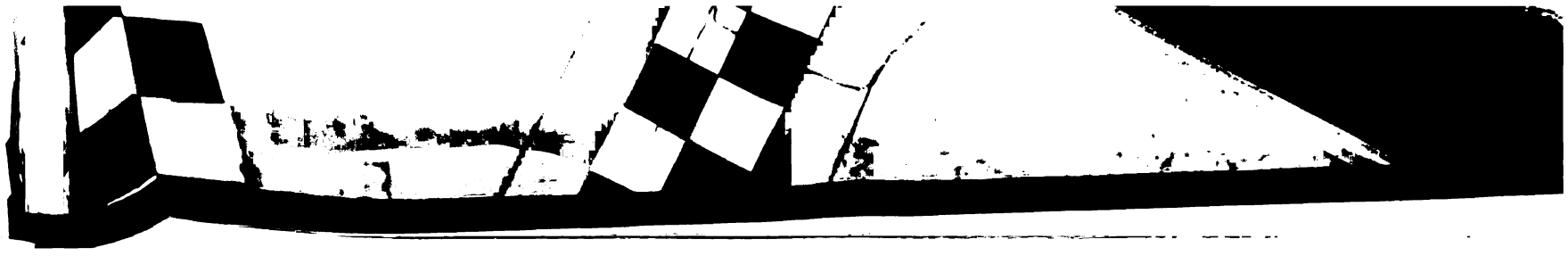

PERFORMANCE AND CARCASS CHARACTERISTICS IN INDIVIDUALLY FED STEER AND HEIFER CALVES

By

Amos Paul Kennedy, Sr.

A THESIS

Submitted to the School of Graduate Studies of Michigan State University of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Animal Husbandry

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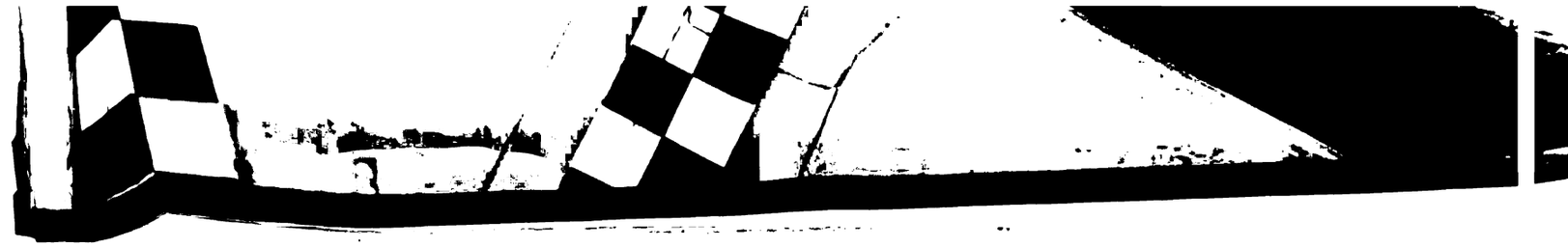


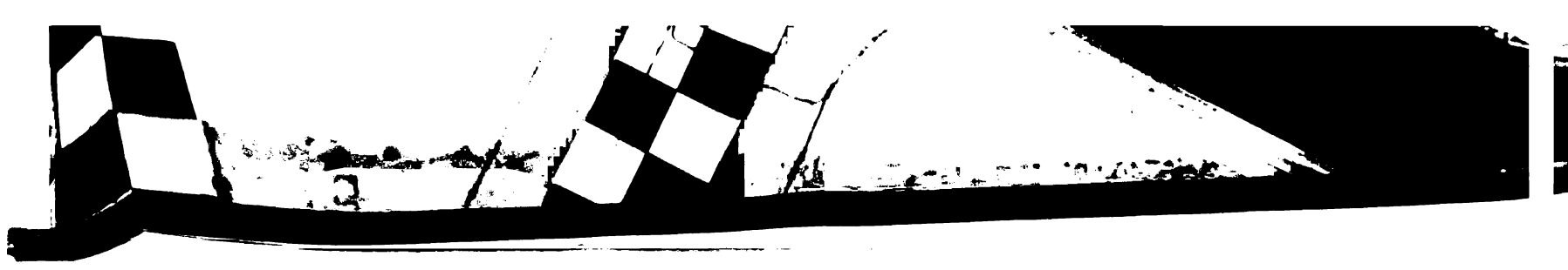
Amos P. Kennedy

ABSTRACT

A series of three experiments was conducted cooperatively by the Michigan Agricultural Experiment Station and the Bureau of Animal Industry of the United States Department of Agriculture to study some of the production factors and carcass characteristics in fattening steer and heifer calves. Data were obtained on twelve steers and twelve heifers, and on the carcasses of the same animals in each of the three experiments. Cattle were slaughtered at four different stages of finish in an attempt to match the two sexes for fatness and grade.

The average initial weights for steers and for heifers were 384 and 367 pounds, respectively. Slaughter weights in Kill 4, after 275 days of feeding, averaged 892 and 816 pounds. Cattle of both sexes maintained high and similar rates of gain early in the feeding period. Heifer gains decreased after the first 84 days of feeding, while steers maintained a high rate of gain for 140 days. The rate of gain for heifers decreased at a faster rate than that of steers. The difference in rate when cattle were matched for finish was very small and was not significant.

During the first 112 days of feeding the daily total digestible nutrient consumption for all cattle increased rapidly and showed small differences between the sexes. After 112 days the daily total digestible nutrient consumption of steers remained almost level, while that of heifers decreased as feeding progressed beyond this point. Total digestible nutrients required per pound of gain was higher for heifers than for steers fed a



similar time, however, when cattle were matched for finish at slaughter small differences were observed.

Slaughter grades, carcasses grades and dressing percentages increased significantly in all cattle as feeding progressed, and each was significantly higher for heifers when cattle were compared by kills, but with similar finish the differences between the sexes were small and none were significant.

Carcass separable fat, separable fat in most wholesale cuts and ether extract content of carcass boneless meat, each increased as feeding progressed. The percentages of lean and bone in the carcass and in most wholesale cuts, along with the percentages of protein and moisture in carcass boneless meat decreased with increasing fatness, and these factors were significantly higher in steer carcasses when cattle were compared by kills. However, when cattle were matched according to finish the differences between the two sexes were small and most of the differences were not significant.

The carcass percentages of flank, kidney knob and rib cuts increased significantly with finish in all cattle while percentages of round and shank decreased significantly. Degree of finish had no significant effect on the percentages of loin, rump, plate and chuck in cattle carcasses.

Factors that were influenced by sex were carcass percentages of hindquarter, flank and flank fat, and meat to bone ratio, which were significantly higher in heifer carcasses both when cattle were compared by kills and matched by finish; and the percentages of forequarter, chuck, chuck bone, shank, shank bone

and total carcass bone, being significantly higher in steer carcasses.

Wholesale cuts not significantly associated with sex as percentage of carcass when matched by finish were the loin, rib, round, rump and plate.

The four measures of finish used in these experiments showed steers and heifers to be very closely matched for finish when steers were fed approximately 50 days longer than heifers.

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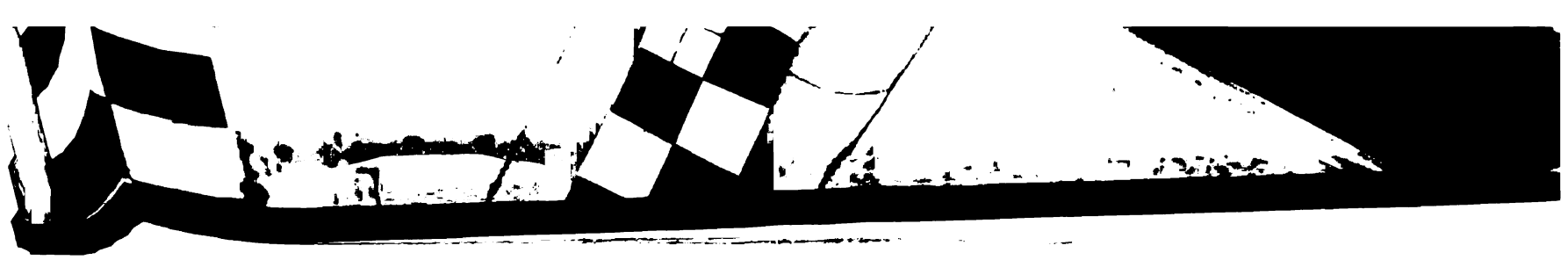

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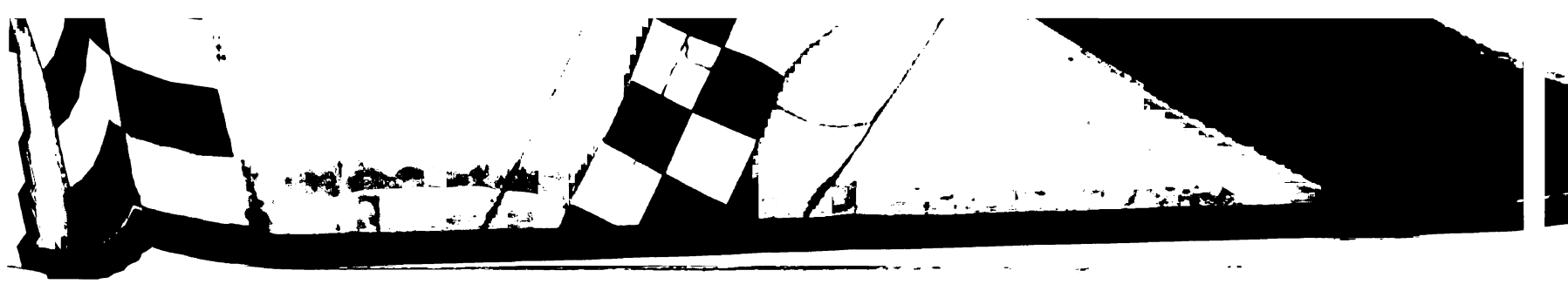

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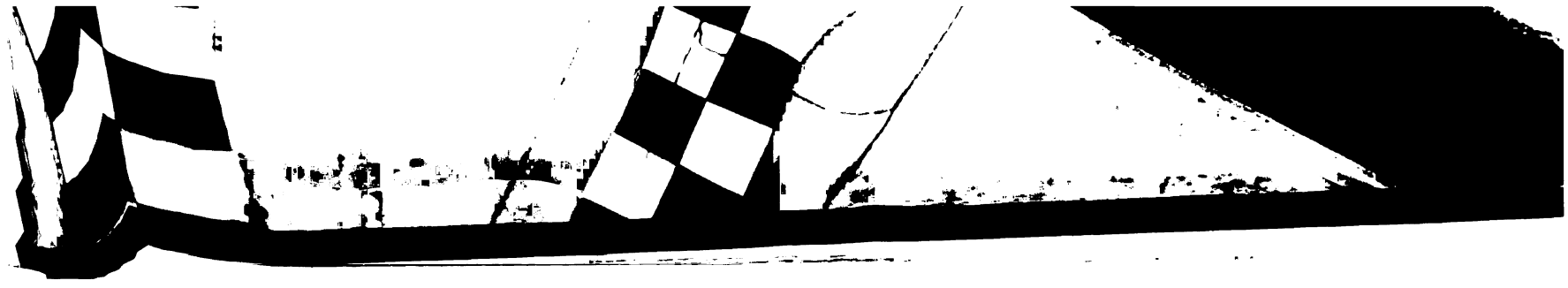

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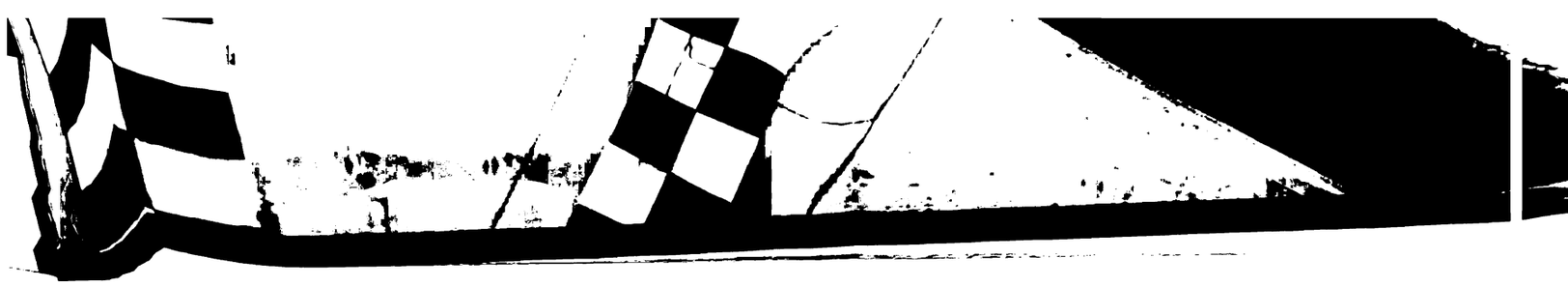

