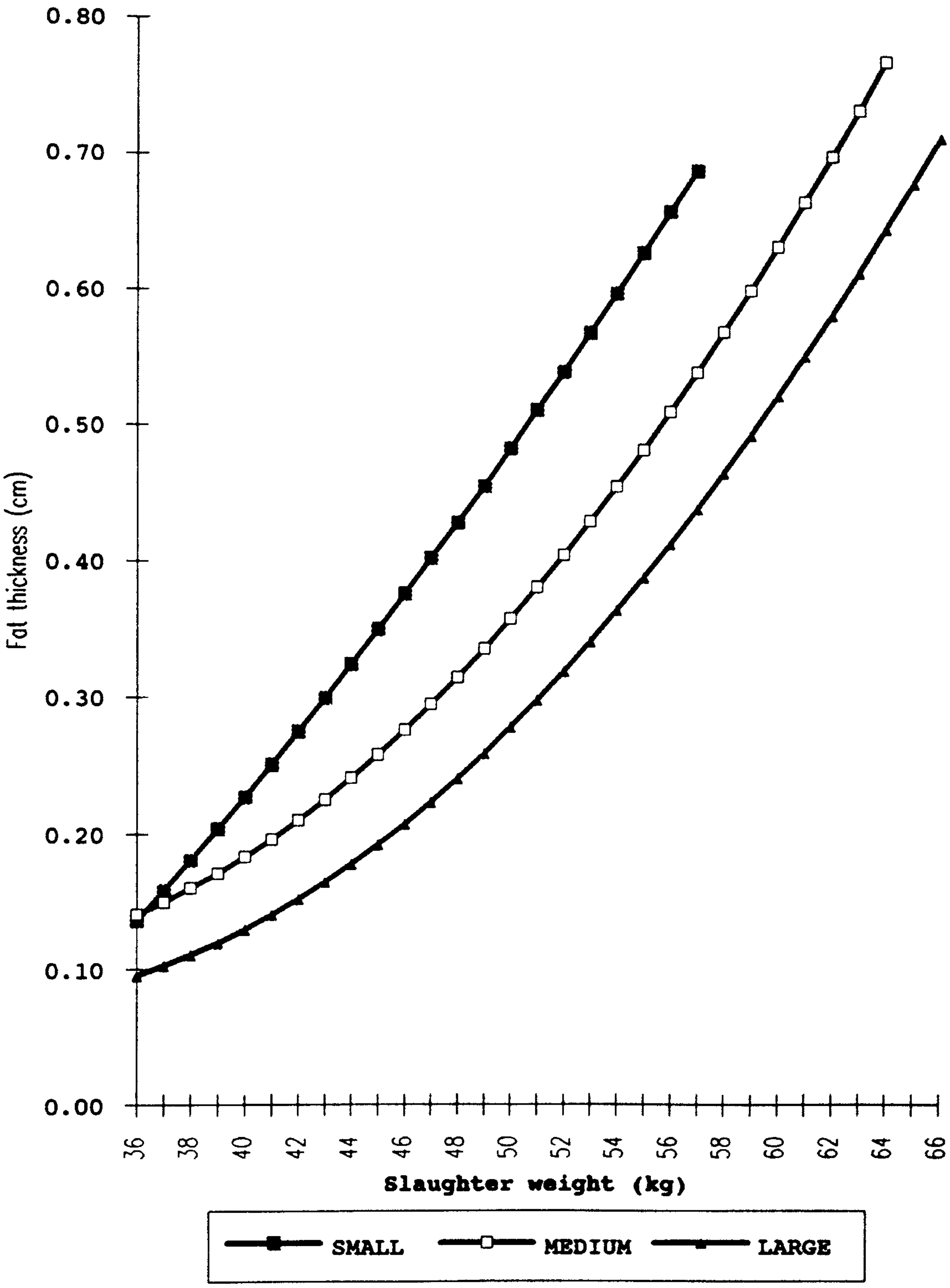


FIGURE 2. MUSCLE TO BONE RATIO BY DAYS IN FEEDLOT STRATIFIED BY FRAME SIZE.