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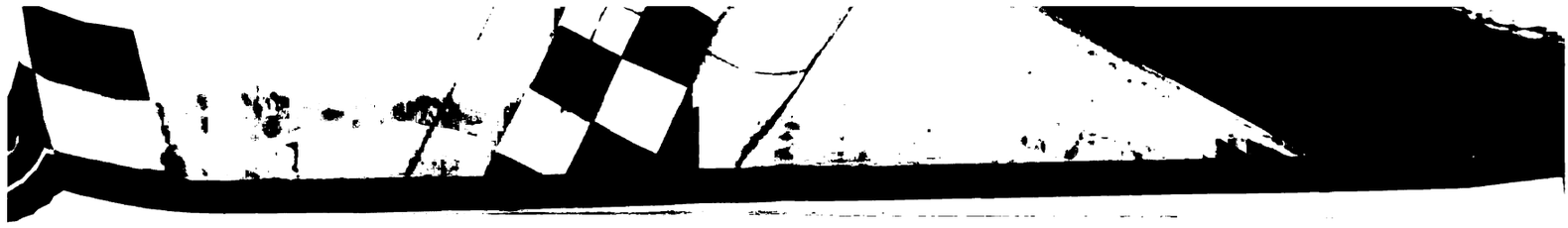

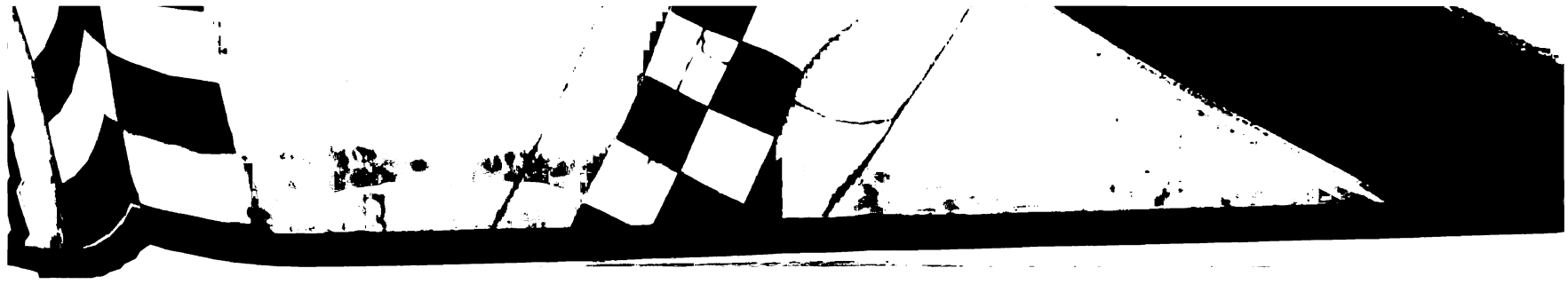

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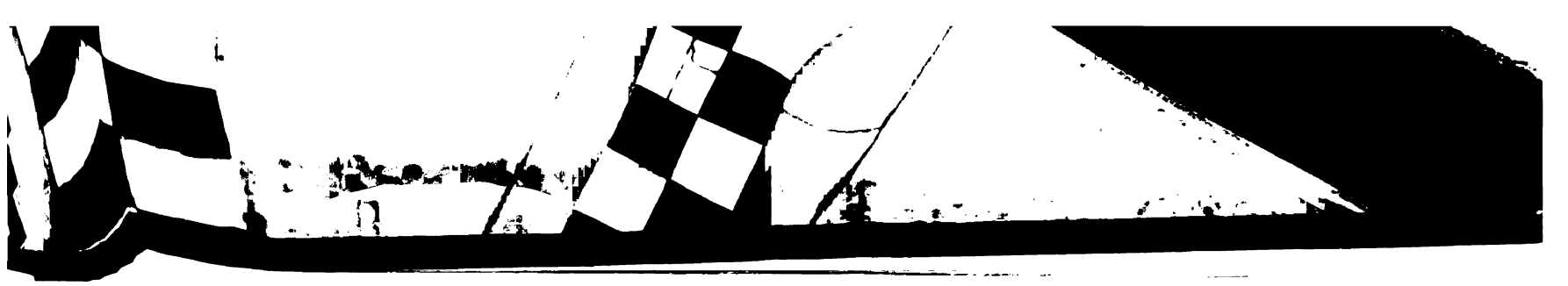

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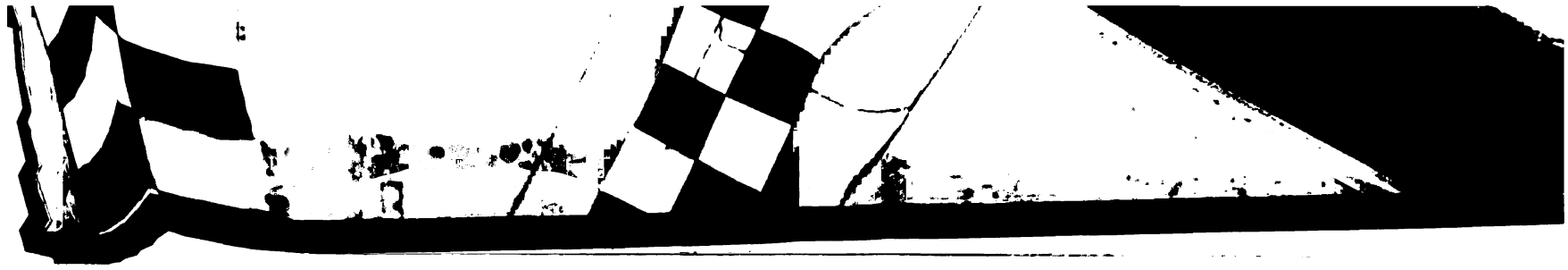
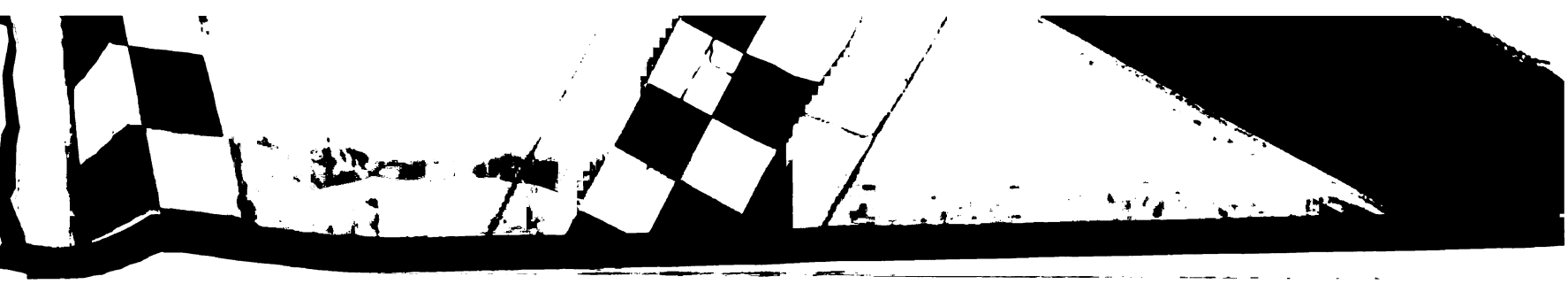


REVIEW OF LITERATURE

Effect of Length of Feeding Period on Feedlot Performance, Finish and Carcass Yields

Man has realized for some time that as an animal grows older and becomes fatter it grows at a decreasing rate and the amount of feed required for gain in liveweight increases. Studies to determine the nature of the factors responsible for this decreasing efficiency in fattening cattle were started in this country during the latter part of the nineteenth century. Jordan (1895), at the Maine station, fed two pairs of steers of beef breeding, ages four to six months, rations differing vastly in protein content. One steer from each pair was slaughtered after seventeen months of feeding and the remaining steers were slaughtered ten months later. Jordan's observations were that digestive matter required to produce a pound of gain in liveweight increased with increased feeding. Daily gains of the steers increased until about the end of the ninth month of feeding, then decreased gradually.

Several years later a similar experiment was conducted by Trowbridge et al., (1918), (1919) at the Missouri station. Three pairs of steers of Shorthorn breeding were maintained on different planes of nutrition. One steer from each pair was slaughtered and analyzed at later intervals. These workers reported increasing cost of gains and decreasing daily gains as feeding progressed. The percentages of shin, shank,



round and neck decreased, while percentages of plate, rib, flank, kidney and kidney fat increased with increasing weight and fatness.

Reports of Haecker (1920), of the Minnesota station, were based on observations made on 189 steers of beef breeding. Forty-nine of these steers were slaughtered and analyzed at various intervals from the time they weighed about 100 pounds until they weighed about 1200 pounds. Feed requirements per pound of gain in liveweight increased with increasing weight, except for the interval of 500 to 600 pounds. Daily gains increased until the steers weighed about 600 pounds, after which the rate decreased.

Moulton et al., (1921), (1922), at the Missouri station, conducted an investigation similar to Haecker's using 59 steer calves of the Hereford-Shorthorn type. The Missouri workers observed a continuous decrease in efficiency during the four-year period in full-fed steers. Observations of the Missouri workers were almost in complete agreement with those of Trowbridge et al., (1919), that is, the rate of gain decreased and the cost of gains increased as feeding progressed. These workers also reported an increase in the proportions of loin, rump, flank and plate, while proportions of round, chuck, neck, shin and shank decreased with increasing age and fatness.

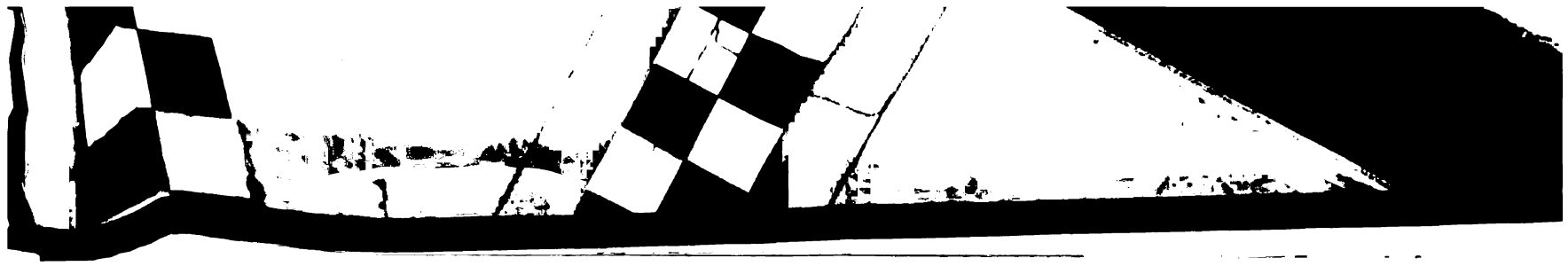
Results obtained by workers at the Illinois station (Ill. Sta. Ann. Repts. 1927-28, 1928-29 and Bull et al., 1930) indicated faster and cheaper gains for calves fed for 140

days than for calves fed for 200 days. The Illinois workers reported a rise in both slaughter and carcass grades as feeding continued. The percentages of cutting fat, flank, navel and brisket increased, while percentages of round and shank decreased as feeding progressed. There were no appreciable changes in the percentages of rump, loin and chuck.

Gramlich (1928), at the Nebraska station, made a study of the effect of age on the rate and cost of gain in steer calves, yearling, 2-year old and 3-year old steers. He reported that all cattle made faster and cheaper gains the first 100 days than the last 100 days of a 200 day feeding period. Gains made by the calves the last 100 days were cheaper than gains made by older cattle the first 100 days.

Gramlich and Loeffel and U.S.D.A. workers (1927), at the Nebraska station, reported results obtained in a heifer feeding experiment showing increases in dressing percentages, slaughter and carcass grades, offal fat, and in the percentages of forequarter, rib and plate. Decreasing percentages of hindquarter, round and shank were noted as feeding progressed. The percentages of loin end and udder remained rather constant. The same workers obtained similar results with cows, except that the percentage of hindquarter increased as feeding progressed due to accumulation of kidney and bed fat.

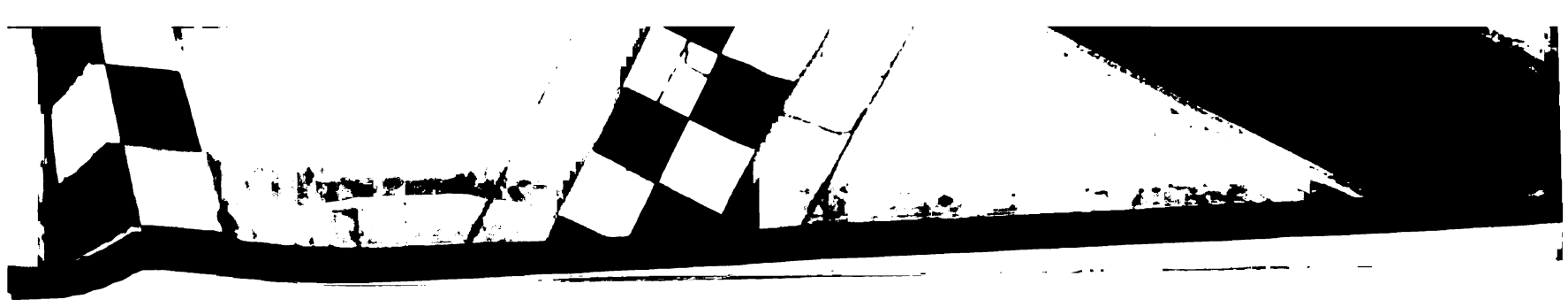
Nelson (1945), (1946) analyzed data collected by workers at the Iowa station while studying the effect of age on efficiency in steers. He concluded that efficiency of feed utilization declined from the beginning of the fattening



period as indicated by gain in liveweight per hundred pounds of total digestible nutrients consumed by choice feeder steer calves. He stated that steer calves fed to good slaughter grade gained about 15.5 pounds in liveweight for each 100 pounds of nutrients consumed, compared with about 11.4 pounds gain in liveweight for calves fed to choice slaughter grade. This was a decrease in efficiency of about 31 percent. Nelson also stated that older cattle follow a similar trend, but in older cattle the decrease in efficiency was larger than in calves.

Morrison (1950) in discussing the fattening process, said: "The fact that the proportion of fat in the gain made by an animal steadily increases during the fattening period is of much practical importance. It is the chief reason why the feed cost per pound of gain increases rapidly after an animal has become fairly well fattened. Such flesh contains much more fat and less water, and is correspondingly more expensive to produce.

"The fat animal also needs a greater proportion of its feed for maintenance than the one which is not yet well fleshed, because of two factors: First, the maintenance requirement of a fat animal per 1,000 lbs. liveweight tends to be higher than for a thinner one; and second, the fat animal eats less feed per 1,000 lbs. liveweight, consequently having less nutrients left for meat production after maintenance requirements have been met."

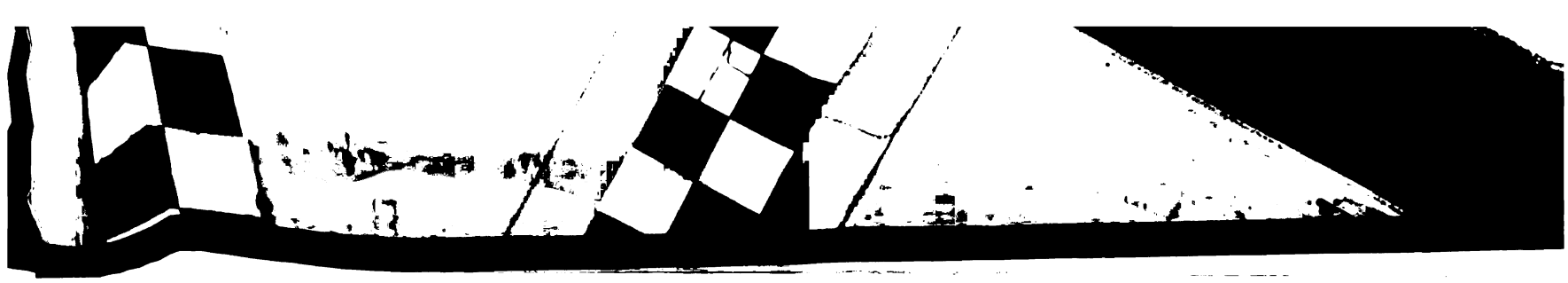


Effect of Length of Feeding Period on Physical and Chemical Carcass Composition

Increases in growth are determined by either weights or measurements or by a combination of the two methods. These determinations are very simple to make and can be made numerous times without any harmful effects on the subject. However, in the determination of the physical and chemical composition of a carcass the animal must be sacrificed, the carcass separated into its various components, and for chemical analyses a uniform sample of certain parts, or of the entire carcass must be obtained. These factors have both complicated and limited the number of investigations of this nature due to the economics involved. Jordan (1895) was the first in this country to conduct an experiment of this nature. Based on observations made on two pairs of steers, he concluded that as feeding progressed the proportion of water in the carcass decreased and the proportion of fat increased; meat from older cattle furnished more water-free edible materials.

Similar conclusions were drawn by Haecker (1920) based on the analyses of 49 steers. The analyses were made at various intervals from birth to about 1200 pounds liveweight. He also concluded that during the growing stage or from birth to 800 pounds liveweight, the protein stored exceeded the fat. and that above 800 pounds more fat was stored and less protein.

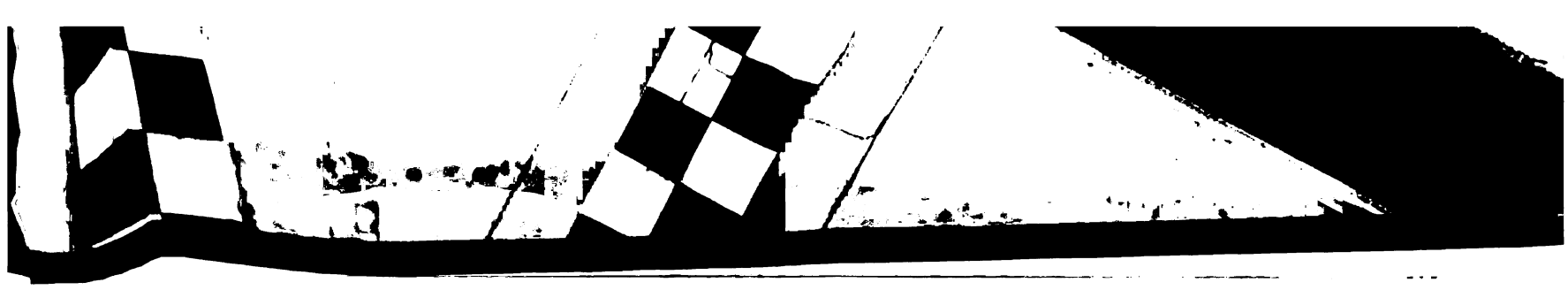
Haecker's observations were in accord with reports of Moulton et al., (1922) of the Missouri station. The Missouri



workers reported that the first gains of thin cattle on restricted rations were 80 percent water, while the next gains were but 62 percent water. On the basis of observations made on steers maintained on different planes of nutrition and slaughtered at various intervals, the Missouri workers concluded that the water content of the animal on restricted rations increased slightly until the animal reached 18.5 months of age, then decreased slightly. In calves that were placed on full-fed at approximately five months of age and maintained on this regimen over a four-year period, the gains became richer in fat and poorer in other constituents with advancing age and fatness until the last gains consisted of about 90 percent fat.

Foster and Miller (1933), and Hankins and Titus (1939) reported a relative decrease in the percentages of lean, bone and moisture and a relative increase in the percentage of fat in cattle carcasses with increased finish.

Callow (1944), (1948), (1950), of England, analyzed carcasses of 147 animals (cows, steers, heifers, pigs and sheep) of various ages and degrees of finish. On the basis of the results of his analyses, he concluded that young animals fatten more slowly and deposit less fat and more protein than older animals. With increasing age and fatness there was a percentage decrease in both muscular and skeletal tissue. The percentage of ether extract in the fatty tissue increased with increasing fatness. Fatty tissue increased with increased carcass fatness. Fatty tissue increased at a more rapid rate



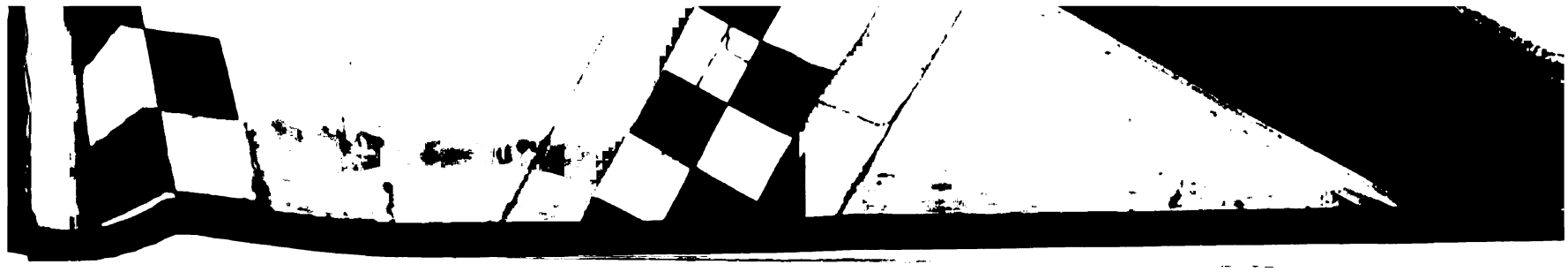
in relation to bone as growth and fattening proceeded, however, in the carcass of cattle there is always more muscular tissue than fatty tissue.

Wellington (1954) fed Holstein calves on three different planes of nutrition from one week of age until they were 80 weeks of age. Representative calves from each group were slaughtered at various intervals. He concluded that as such cattle increased in age the ratio of edible meat to bone increased. Age showed no consistent influence on percentage weight of muscle in the carcass.

Effect of Sex on Feedlot Performance, Finish and Carcass Yields

Investigations were started during the latter part of the nineteenth century to study the validity of the prevailing claim that open heifers were inferior to steers and spayed heifers as beef producers. Probably the first investigations of this nature were those of Wilson and Curtis (1894), (1896) of the Iowa station. These investigators ran two separate experiments comparing steers, open heifers and spayed heifers.

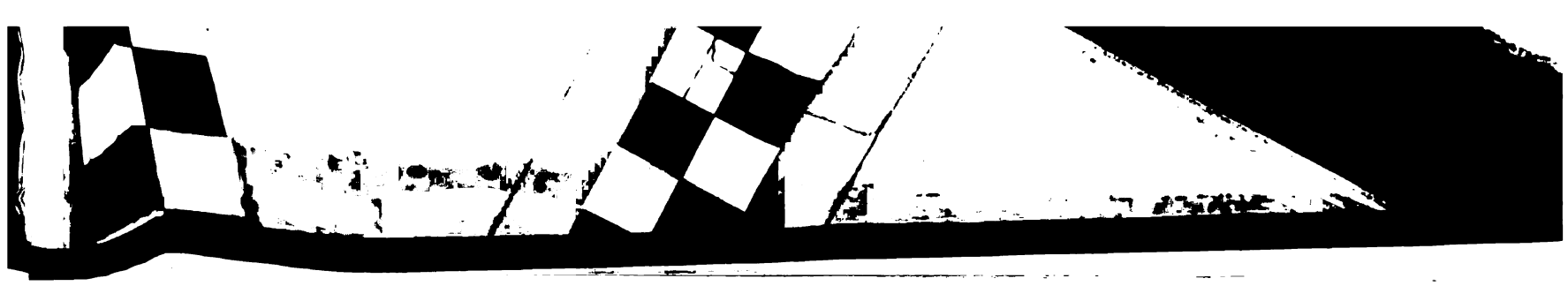
Cattle used in the first experiment were high grade Shorthorn yearlings, with initial weights of 819, 751 and 718 pounds, respectively, for steers, spayed heifers and open heifers. Results of the first experiment supported the claim of steer and spayed heifer superiority, that is, steers made the fastest and most efficient gains, while open heifers made the slowest and most expensive gains of the three lots of



cattle. Dressing percentages of the steers were the highest while those of the open heifers were the lowest. Yet both open and spayed heifers yielded about one percent higher in the rib and loin cuts than steers.

In the second experiment conducted by the Iowa workers, Hereford calves were fed separately for 14 months. Results of this experiment did not support the postulated open heifer inferiority. The open heifers made the fastest and most efficient gains. Steers and spayed heifers made practically equal and slower gains at about equal costs. Open heifers had the highest dressing percentages and those of the steers were the lowest. The results of cutting tests indicated that there was no material difference in the character, composition or quality of the meat due to sex. The heifers yielded more rib and loin than the steers and thus put more of their weight in the higher priced cuts.