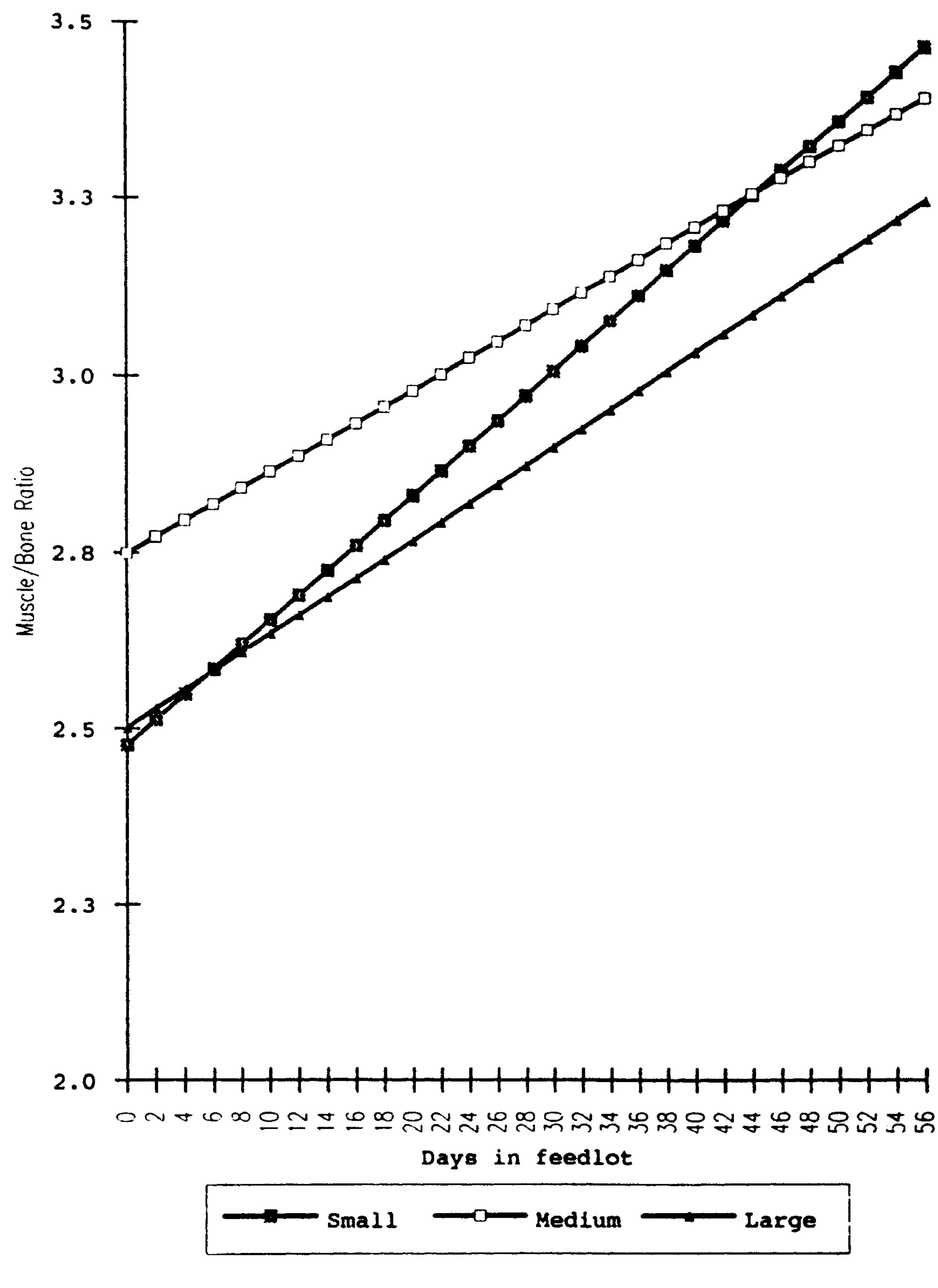


FIGURE 3. PERCENT FAT FREE LEAN BY DAYS IN FEEDLOT STRATIFIED BY FRAME SIZE.

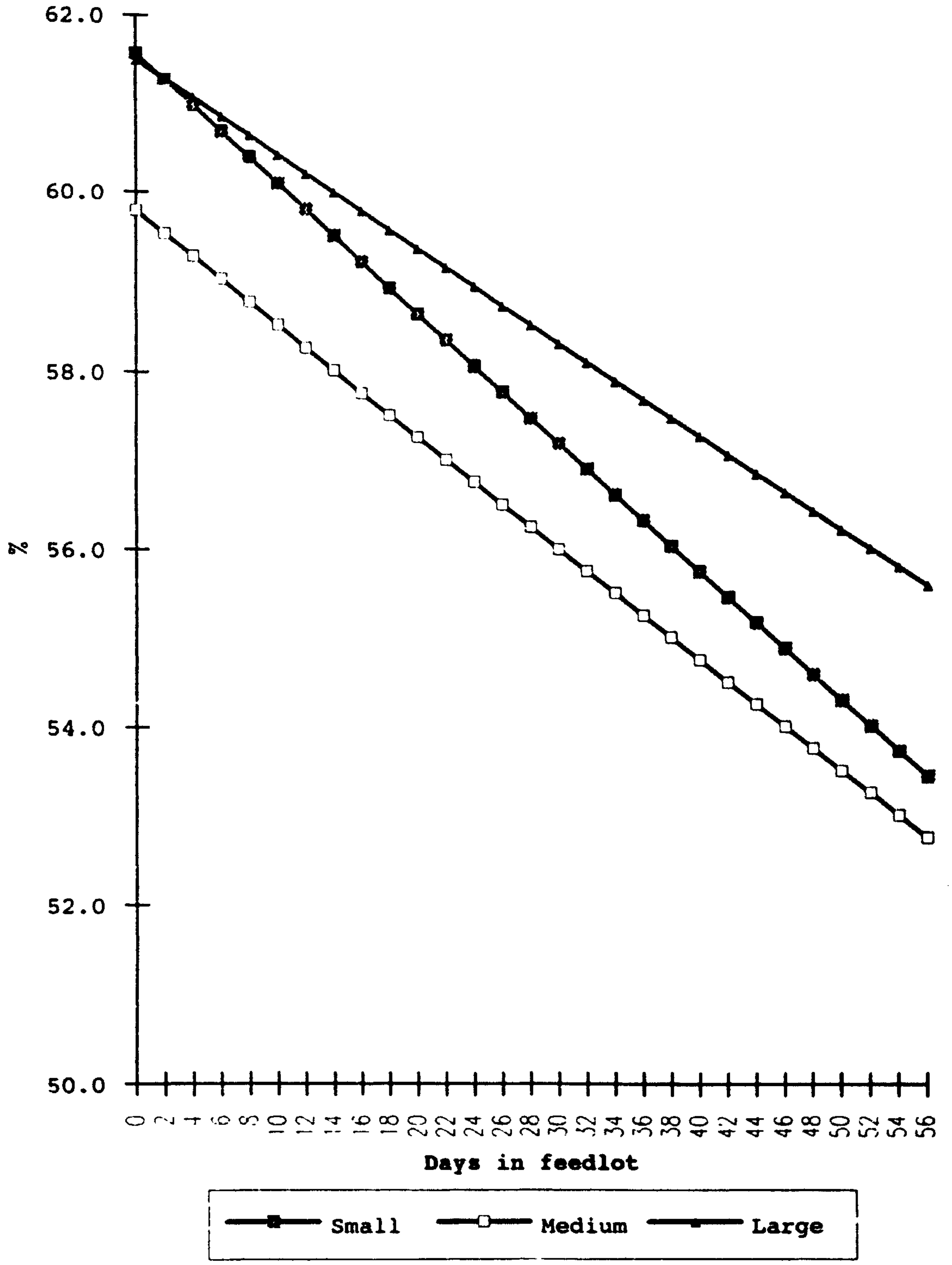


FIGURE 4. PERCENT LEAN BY DAYS IN FEEDLOT STRATIFIED BY FRAME SIZE.