An extensive and detailed investigation in which the two sexes of beef cattle were compared was carried out at the Illinois station (Ill. Sta. Ann. Repts. 1927-28, 1928-29 and Bull et al., 1930). High grade Hereford calves were used by these investigators. One group of steer and heifer calves was slaughtered after 140 days of full feeding and another similar group was slaughtered after 200 days of full feeding. The results of this investigation did not favor, in all respects, the claim of steer superiority. The Illinois workers found no significant difference in dressing percentages of steers and heifers slaughtered at the beginning of the experi-



ment nor after 140 days of feeding, although after 200 days of feeding there was a slight difference in dressing percentages in favor of the heifers. After 140 days of feeding, carcasses of the heifers graded higher than those of steers killed at the same time, but after 200 days of feeding the reverse was true. Workers at the Illinois station reported a higher percentage of cutting fat in feeder heifers than in feeder steers. However, in partly fattened and fat cattle there was no difference in cutting fat due to sex. Heifer carcasses cut out a larger percentage of flank and a smaller percentage of shank than steer carcasses. The percentage of "rib eye" was higher in steer carcasses than in heifer carcasses due to the higher finish of the heifer ribs. The Illinois investigators concluded that heifer calves reached a suitable market finish sooner than steer calves and, for this reason, heifers are better suited for feeding periods of 150 to 180 days. However, in the production of prime grade beef, they stated that steers usually bring greater profit because of the higher prices buyers will pay for them.

According to Bohstedt (1927), of the Ohio station, when Hereford steer and heifer calves were fed a ration of corn, oil meal, alfalfa hay and corn silage for 154 days, steers made the largest and the more economical gains. Vaughan (1927), at the Minnesota station, obtained similar results by group feeding three lots of grade Hereford calves a ration of shelled corn, linseed meal, alfalfa hay and corn silage for 217 days. Steers, steers and heifers, and heifers comprised Lots 1, 2,

and 3, respectively. He reported larger and cheaper gains for steers than for heifers. The mixed lot results resembled the average of the lots fed separately by sex.

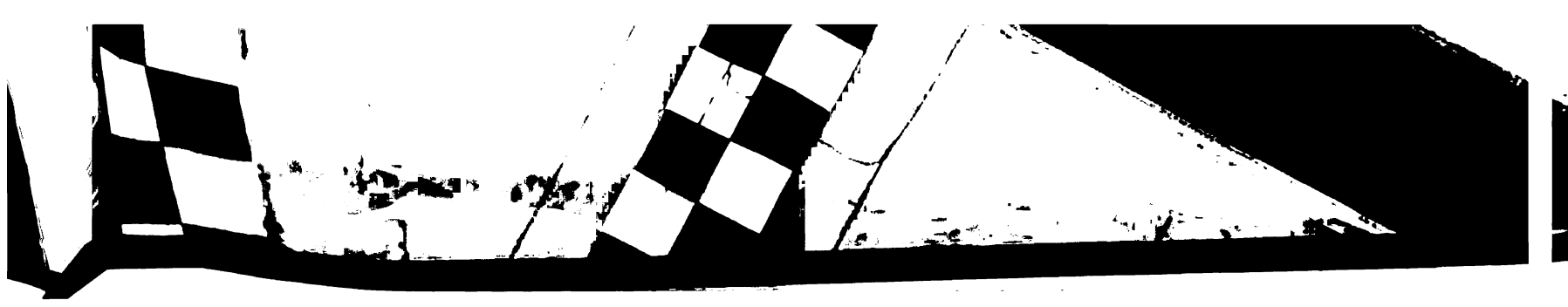
In order to determine how heifers compared with steers on different regimens, Trowbridge and Moffett (1932), at the Missouri station, fed high grade yearling Hereford steers and heifers separately. One lot of steers and one lot of heifers were full-fed for 182 days, and one lot of steers and one lot of heifers were given one-half the grain of the full-fed lots for 140 days and then full-fed on pasture for 168 days. According to the reports of these investigators, steers full-fed 182 days made larger and more economical gains than heifers treated in a similar manner. However, heifers yielded a higher percentage of beef and graded higher as slaughter cattle and as carcass beef. When calves were wintered on a limited amount of grain then full-fed on pasture for 168 days, steers showed greater margins for insurance, risk, interest and profit because steers made more economical gains and sold at higher prices. Results of a similar experiment conducted by Foster and Miller (1933), of the Missouri station, showed a larger percentage of forequarter in steer carcasses than in heifer carcasses. Steer carcasses contained a larger percentage of chuck than heifer carcasses, otherwise there were no appreciable differences in wholesale cuts attributable to sex.

Hankins (1932) reviewed the results of various meat investigations conducted at various experiment stations,

including Michigan, in cooperation with the United States Department of Agriculture. He concluded that heifers reached a given finish at lighter weights than steers and usually exceeded steers in the amount of kidney and crotch fat. He found no significant difference in dressing percentage due to sex.

Comparisons of dressing percentages and carcass yields of steers and heifers were made by Brown and Branaman (1935) at the Michigan station. One comparison was made on steers and heifers fed in equal numbers in mixed lots. The cattle were placed on feed at approximately seven months of age and fed liberally for 6½ months, during each of three years. In this group of cattle the Michigan workers found slightly higher dressing percentages for heifers, although retail cutting records showed that steers yielded slightly more retail meat. In another experiment Brown and Branaman fed equal numbers of high grade steer and heifer calves individually, the feeding beginning when the calves were about seven months of age. Calves were slaughtered at four different periods weighing approximately 600, 700, 800 and 900 pounds. In this latter test the heifers yielded slightly more retail meat. In both tests the percentages of chuck, round and shank were higher in steer carcasses, while percentages of rib, loin and rump were higher in heifer carcasses.

Branaman et al., (1936), at the Michigan station, made a study of the relation of degree of finish in cattle to production and meat factors. Thirty-six steer calves and



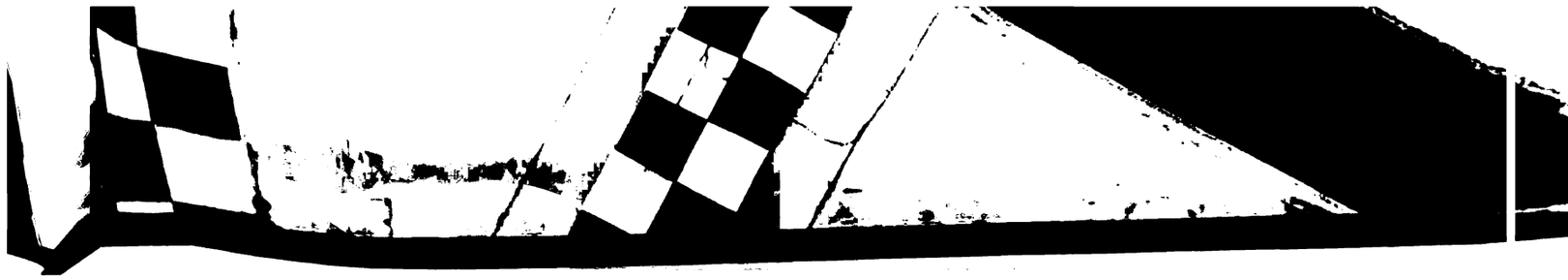
thirty-six weanling grade Hereford heifer calves were fed individually and slaughtered at four different stages of finish. Chemical analyses were carried out on the edible portion of the right half of each carcass. These workers grouped the calves according to the ether extract content of the analyzed right side. Six stages of finish were provided for, according to the following intervals of ether extract percentages: 12.0 to 15.9, 16.0 to 19.9, 20.0 to 23.9. 24.0 to 27.9, 28.0 to 31.9 and 32.0 to 35.9. The Michigan workers reported that heifers in the first and fourth stages were fed 10 and 5 days longer, respectively, than steers in the corresponding stages in order to reach a similar degree of fatness. However, at each of the other stages of finish the steers were fed from 32 to 45 days longer than heifers.

The Michigan workers made the observation that the average feedlot weight increased through the series much more regularly than was true with respect to time in the feedlot. The same situation was true in regard to the average total gain per animal. In every case a greater gain and consequently a heavier weight were necessary among steers than among heifers to produce similar fatness.

Workers at the Mississippi station in cooperation with the United States Department of Agriculture workers (1937) made three comparisons that involved steers and heifers of various ages and fed similar lengths of time. In all comparisons steers gained more rapidly and more economically than heifers. Differences in dressing percentages were small and in favor of the heifers.

There was a common belief that pregnancy was conducive to a more tranquil disposition and less bodily activity (Snapp 1935). On the basis of this assumption, pregnant heifers should be better performers in the feedlot than open heifers (Snapp 1935). This supposition was the basis for several investigations. An experiment of this nature was conducted by Snapp (1935), at the Illinois station. In this experiment he compared steer, open heifer and bred heifer yearlings. He observed retardation of growth in the region of the loin, hips and rump of pregnant heifers, while the greatest increases took place in the paunch and heart girth. Carcasses of bred heifers graded the highest of the three groups, while those of steers graded the lowest. Neither pregnancy nor sex had any significant effect on total gains. Dressing percentages of open and bred heifers were higher than dressing percentages of steers. The results of a later experiment conducted by Snapp and Bull (1944), at the Illinois station, supported the above data. They found that pregnant heifers were less active and had keener appetites than open heifers, nevertheless, there was no difference in the rate of gain and dressing percentages. The Illinois workers reported that the proportions of loin end, flank and round were significantly larger in open heifer carcasses than in carcasses of bred heifers, otherwise there were no significant differences in wholesale cuts.

Open, spayed and bred heifers were compared by Hart et al., (1940) at the California station. The observations of these



workers were not in complete agreement with those of the Illinois workers. The California workers reported that the activity of open heifers was not serious and that they become less active as they fatten. These workers did not find that pregnancy in beef cattle increased feed consumption nor did its existence, up to the fifth or sixth month, seriously affect the dressing percentage of well finished cattle. The California workers concluded that no advantage was to be gained by spaying heifers that are going into the feedlot.

Effect of Sex on Physical and Chemical Composition

The assumption that sex may influence the physical and chemical composition of beef carcasses stimulated study along these lines. The economics involved and the difficulties encountered in separation and sampling have somewhat limited the amount of research conducted in this field. For this reason experiments of this nature are few and they have included only small numbers of animals.

Workers at the Illinois station (Ill. Sta. Ann. Repts. 1927-28, 1928-29 and Bull et al., 1930) carried out physical analyses on carcasses of one steer and one heifer at each time, namely: the beginning of the experiment, after 140 days of feeding and after 200 days of feeding. They observed that carcasses of heifers contained a larger percentage of fat, the difference being greater in feeder heifers and decreasing as feeding progressed. These workers concluded that up to 800 or 900 pounds liveweight, heifer calves put on fat

more readily than steer calves. However, this added fat was deposited as adipose tissue almost entirely, therefore at equal body weights, heifer calves possessed more visible fat than steers. In spite of this, steer calves had more intramuscular fat.

Brown et al. (1937), Trowbridge et al., (1937), Gramlich and Thalaman (1930), Gramlich et al., (1927) and Hunt et al., (1937) reported higher percentages of "eye" muscle, bone and tendon in steer carcasses. There were lower percentages of separable fat, ether extract and total edible portion in ribs of steers than in ribs of heifers treated similarly.

The United States Department of Agriculture workers at the Iberia Livestock Experiment Station (1937) concluded that the higher content of fat in heifer carcasses could be demonstrated both by increased intramuscular and intermuscular fat when compared with steers.

Hirzel (1939), in summarizing the results of meat investigations that compared steers and heifers, concluded that after twenty-two months of age, in general, females were fatter than males. Nevertheless, the ratio of muscle to bone remained nearly the same for both sexes. The fat to bone ratio in young animals under fifteen months of age showed no difference between sexes, however, above this age the ratio was higher in heifers.

According to observations of Snapp and Bull (1944) bred heifer carcasses contained approximately 20 percent more separable fat, 5 percent less lean and 10 percent less bone

than open heifer carcasses. The chucks, ribs, navels, short-loins, loin ends and rounds of the bred heifers contained a significantly larger proportion of fat than the corresponding cuts from open heifers.

A series of three experiments was inaugurated in 1933 cooperatively by the Michigan Agricultural Experiment Station and the Bureau of Animal Industry of the United States Department of Agriculture to study some of the production factors and carcass characteristics of fattening steers and heifers. Larger numbers of cattle were available than had been used in previously reported experiments or in tests since 1933 that have been reviewed herein from the literature.

The data from these experiments were available for detailed analyses and offered a good problem for thesis material, however, it was not reasonable to attempt to complete analyses of all of the data for this thesis.

The objectives of these experiments were as follows with regard to individually fed growing-fattening Hereford steer and heifer weanling calves:

1. To study growth and development
2. To study feed requirements
3. To determine when cattle of the two sexes attain similar market grade
4. To analyze the carcasses for:
   a. Cutting yields
   b. Physical composition

c. Chemical composition

5. To study the wholesale rib cut:

a. As a sample representing the carcass

b. For cooking and palatability tests

EXPERIMENTAL PROCEDURES

Source of Calves and Feeding Methods

The calves used in the experiment each year were grade Herefords raised on the United States Department of Agriculture Range Experiment Station at Miles City, Montana. Equal numbers of steers and heifers were selected for uniformity from one herd at the station and thus had similar breeding and care. The calves arrived by rail shipment in late October or early November and were started on experiment within about three weeks.