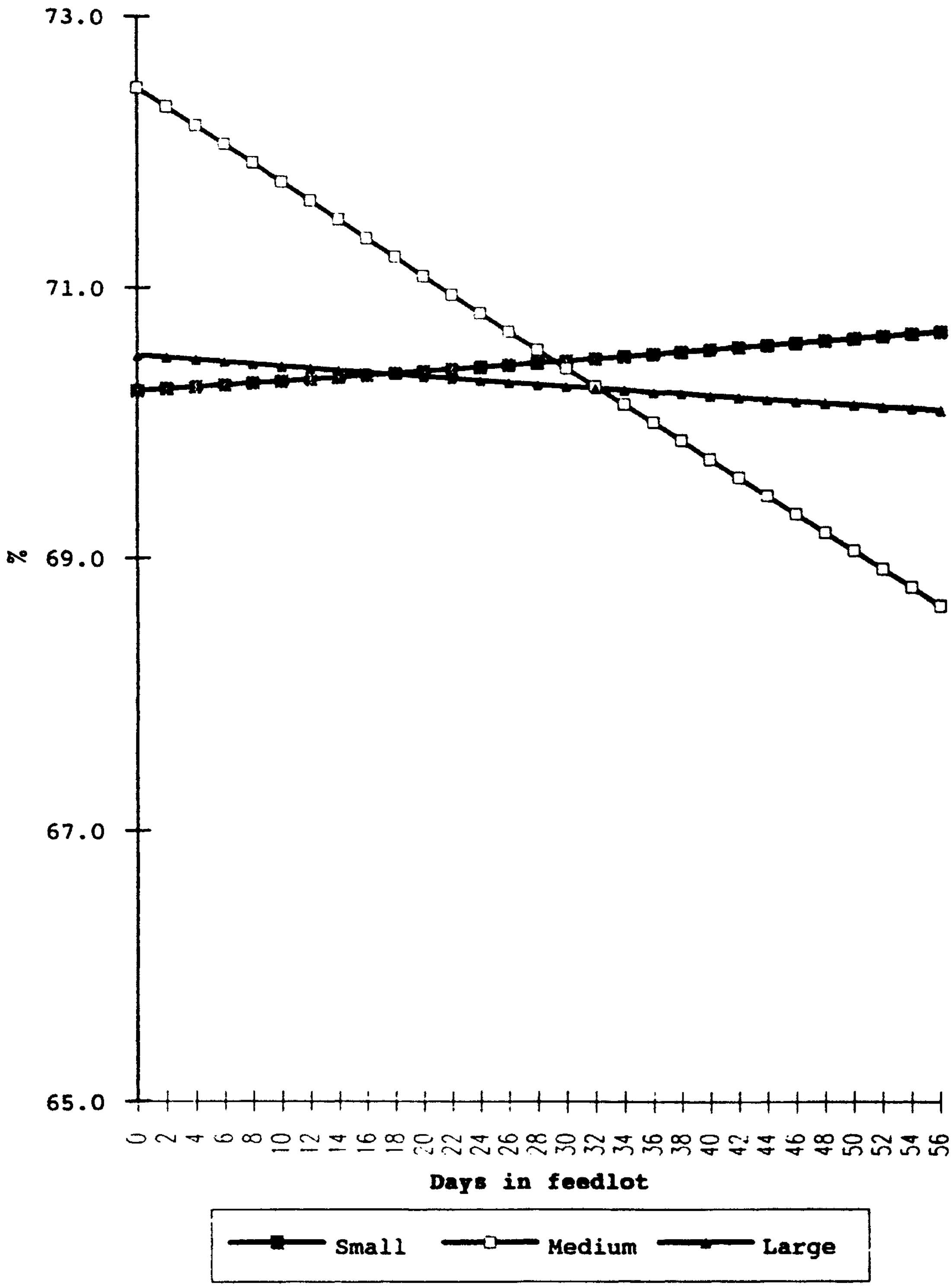


FIGURE 5. PERCENT BONE BY DAYS IN FEEDLOT STRATIFIED BY FRAME SIZE.