Steer and heifer calves were full-fed individually. Each calf was confined in a small individual stall for about two hours at feeding time, night and morning. There was no water in the stall and it was not large enough for the calf to turn around. Heifers were released in one pen and steers in another after feeding time, where they had water and salt in a roomy inside pen, and access to an outside yard.

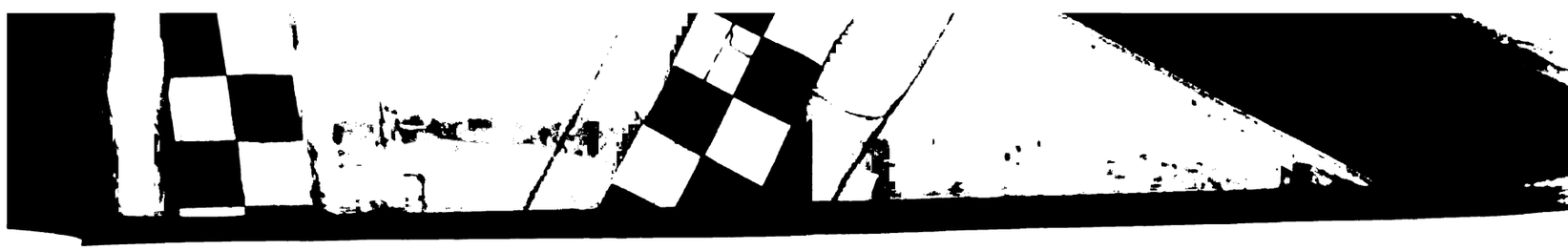
Free choice feeding for each calf of hay in a rack and grain in a manger was attempted, but was not satisfactory. Some calves selected the coarse feeds and some the fine feeds, so that similar performance could not be measured.

A similar mixture was full-fed each calf thereafter, consisting of coarsely ground corn 6 parts, cottonseed meal 1 part, corn silage 3.5 parts and mixed alfalfa hay 1 part. Conditions forced minor changes at times, but all calves were handled and fed the same at any one time.

Methods of Grading, Slaughtering, Cutting and Sampling

Grading of the feeder and slaughter cattle and of the carcasses was done with a detailed chart formulated by a committee in the National Cooperative Meat Investigation group. All grading was done by the same committee of three members of the Animal Husbandry Department who had graded cattle for several years with members of the official grading committee of the Cooperative Meat Investigations. Slaughter cattle grades along with weights and gains are shown in Tables 1-4. The grades reported herein were those in use at the time the experiments were conducted and up to 1950, using the following abbrevations: F for Fancy, P for Prime, Ch for Choice and G for Good, with "/" or "-" indicating "high" or "low" third of a grade.

Weights were taken at 14 day periods and certain measurements were taken of the live cattle at the beginning and at the end of each trial, and of the carcass. Feed was withheld after the morning feed of the day before slaughter, but water was available. Cattle were slaughtered at four stages of fattening and these stages were called kills. Each kill was completed in one day with hot weights off the killing floor and cold weights were taken 48 hours afterward. Weights were taken for each part of the offal. All parts of the digestive tract were weighed, emptied, washed and reweighed. The digestive content was determined in this manner and when subtracted from slaughter weight the empty body weight was obtained.



Cutting and separation records on each right half were made within the next three or four days after the 48 hour cold weight.

The Chicago Method of cutting with details recommended by the Cooperative Meat Conference were followed. One man made all wholesale and retail cuts, and one man checked the completeness of the separation of each cut into bone, fat and lean.

The rib cut from each side of the carcass, including ribs 8-12, and a ground and mixed sample of each separate component (fat and lean) of the right half were sent to the United States Department of Agriculture Research Station at Beltsville, Maryland for analyses. The wholesale rib cuts along with the samples were packed with liberal amounts of crushed paper in a large insulated box and cool temperature, without freezing, was maintained by the use of a small amount of dry ice.

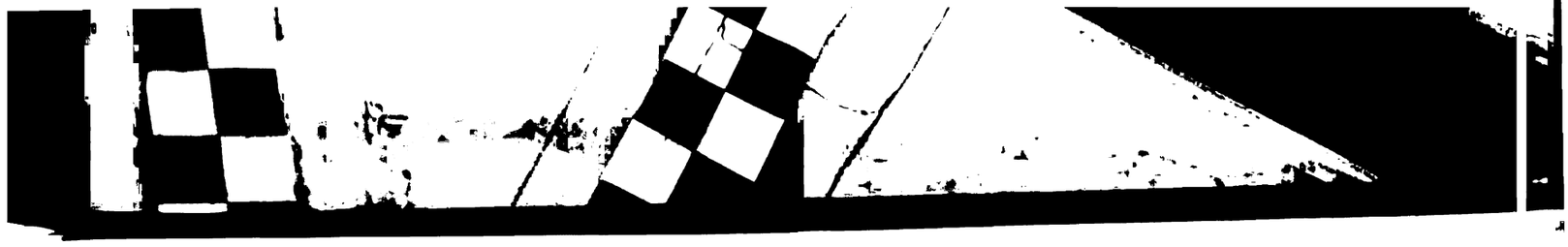


Table 1. Performance of Kill 1 Steers and Heifers

Calf Number	Days on Feed	Initial Weight (lbs.)	Final Weight (lbs.)	Total Gain (lbs.)	Average Daily Gain (lbs.)	Slaughter Grade
STEERS						
Trial 1						
14	126	400	628	228	1.81	M ⁄
16	126	389	659	270	2.14	G ⁄
18	126	399	568	169	1.34	G
Trial 2						
16	105	362	631	269	2.56	G -
23	105	405	588	183	1.74	G
28	105	463	688	225	2.14	Ch -
Trial 3						
16	132	409	713	304	2.30	G
17	132	325	666	341	2.58	Ch
39	132	346	601	255	1.93	Ch -
Average, 9 Steers						
	121	389	638	249	2.06	G
HEIFERS						
Trial 1						
4	126	353	550	197	1.56	G -
6	126	404	702	298	2.37	Ch -
13	126	380	600	220	1.75	G ⁄
Trial 2						
5	105	442	695	253	2.41	Ch -
9	105	388	594	206	1.96	G ⁄
11	105	373	577	204	1.94	G
Trial 3						
4	132	364	691	327	2.48	Ch
6	132	311	596	285	2.16	Ch -
11	132	326	597	271	2.05	G -
Average, 9 Heifers						
	121	371	622	251	2.08	G ⁄

Table 2. Performance of Kill 2 Steers and Heifers

STEERS

Calf Number	Days on Feed	Initial Weight (lbs.)	Final Weight (lbs.)	Total Gain (lbs.)	Average Daily Gain (lbs.)	Slaughter Grade
Trial 1						
21	175	414	747	333	1.90	Ch
23	175	376	756	380	2.17	Ch -
26	175	401	773	372	2.13	G
Trial 2						
17	154	394	716	322	2.09	G /
26	154	441	742	301	1.95	Ch
27	154	419	813	394	2.56	G /
Trial 3						
14	182	396	818	422	2.32	Ch /
15	182	341	726	385	2.12	G /
24	182	340	780	440	2.42	Ch
Average, 9 Steers						
	170	391	763	372	2.19	Ch -

HEIFERS

Trial 1						
8	175	400	706	306	1.75	Ch
10	175	345	649	304	1.74	G
11	175	369	713	344	1.97	Ch -
Trial 2						
1	154	364	701	337	2.19	Ch /
7	154	430	773	343	2.23	Ch
12	154	399	683	284	1.84	Ch -
Trial 3						
1	182	338	711	373	2.05	Ch /
5	182	346	775	429	2.36	Ch /
12	182	336	631	295	1.62	G /
Average, 9 Heifers						
	170	370	705	335	1.97	Ch

Table 3. Performance of Kill 3 Steers and Heifers

Calf Number	Days on Feed	Initial Weight (lbs.)	Final Weight (lbs.)	Total Gain (lbs.)	Average Daily Gain (lbs.)	Slaughter Grade
STEERS						
Trial 1						
17	224	366	784	418	1.87	P -
22	224	415	866	451	2.01	Ch -
27	224	392	821	429	1.92	G ≠
Trial 2						
18	203	370	821	451	2.22	Ch -
24	203	377	788	411	2.02	Ch -
25	203	415	906	491	2.42	Ch
Trial 3						
13	247	377	831	454	1.84	Ch
18	247	339	793	454	1.84	G ≠
20	247	357	843	486	1.97	Ch ≠
Average, 9 Steers						
	225	379	828	449	2.00	Ch
HEIFERS						
Trial 1						
3	224	389	751	362	1.62	Ch
5	224	372	710	338	1.51	P -
7	224	373	812	439	1.96	Ch ≠
Trial 2						
3	203	392	784	392	1.93	P
4	203	395	805	410	2.02	Ch
15	203	323	735	412	2.03	Ch ≠
Trial 3						
0	247	323	695	372	1.51	Ch -
3	247	325	804	479	1.94	Ch ≠
9	247	346	834	488	1.97	P
Average, 9 Heifers						
	225	360	770	410	1.82	P -*

* Significant at the 5 percent level.

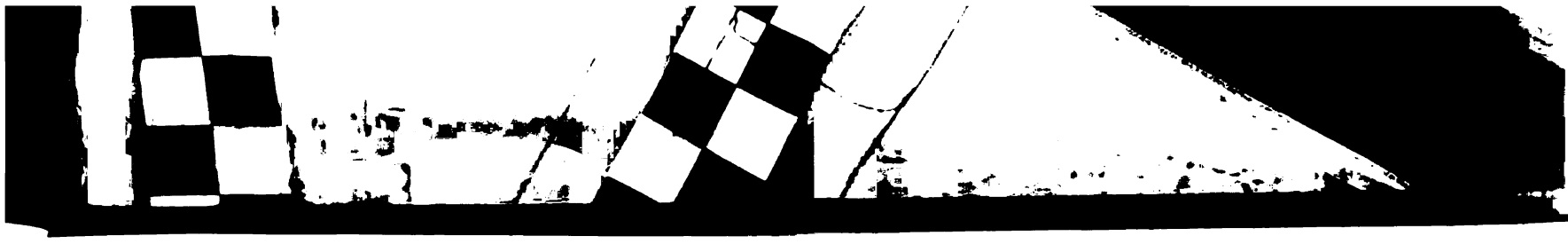


Table 4. Performance of Kill 4 Steers and Heifers

STEERS

Calf Number	Days on Feed	Initial Weight (lbs.)	Final Weight (lbs.)	Total Gain (lbs.)	Average Daily Gain (lbs.)	Slaughter Grade
Trial 1						
19	273	378	889	511	1.87	Ch
20	273	398	927	529	1.94	P -
24	273	375	828	453	1.66	G +
Trial 2						
19	259	358	968	610	2.36	P
22	259	442	976	534	2.06	P -
29	259	377	886	509	1.97	P -
Trial 3						
0	294	329	845	516	1.77	Ch +
19	294	368	989	621	2.11	Ch
21	294	387	1009	622	2.12	P -
Average, 9 Steers						
	275	369	924**	545	1.98*	Ch +

HEIFERS

Trial 1						
1	273	371	800	429	1.57	P -
2	273	370	731	361	1.32	Ch -
9	273	360	819	459	1.68	Ch +
Trial 2						
6	259	371	872	501	1.93	P
10	259	419	1037	618	2.39	P -
13	259	366	822	456	1.76	P
Trial 3						
2	294	311	876	565	1.92	Ch +
7	294	385	867	482	1.64	P
8	294	361	782	421	1.43	Ch
Average, 9 Heifers						
	275	368	845	477	1.73	P -

* Significant at the 5 percent level.
** Significant at the 1 percent level.

RESULTS AND DISCUSSION

Data were tabulated in Tables 1 to 4 for individual cattle showing weights, gains and slaughter cattle grades. The cattle were grouped by kills and sexes so that comparisons may be noted.

The slaughter grade of the cattle was used in determining the time for slaughter of each kill. An attempt was made to space the kills so that the heifers would average the same stage of fatness as the steers in the succeeding kill. The slaughter grades listed in the last column of Table 1 indicate reasonable success. It was necessary to divide the cattle of each sex at the time of the first kill so as to have representative cattle for each kill. There were, of course, variations among cattle of each group and it seemed advisable to shift an animal occasionally as killings took place to keep the groups representative.

Further comparisons and discussions of grades, separable fat of the carcass and ether extract content of boneless meat of the carcass are made later in the manuscript together with comparative tables that will show the cattle to have been killed at rather closely matched degrees of fatness.

There were slight differences in lengths of feeding periods, the differences being in Trial 3, and they were due chiefly to coordinating work schedules at East Lansing and Beltsville. The average number of days on feed were 121, 170, 225 and 275 days for cattle in Kills 1, 2, 3 and 4, respectively, with the difference between kills being 49, 55 and 50 days.

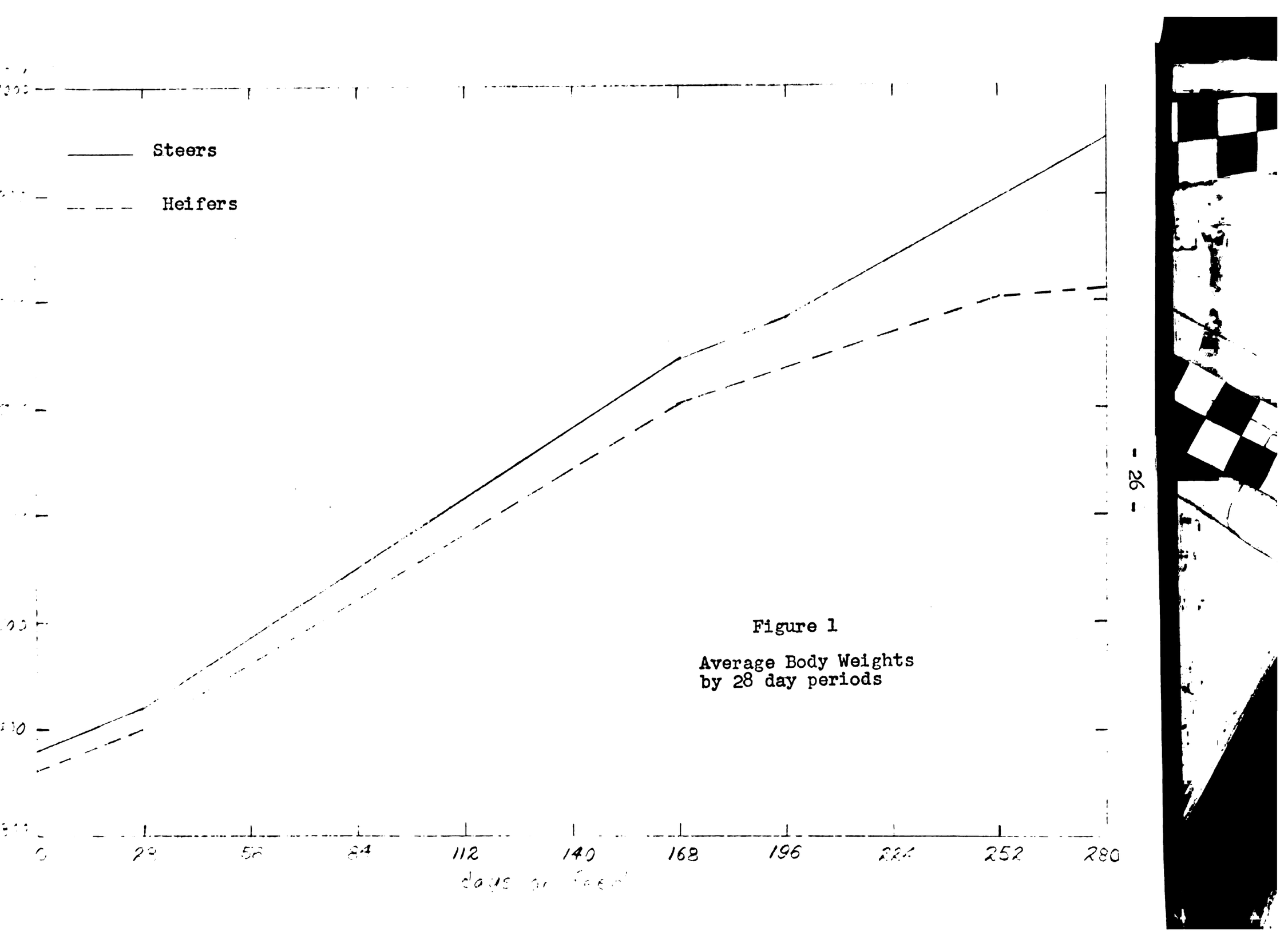


Figure 1

Average Body Weights
by 28 day periods

The results shown in Figures 1 to 3 were based on 28 day averages of all cattle used in the three experiments. The number of cattle in each sex was reduced by nine cattle at each kill, therefore, the reliability of all measurements decreased as the killings progressed due to the decreasing number of cattle representing the right hand segment of these curves.

On the average the steers used in these experiments were slightly heavier than the heifers at the beginning of each experiment, although, as seen in Tables 1 to 4, several heifers weighed more than several of the steers. Figure 1 shows that the weight advantage of the steers increased as feeding progressed. The average feedlot weights of the steers were 16, 58, 58 and 79 pounds heavier than that of the heifers after 121, 170, 225 and 275 days of feeding, respectively. These differences merit consideration, however, due to large variations in individual weights and the small number of cattle, the difference due to sex reached significance only when cattle were fed for 275 days.

Figure 2 shows that cattle of both sexes had about the same daily rate of gain the first 84 days of feeding, although after this period steers made the fastest gains. During the period between 56 and 168 days on feed cattle of the two sexes gained at rather constant and parallel rates. Following the 168 day weigh period, a sharp decline in rate of gain for cattle of both sexes occured. The heifers continued at the slow rate of gain, while the steer gains were lower than earlier

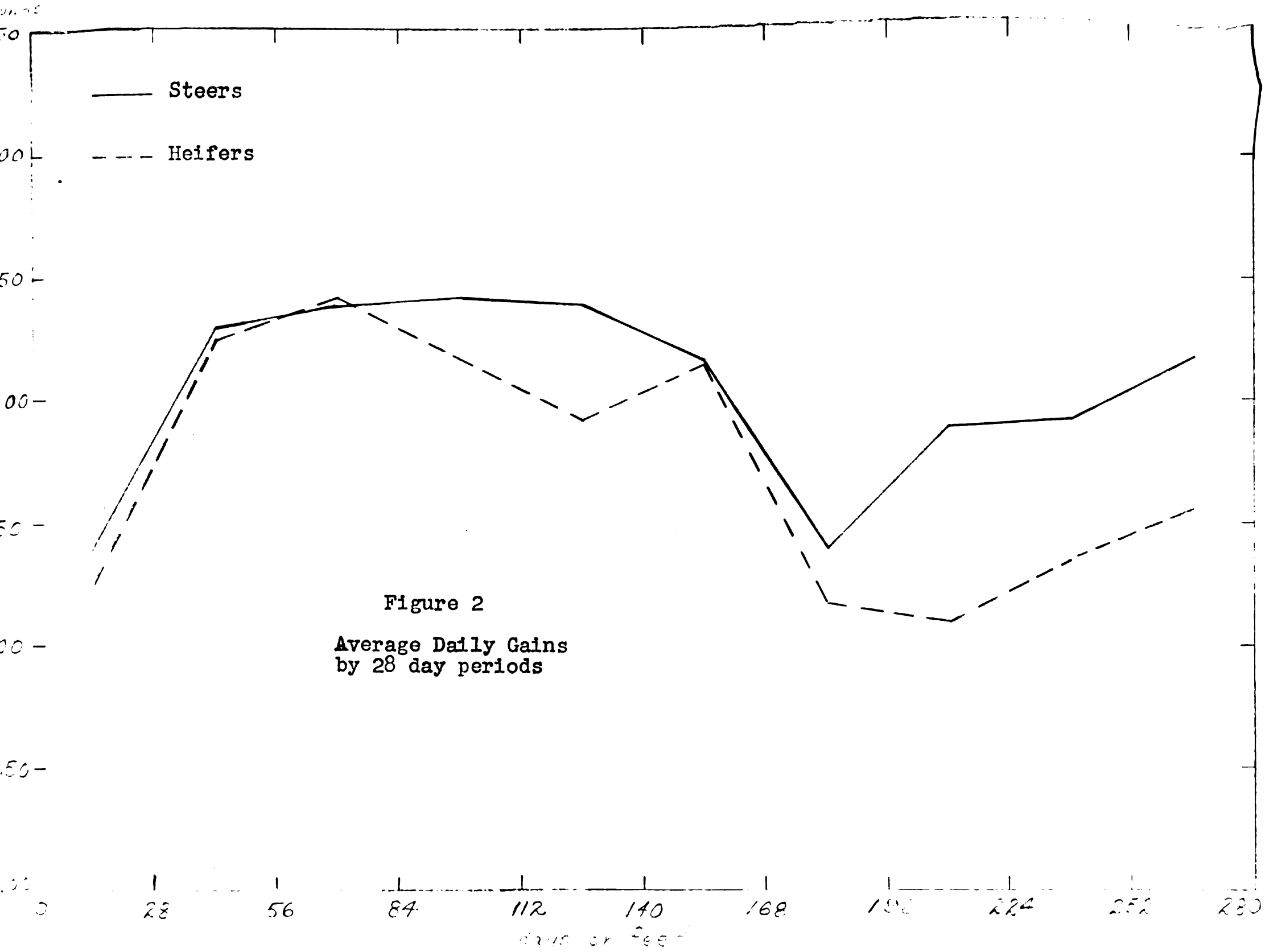
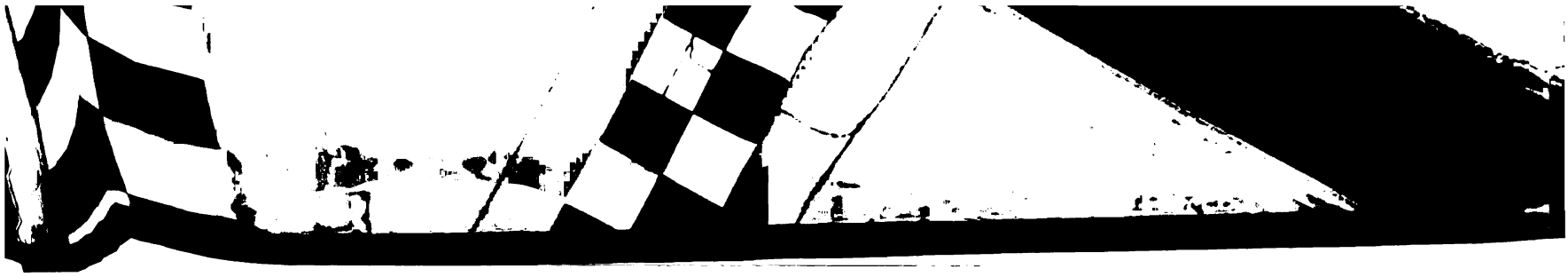


Figure 2

Average Daily Gains
by 28 day periods



in the feeding period but they continued to gain at a rate faster than that of the heifers. When cattle of similar finish are compared by referring to Tables 1-4, and comparing each kill of heifers with the succeeding kill of steers, the difference between the rate of gain for the two sexes is very small.

Daily gain per hundred pounds of body weight in Figure 3 followed a pattern similar to that of average daily gains, except for an earlier drop and a more even drop at a faster rate. During the first 112 days of feeding, gains averaged over 0.4 pound daily for each hundred pounds that the cattle weighed, which was about twice the rate during the time after 196 days of feeding. Heifers made larger gains per unit live weight than steers during the second and third 28 day feeding periods because daily gains made by heifers during these periods were about equal to those of the steers and the heifers were of lighter weights, but heifers dropped more rapidly thereafter. The rate decreased in cattle of both sexes after 56 days of feeding with cattle of the two sexes following a similar pattern.

In order to express feed consumption in one figure the results were computed on the basis of total digestible nutrients (TDN) from values in Morrison's text "Feeds and Feeding" (1950).