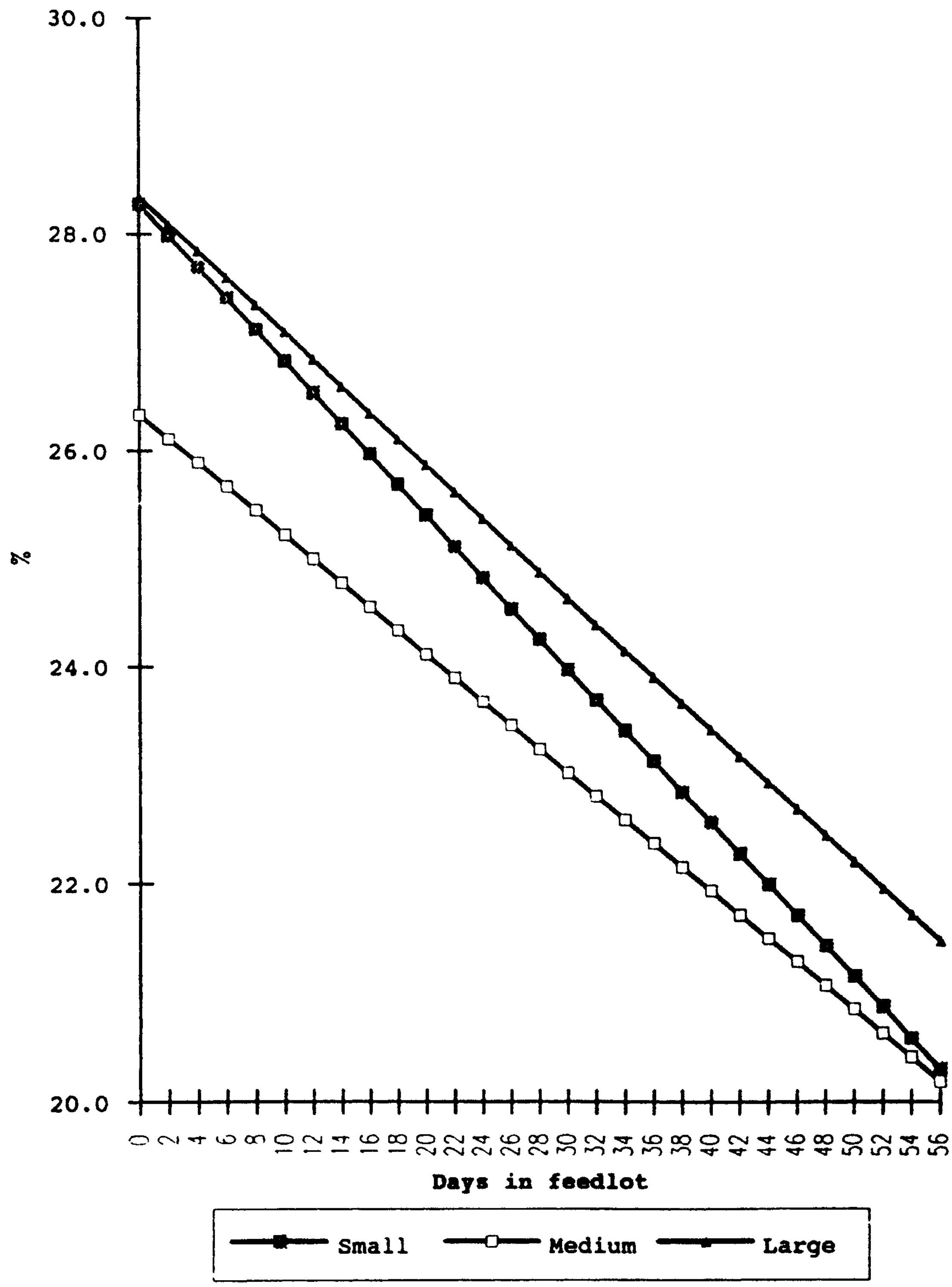
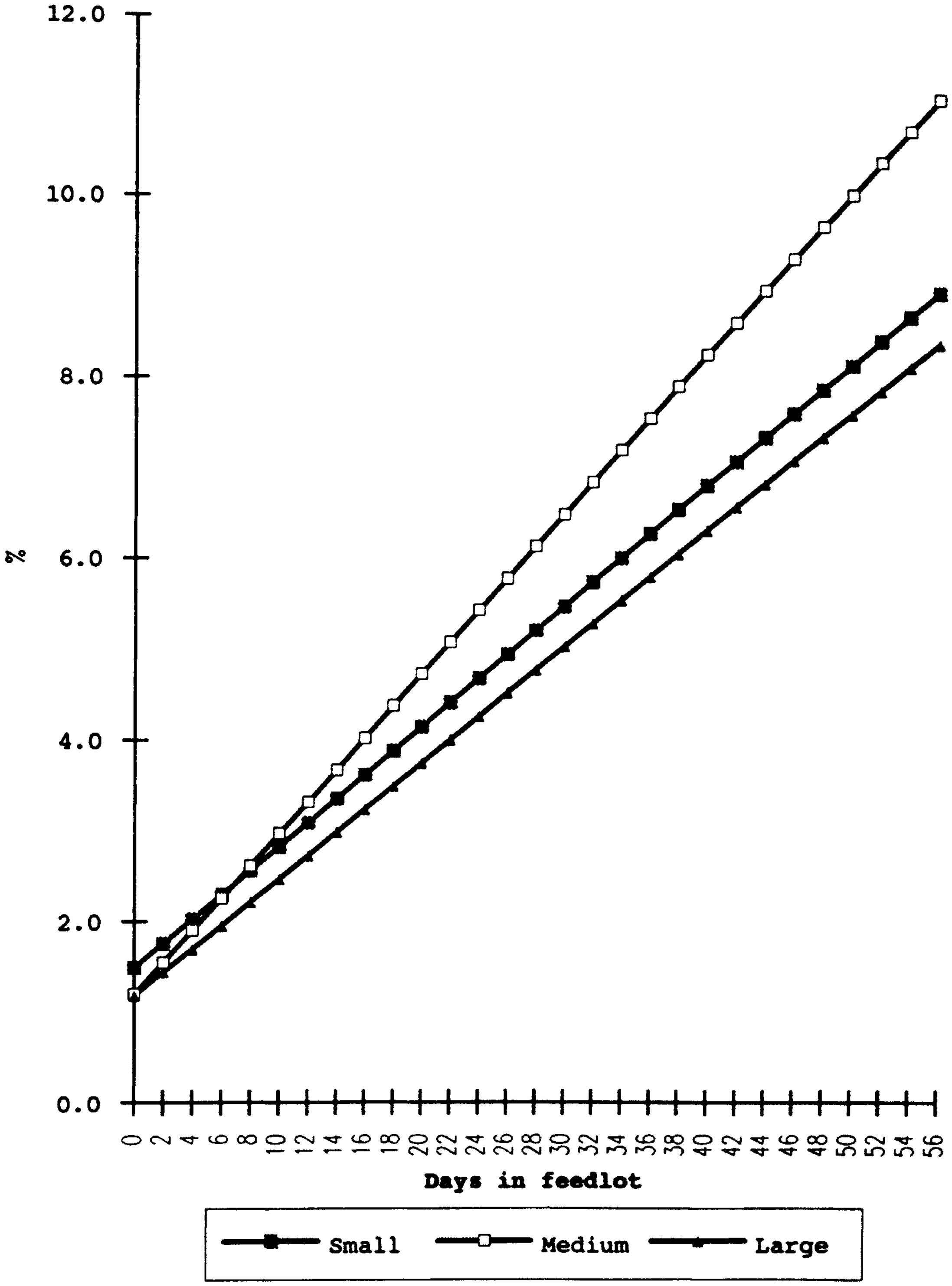


FIGURE 6. PERCENT FAT BY DAYS IN FEEDLOT STRATIFIED BY FRAME SIZE.



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APPENDIX A

TABLE A-1. COEFFICIENTS FOR REGRESSION OF ADJUSTED FAT THICKNESS (cm) ON SLAUGHTER WEIGHT (kg).[a]

Variable	Frame size		
	Small	Medium	Large
β_0	-0.3890685639	0.4624134369	0.4710138600
β_1	0.0070946373	-0.0266817181	-0.0273913402
β_2	0.0002077380	0.0004922947	0.0004710834
R^2	0.701437	0.634090	0.754830
RSD	0.090230	0.099509	0.079927

[a] Adjusted fat thickness (cm) = β_0 + β_1*slaughter wt. + β_2*slwt^2.

TABLE A-2. COEFFICIENTS FOR REGRESSION OF MUSCLE TO BONE ON DAYS IN FEEDLOT[a]

Variable	Frame size		
	Small	Medium	Large
β_0	2.477642863	2.749353760	2.501951714
β_1	0.017817126	0.011675793	0.013425215
R^2	0.681942	0.587978	0.577061
RSD	0.315429	0.253367	0.297943

[a] Muscle to bone = $\beta_0 + \beta_1$*days in feedlot.