The daily TDN consumption of the steers and heifers shown in Figure 4, followed a very close parallel to each other during the first 112 days, with an increase of near 50 percent from the 28th to the 112th day. After the first 112

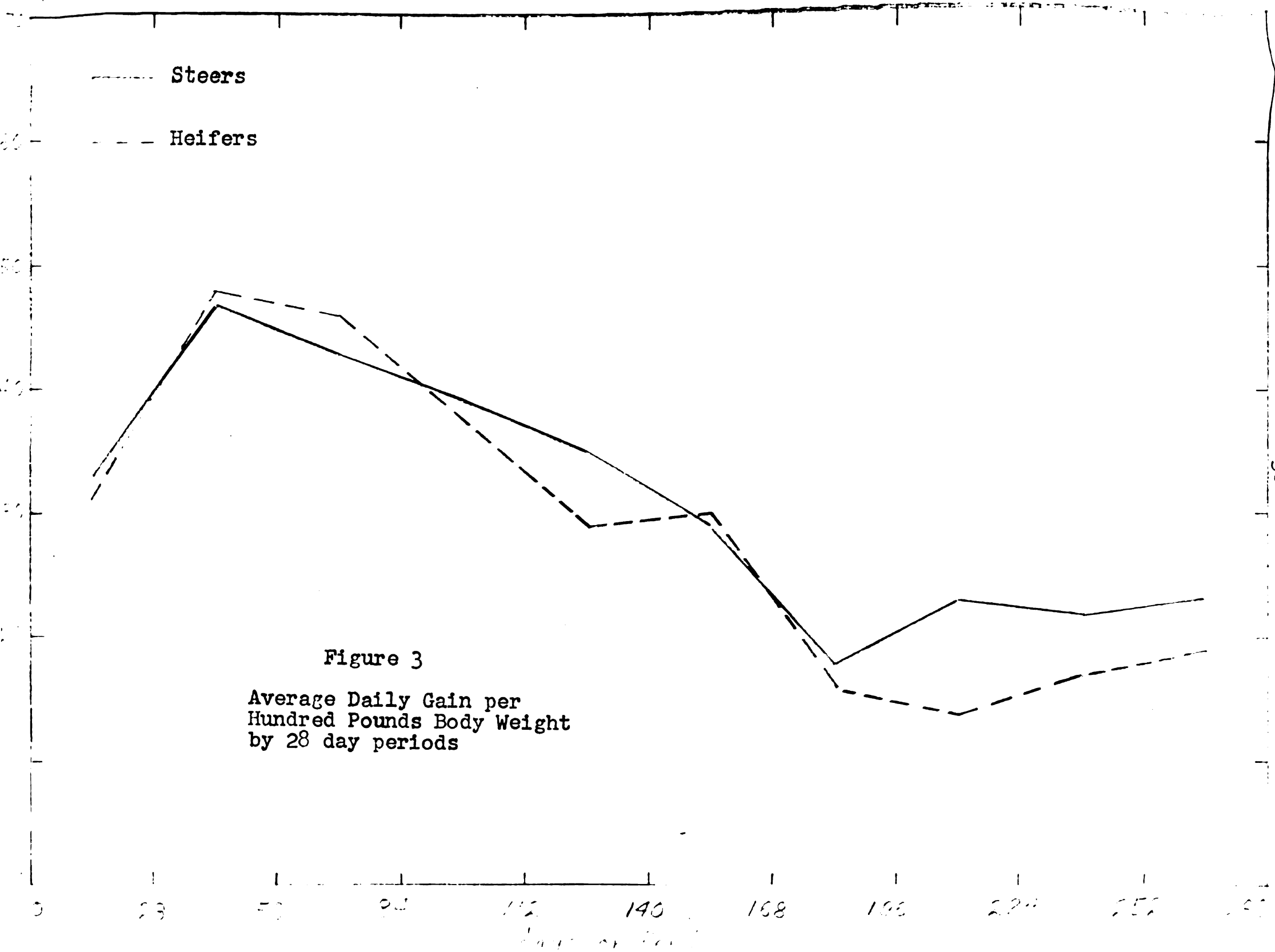


Figure 3

Average Daily Gain per
Hundred Pounds Body Weight
by 28 day periods

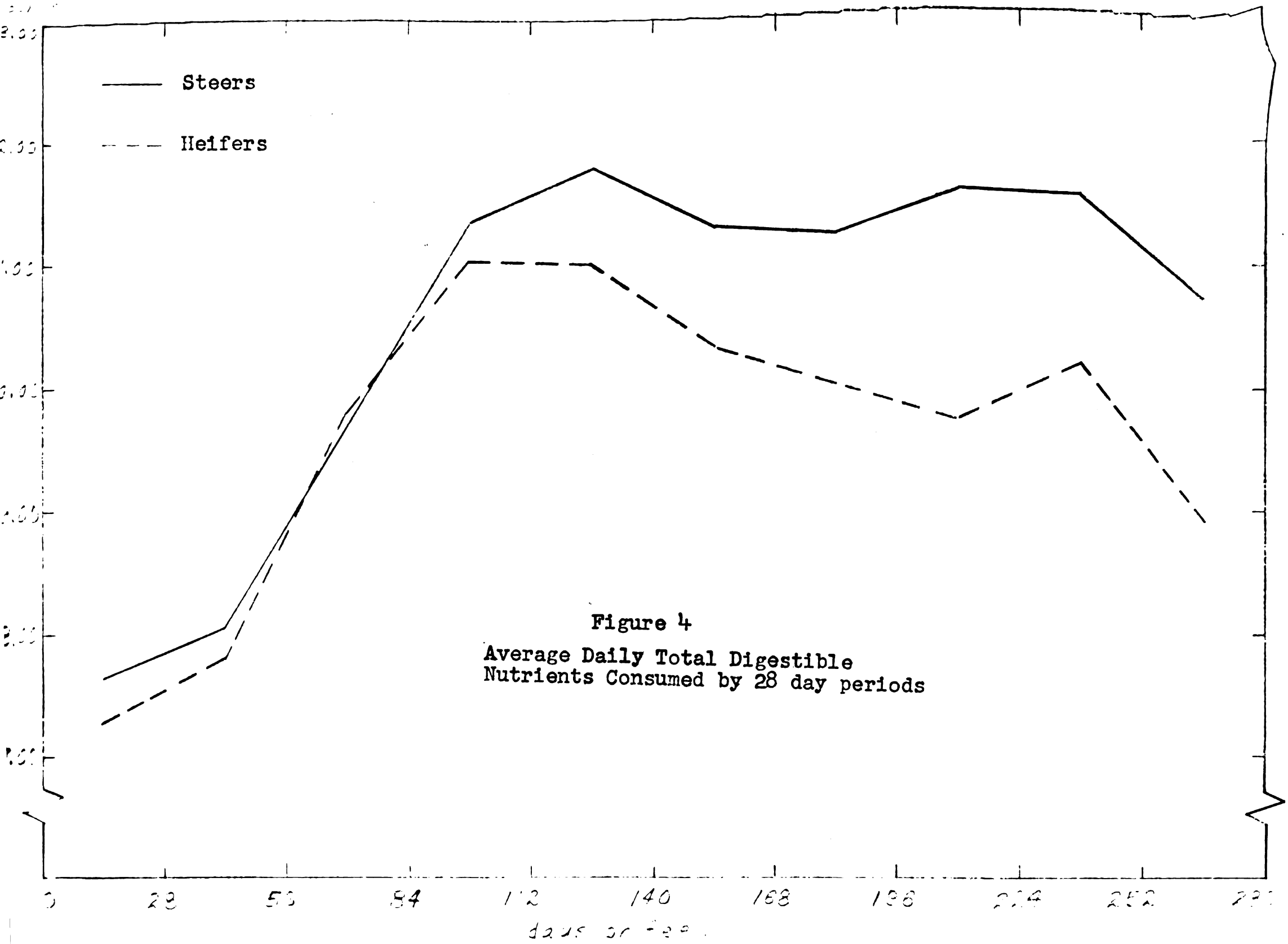
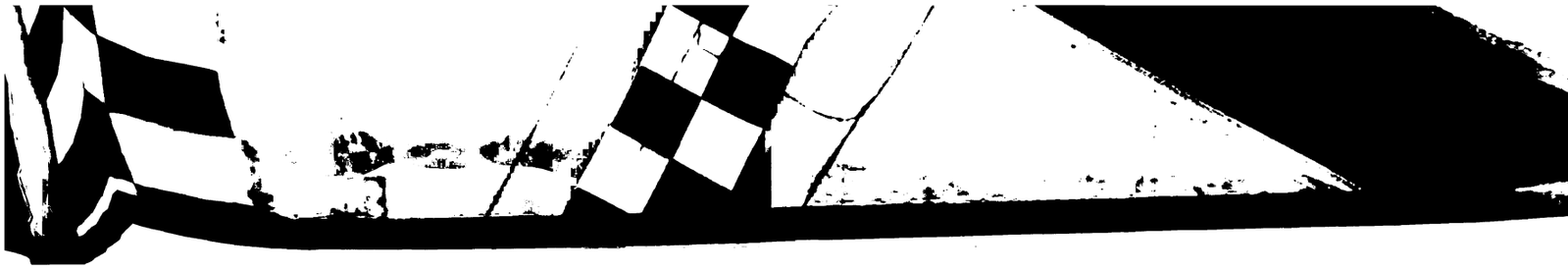


Figure 4

Average Daily Total Digestible Nutrients Consumed by 28 day periods



days of feeding the steers ate more than the heifers and the difference due to sex increased as feeding progressed. The large increase in daily TDN consumption between 56 and 112 days of feeding was due in part to the cattle having become adjusted to the environment, and there also was an increased energy demand due to the rapid growth that took place during these stages. After the 140th day of feeding daily TDN consumption decreased for cattle of both sexes. The daily TDN intake of the steers was increasingly greater than that of the heifers after 112 days of feeding for two reasons, namely; higher maintenance costs due to heavier weights and the increased growth rate of the steers above that of the heifers.

Figure 5 shows that during the second 28 day feeding period TDN consumed per hundred pounds live weight decreased for cattle of both sexes, the decrease being larger for steers. Between 56 and 112 days of feeding there was an increase in TDN consumption per hundred pounds live weight in cattle of both sexes. Heifers showed the largest increase during this period, when they were of lighter weights and, as shown in Figure 4, there was a very small difference between the sexes in daily TDN consumption. The increase for all cattle follows less rapidly the large increase in daily TDN consumption as shown in Figure 4. Cattle fed beyond 112 days showed a marked and continued decrease in TDN consumption per unit of body weight.

Total digestible nutrient requirements per pound of gain was one method used to measure efficiency in these experiments.

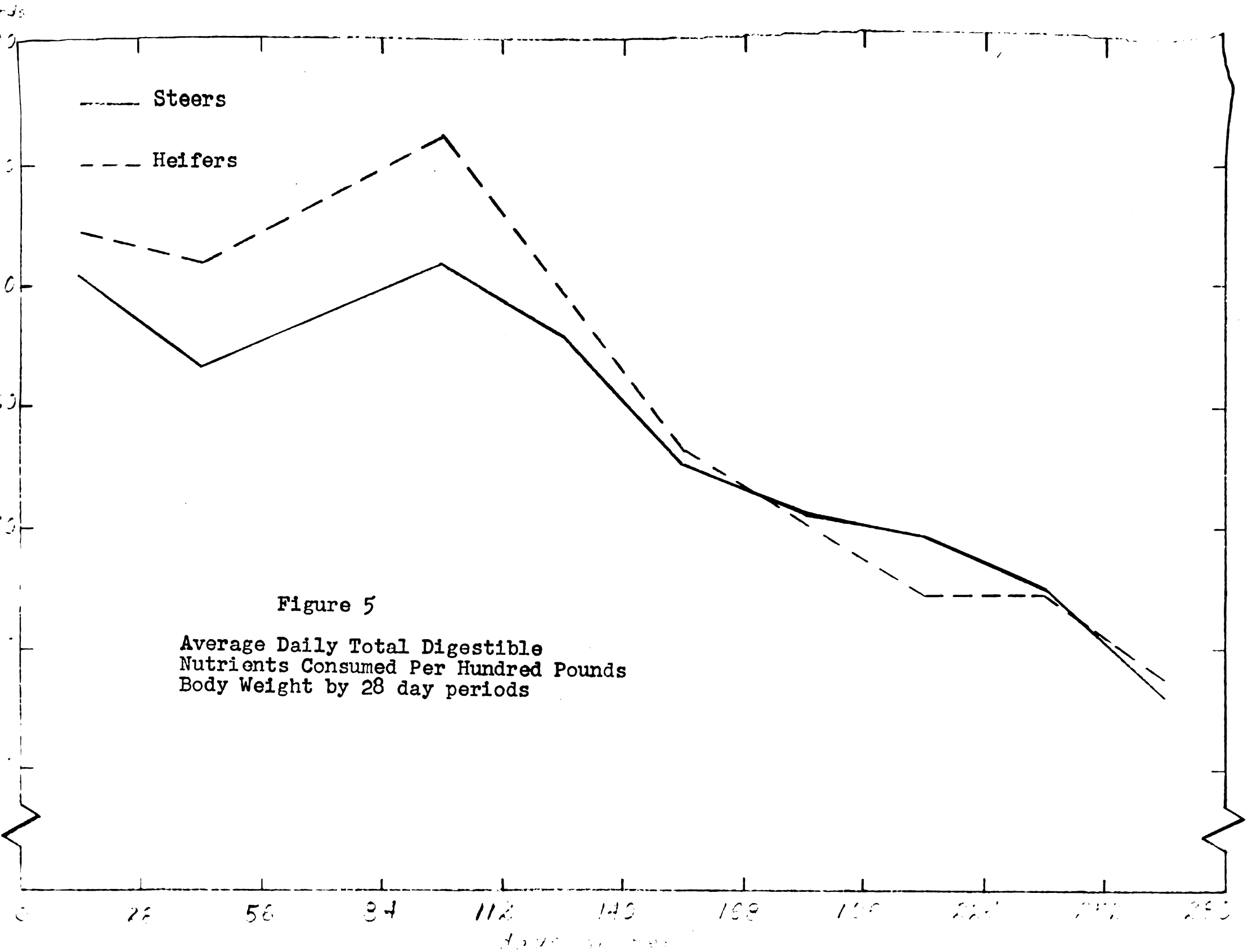


Figure 5

Average Daily Total Digestible Nutrients Consumed Per Hundred Pounds Body Weight by 28 day periods

Although the validity of this method of measuring efficiency in livestock is criticized by many investigators, especially those who feel that efficiency in livestock should be measured in terms of units of human food, nevertheless it is still the most practical method of measuring efficiency in livestock.