TABLE A-3. COEFFICIENTS FOR REGRESSION OF PERCENT FAT FREE LEAN ON DAYS IN FEEDLOT[a]

Variable	Frame size		
	Small	Medium	Large
β_o	61.57401605	59.79368870	61.50099710
β_1	-0.14460389	-0.12507201	-0.10460123
R^2	0.729910	0.642310	0.715664
RSD	2.280260	2.419503	1.709161

[a] Percent fat free lean = β_o + β_1*days in feedlot.

TABLE A-4. COEFFICIENTS FOR REGRESSION OF PERCENT LEAN ON DAYS IN FEEDLOT[a]

Variable	Frame size		
	Small	Medium	Large
β_0	70.23626203	72.47335675	70.50265688
β_1	0.00869014	-0.06770907	-0.00660835
R^2	0.014592	0.340043	0.003771
RSD	1.851252	2.445182	2.784397

[a] Percent lean = $\beta_0 + \beta_1$*days in feedlot.

TABLE A-5. COEFFICIENTS FOR REGRESSION OF PERCENT BONE ON DAYS IN FEEDLOT[a]

Variable	Frame size		
	Small	Medium	Large
β_0	28.27238762	26.33145374	28.31449498
β_1	-0.14234090	-0.10967710	-0.12243969
R^2	0.767585	0.742055	0.717103
RSD	2.030405	1.676280	1.993565

[a] Percent bone = $\beta_0 + \beta_1$*days in feedlot.

TABLE A-6. COEFFICIENTS FOR REGRESSION OF PERCENT FAT ON DAYS IN FEEDLOT[a]

Variable	Frame size		
	Small	Medium	Large
β_o	1.494350357	1.19589510	1.182848141
β_1	0.133650765	0.177386179	0.129018033
R^2	0.784479	0.755851	0.679458
RSD	1.815979	2.613446	2.297722

[a] Percent fat = β_o + β_1*days in feedlot.

TABLE A-7. SLAUGHTER AND CARCASS TRAIT MEANS BY FRAME FOR BODY COMPOSITION SUBSETS

Trait	Frame size		
	Small	Medium	Large
Days in feedlot = 0			
Slaughter wt. (kg)	33.3	37.2	39.8
Hot carcass wt. (kg)	14.3	17.4	18.5
Dressing percent	42.9	46.5	46.4
Actual fat thickness (cm)	0.000	0.004	0.001
Adjusted fat thickness (cm)	0.075	0.149	0.091
Kidney and Pelvic fat (%)	0.499	1.013	0.552
Ribeye area (cm^2)	2.96	3.79	3.77
Yield grade[a]	1.14	1.24	1.15
Quality grade[b]	8.8	8.9	9.0
Days in feedlot = 28			
Slaughter wt. (kg)	40.17	48.70	48.84
Hot carcass wt. (kg)	19.04	17.37	23.31
Dressing percent	47.46	45.66	46.71
Actual fat thickness (cm)	0.219	0.208	0.177
Adjusted fat thickness (cm)	0.273	0.149	0.234
Kidney and Pelvic fat (%)	1.54	1.51	1.53
Ribeye area (cm^2)	3.99	3.79	4.69
Yield grade[a]	1.57	1.47	1.41
Quality grade[b]	9.8	10.5	10.0

a USDA, 1992.

b $Choice^-$=10, $Choice^o$=11, $Choice^+$=12; USDA, 1982.

TABLE A-7. SLAUGHTER AND CARCASS TRAIT MEANS BY FRAME FOR BODY COMPOSITION SUBSETS

Trait	Frame size		
	Small	Medium	Large
Days in feedlot = 56			
Slaughter wt. (kg)	44.97	53.14	56.09
Hot carcass wt. (kg)	23.63	28.20	30.20
Dressing percent	49.57	51.17	52.00
Actual fat thickness (cm)	0.272	0.443	0.258
Adjusted fat thickness (cm)	0.342	`0.443	0.263
Kidney and Pelvic fat (%)	1.93	2.70	2.48
Ribeye area (cm^2)	4.34	5.06	5.90
Yield grade[a]	1.90	1.73	1.60
Quality grade[b]	11.5	11.9	11.0

[a] USDA, 1992.

[b] $Choice^-$=10, $Choice^o$=11, $Choice^+$=12; USDA, 1982.

APPENDIX B

FIGURE B-1. MUSCLE TO BONE RATIO BY SLAUGHTER WEIGHT STRATIFIED BY FRAME SIZE.

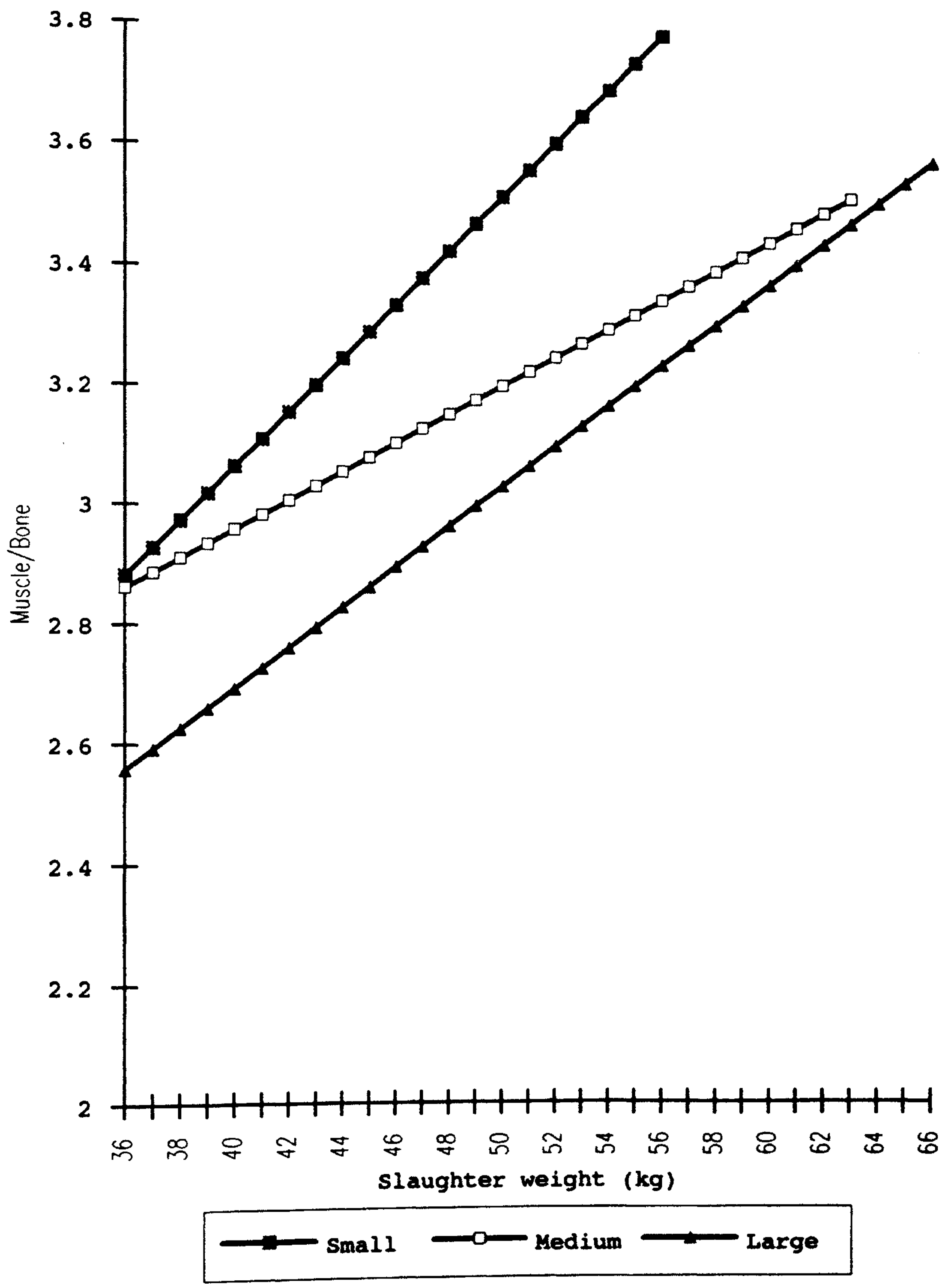


FIGURE B-2. PERCENT FAT FREE LEAN BY SLAUGHTER WEIGHT STRATIFIED BY FRAME SIZE.

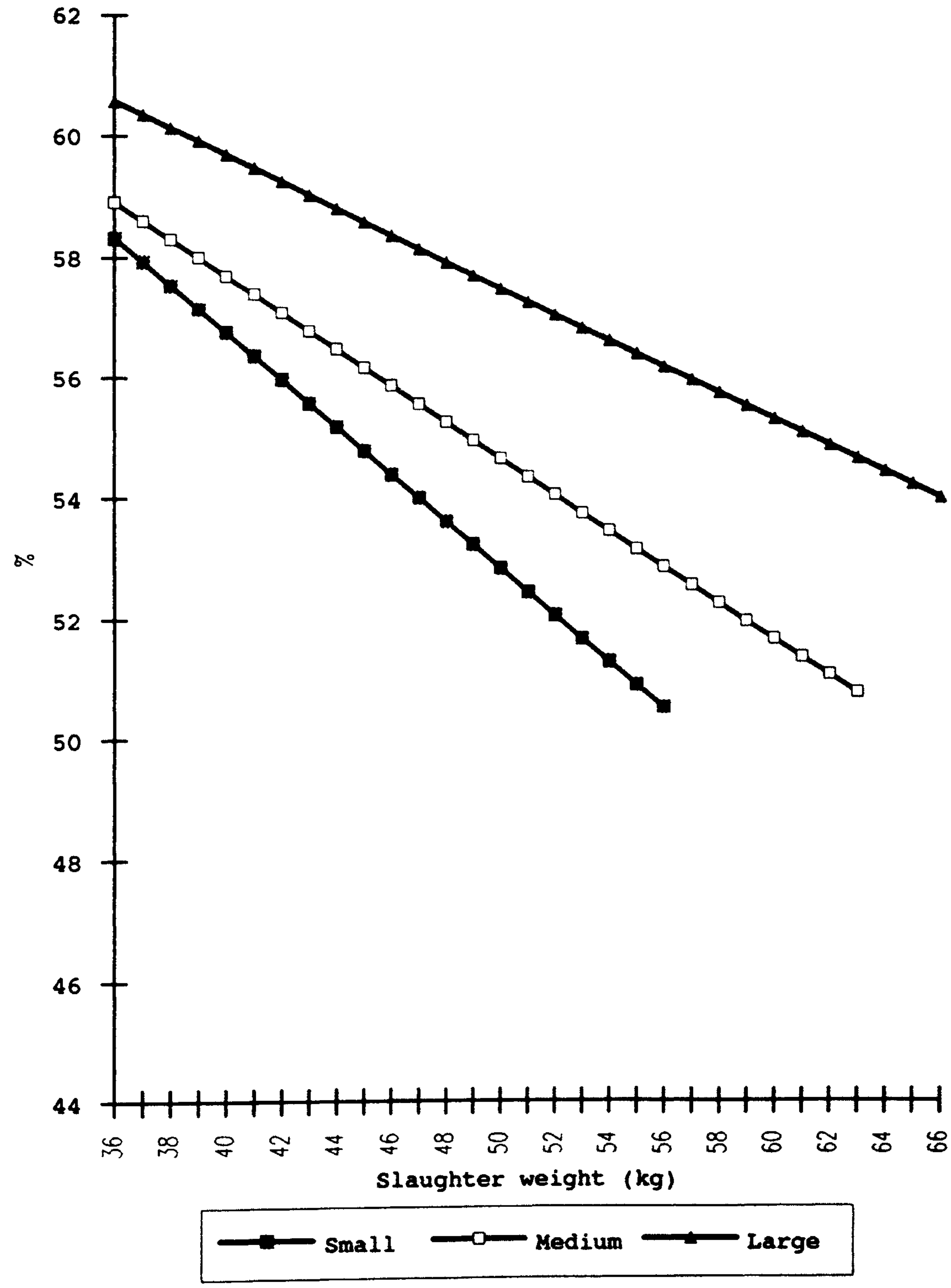


FIGURE B-3. PERCENT LEAN BY SLAUGHTER WEIGHT STRATIFIED BY FRAME SIZE.

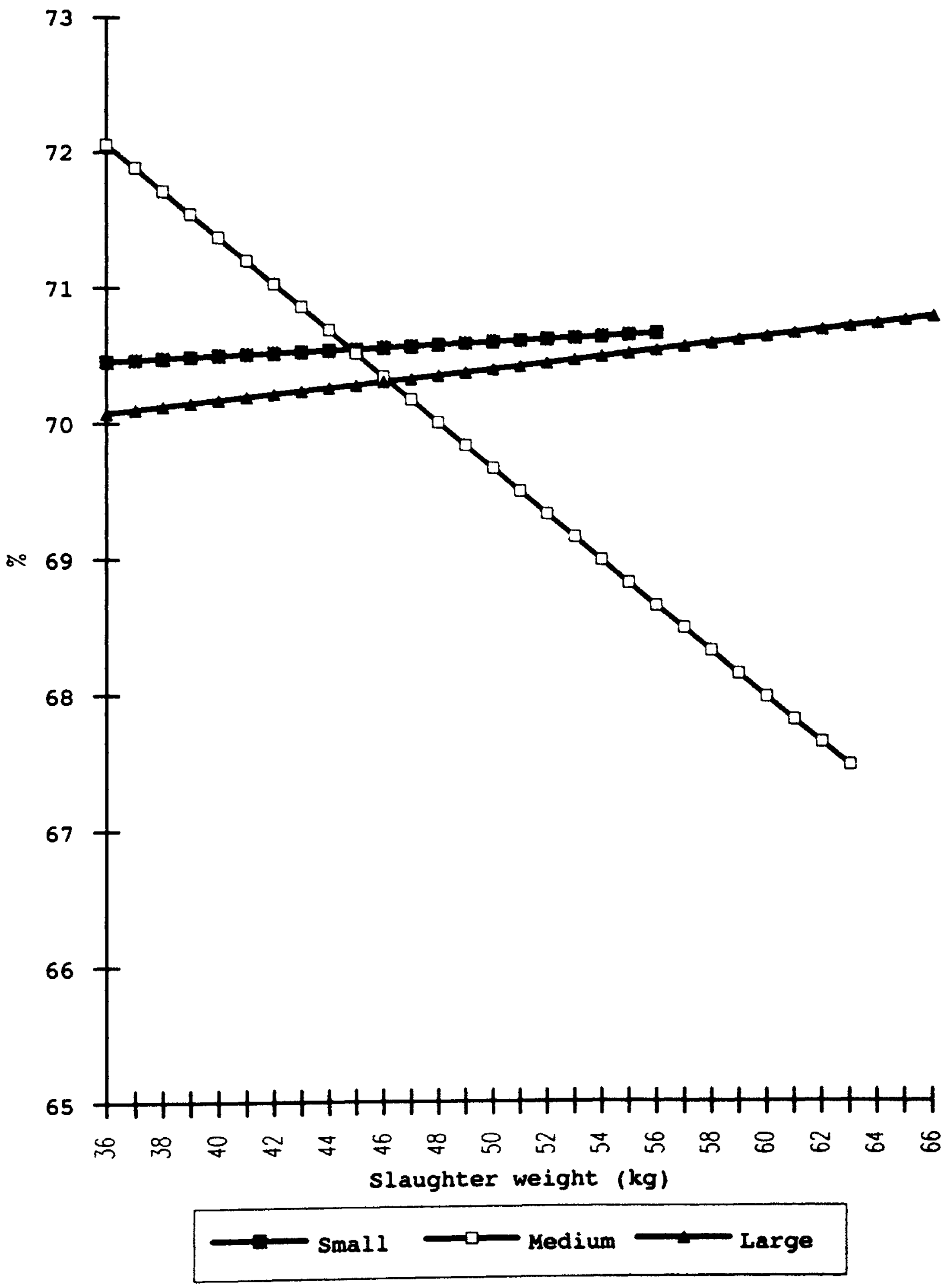


FIGURE B-4. PERCENT BONE BY SLAUGHTER WEIGHT STRATIFIED BY FRAME SIZE.

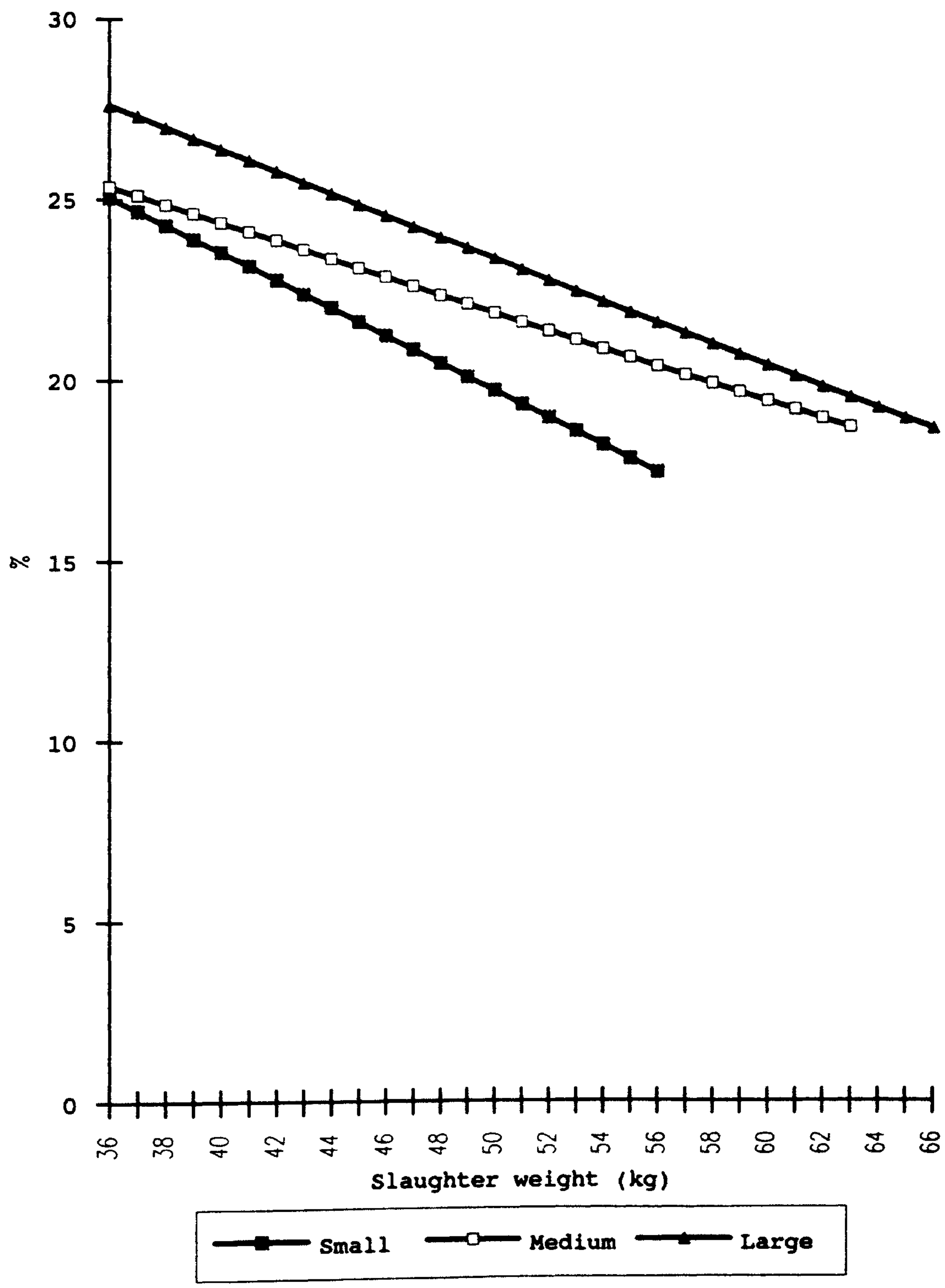
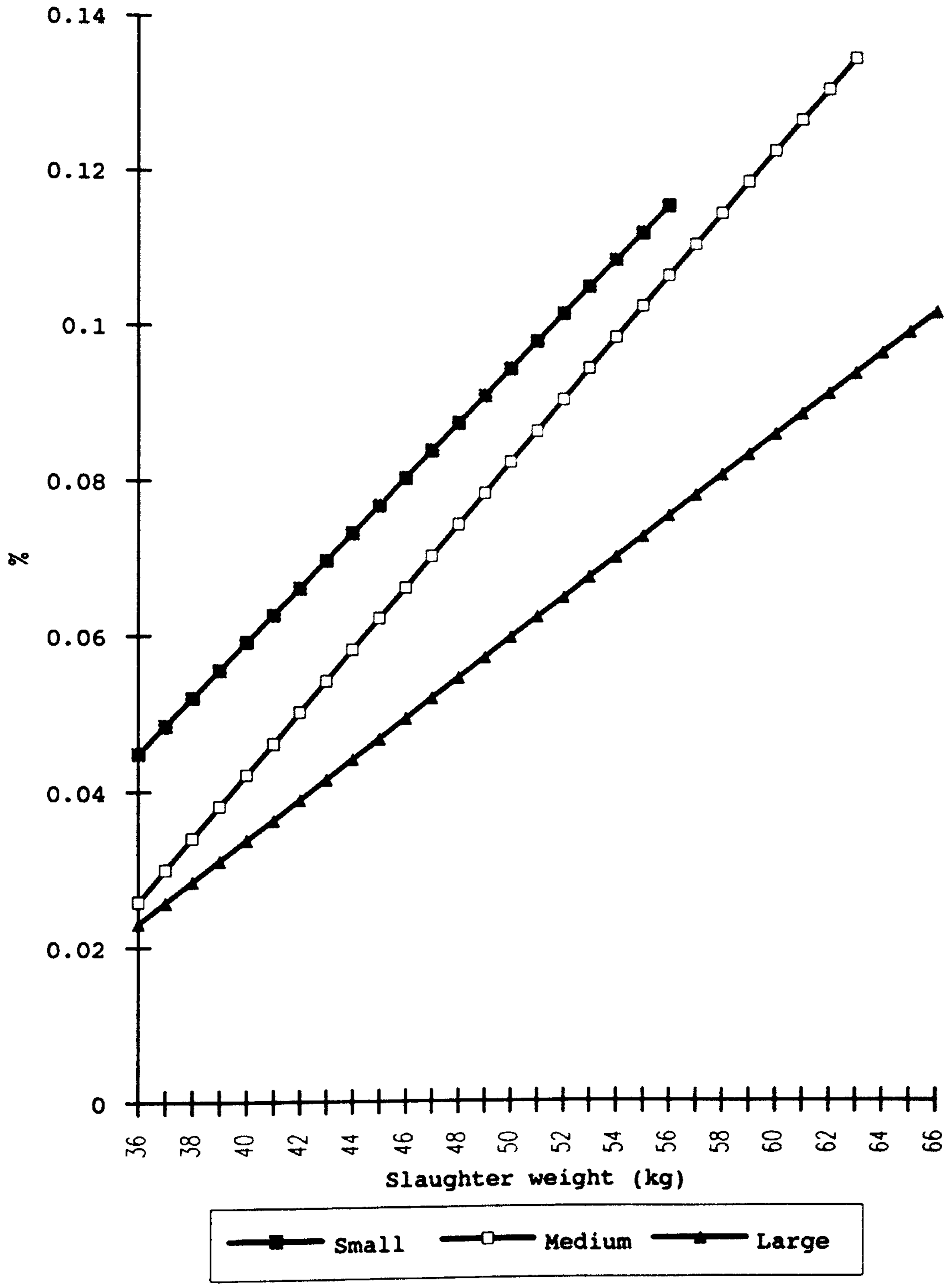


FIGURE B-5. PERCENT FAT BY SLAUGHTER WEIGHT STRATIFIED BY FRAME SIZE.



VITA

MATTHEW E NICHOLS

Candidate for the Degree of

Master of Science

Thesis: FEEDLOT PERFORMANCE AND CARCASS CHARACTERISTICS: COMPARISON OF SMALL, MEDIUM, AND LARGE FRAME WETHERS BACKGROUNDED ON WHEAT PASTURE

Major Field: Animal Science

Biographical:

Personal Data: Born in Topeka, Kansas November 12, 1967, the son of Jack and Connie Nichols. Married Beverly Annan on June 2, 1990.

Education: Graduated from Russell High School, Russell, Kansas, in May 1986; received the Bachelor of Science Degree from Kansas State University, Manhattan, Kansas in May, 1990; completed requirements for the Master of Science Degree at Oklahoma State University, Stillwater, Oklahoma, May 1994; completed requirements for the Master of Business Administration Degree at Oklahoma State University, Stillwater, Oklahoma, May 1994.

Professional Experience: Assistant Shepherd, Department of Animal Science, Kansas State University, August, 1988 to May, 1990; Teaching Assistant, Department of Animal Science, Oklahoma State University, July, 1990 to August 1992.

Professional Organizations: Animal Science Department Graduate Student Association; Graduate Students in Business Administration Association.