An examination of Figure 6 and Table 5 will reveal a very small difference in TDN requirements per pound of gain due to sex during the early stages of feeding, although during the later stages of feeding heifers required more TDN per pound of gain than steers. Figures 2 and 4 show that heifers made smaller gains and ate less nutrients during the later stages of feeding. Heifer number 8 of Kill 4, Trial 3 lost nine pounds between 196 and 224 days of feeding while several other heifers made very small gains. These facts account for the high point in the heifer curve in Figure 6 at the 224 day period.

The results tabulated in Table 6 show that for cattle of similar finish the TDN requirements per pound of gain were slightly higher for steers than for heifers but not significant. These results indicated that degree of finish or added weight had a greater effect on efficiency in fattening cattle than sex.

Another comparison was made using a predicting equation derived according to Fisher's Statistical Methods for Research Workers, 4th edition, pages 142-150. Total digestible nutrients required per pound of gain were predicted from average body weight and ether extract content of the carcass boneless meat. The predicting equation was found to be $y = -0.095x + .221z + 0.83$,

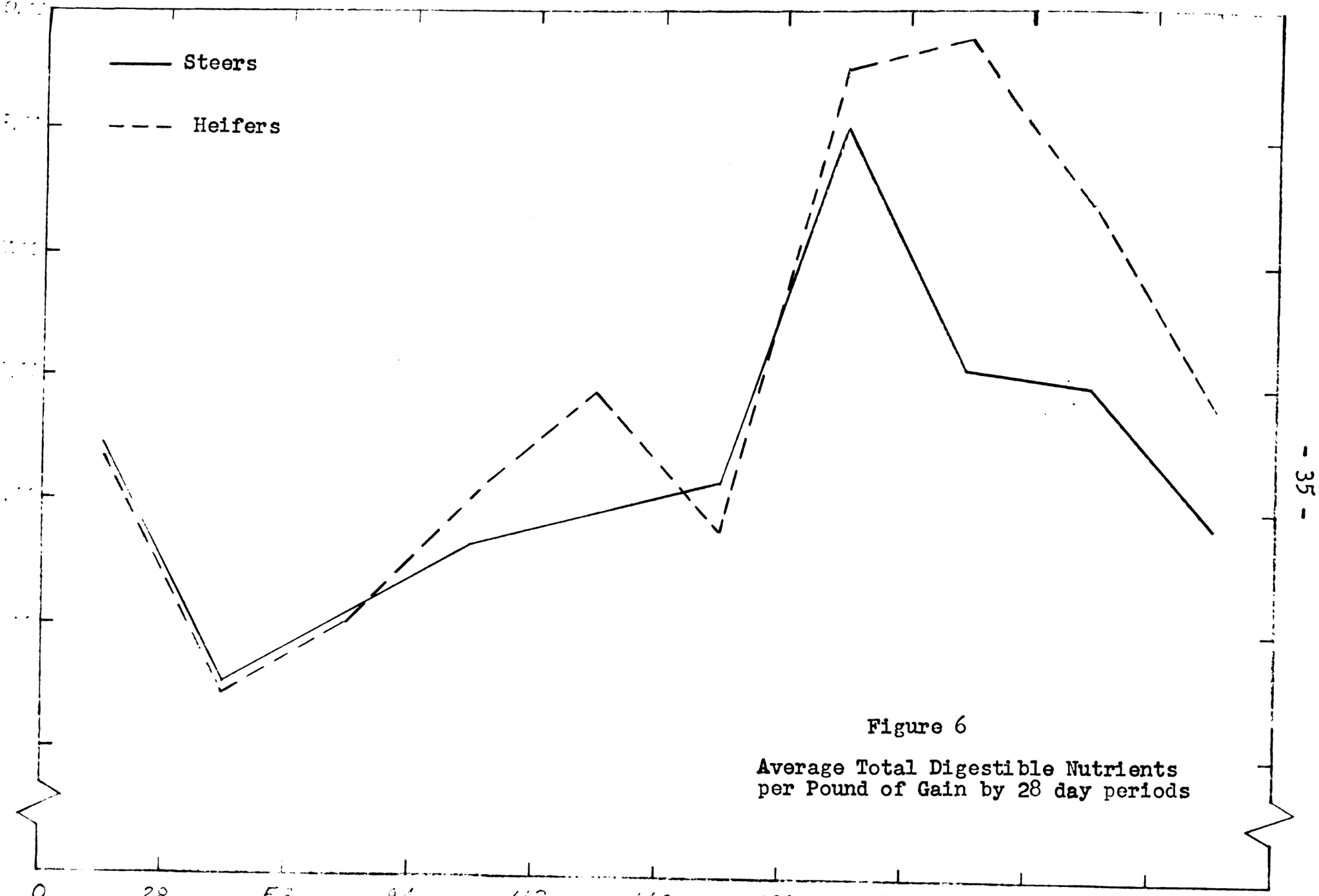


Figure 6

Average Total Digestible Nutrients per Pound of Gain by 28 day periods

Table 5. Performance of Steers and Heifers (By Kills)

Sex	Number of Cattle	Days on Feed	Final Weight (lbs.)	Average Daily Gain (lbs.)	Total Digestible Nutrients per Pound of Gain (lbs.)
Steers, Kill 1	9	121	638	2.06	4.6
Heifers, Kill 1	9	121	622	2.08	4.6
Difference Steers over Heifers			16	-0.02	0.0
Steers, Kill 2	9	170	763	2.19	4.8
Heifers, Kill 2	9	170	705	1.97	4.9
Difference Steers over Heifers			58	0.22	-0.1
Steers, Kill 3	9	225	828	2.00	5.0
Heifers, Kill 3	9	225	770	1.82	5.3
Difference Steers over Heifers			58	0.18	-0.3
Steers, Kill 4	9	275	924	1.98	5.4
Heifers, Kill 4	9	275	845	1.73	5.8
Difference Steers over Heifers			79**	0.25*	-0.4*
Averages					
Steers	36		790**	2.06*	5.0
Heifers	36		736	1.90	5.2*

* Significant at the 5 percent level.

** Significant at the 1 percent level.

when y equals pounds of TDN per pound of gain, x equals average body weight, and z equals ether extract content of carcass boneless meat. A test was made in order to determine whether or not the magnitude of the difference between the constants -0.095 and 0.221 was significant. The t value in this case was 2.95 which was highly significant. Therefore, ether extract content of the carcass was better for predicting total digestible nutrients required per pound of gain than final body weight, or in other words the fatness of the carcass was a better measure of nutrient requirement than was final body weight.

Slaughter Data

Averages of slaughter weights, shrink from feed lot to slaughter, empty body weight, and percentages of digestive contents and caul and ruffle fat are shown in Tables 7 and 8.

All cattle were weighed for three consecutive days before slaughter and the average of these weights was taken as the final weight. On the day the third weight was taken the cattle received no evening feed, but had access to water. They were slaughtered the next day with one weight being taken just before slaughter. The difference between final feedlot weight and slaughter weight was termed "shrink, feedlot to slaughter." The shrink from feedlot to slaughter did not follow any definite pattern, neither in sexes nor in groups of cattle fed for different lengths of time. The season of the year and the amount of water consumed may have had more influence on shrink than either sex or the length of the feeding period.

Table 7. Slaughter Data (By Kills)

Sex	Number of Cattle	Aver. Days on Feed	Shrink from Feedlot (% Final Weight)	Slaughter Weight (lbs.)	Digestive Content (% slaug. wt.)	Empty Body Weight (lbs.)	Caul and Ruffle Fat (% Slaug. wt.)
Steers, Kill 1	9	121	1.9	625.7	9.9	564.0	2.9
Heifers, Kill 1	9	121	3.7	599.8	9.3	544.1	3.2
Difference, Strs. over Hefs.			-1.8	25.9	0.6	19.9	-0.3
Steers, Kill 2	9	170	3.8	734.3	10.5	657.3	3.8
Heifers, Kill 2	9	170	3.5	679.8	9.8	611.0	3.8
Difference, Strs. over Hefs.			0.3	54.5	0.7	46.3	0.0
Steers, Kill 3	9	225	2.7	805.5	10.1	724.4	3.7
Heifers, Kill 3	9	225	2.7	750.4	9.6	678.8	4.0
Difference, Strs. over Hefs.			0.0	55.1	0.5	45.6	-0.3
Steers, Kill 4	9	275	3.5	891.9	9.1	810.7	4.3
Heifers, Kill 4	9	275	3.5	816.4	8.8	745.0	4.5
Difference, Strs. over Hefs.			0.0	75.5**	0.3	65.7**	0.2
Averages							
Steers	36		3.0	764.1**	9.9	689.1**	3.7
Heifers	36		3.3	711.6	9.4	644.7	3.9

** Significant at the 1 percent level.

Table 8. Slaughter Data (Cattle of similar finish).

Sex	Number of Cattle	Aver. Days on Feed	Shrink from Feedlot (% Final Weight)	Slaughter Weight (lbs.)	Digestive Content (% slaug. wt.)	Empty Body Weight (lbs.)	Caul and Ruffle Fat (% Slaug. wt.)
Steers, Kill 2	9	170	3.8	734.3	10.5	657.3	3.8
Heifers, Kill 1	9	121	3.7	599.8	9.3	544.1	3.2
Difference, Strs over Hefs.		49	0.1	134.5**	1.2	113.2**	0.6
Steers, Kill 3	9	225	2.7	805.5	10.1	724.4	3.7
Heifers, Kill 2	9	170	3.5	679.8	9.8	611.0	3.8
Difference, Strs. over Hefs.		55	-0.8	125.7**	0.3	113.4**	-0.1
Steers, Kill 4	9	275	3.5	891.9	9.1	810.7	4.3
Heifers, Kill 3	9	225	2.7	750.4	9.6	678.8	4.0
Difference, Strs. over Hefs.		50	0.8	141.5**	-0.5	131.9**	0.3
Averages							
Steers	27		3.3	810.6**	9.9	730.8**	3.9
Heifers	27		3.3	676.7	9.6	611.3	3.7

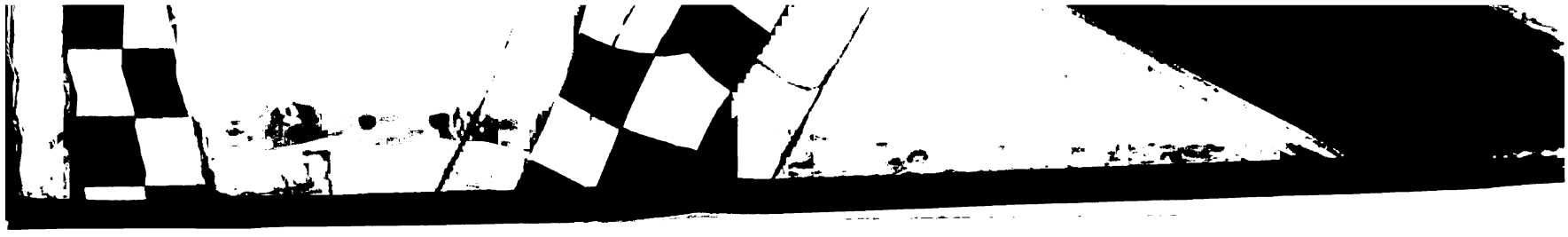
** Significant at the 1 percent level.

Shrunk weights at time of slaughter showed that steers were 25.9, 54.5, 55.1, and 75.5 pounds heavier than heifers after 121, 170, 225, and 275 days of feeding, respectively. However, due to the large individual variations in weight, the difference due to sex reached significance only when cattle were fed for 275 days as shown in Table 7.

When cattle of similar finish were compared the results showed that steers were significantly heavier than heifers at the end of each feeding period. This fact sustained the generally quoted report that heifers finish at earlier ages and lighter weights than steers. Differences of 126 to 142 pounds in shrunk weights between steers and heifers, with 49 to 55 days difference in feeding periods gave steers a significant weight advantage in cattle with similar finish.

The digestive tract was weighed both full and empty and the difference between these two weights represented the contents of the digestive tract, allowing empty body weight to be calculated. The digestive content as percent of slaughter weight was slightly higher in steers than in heifers, although the difference due to sex was too small to be significant at the levels used in testing differences.

The percentage of digestive content did not vary consistently with finish or weight. The results indicated a slight decrease in the percentage digestive content with increasing fatness, except for the first kill cattle which had a lower content than the second or third kills.



Net or empty body weight was obtained by subtracting the weight of the contents of the digestive tract from slaughter weight. The differences between sexes in net body weight followed the same trend as slaughter weight, that is steers, on the average, were heavier than heifers. The net body weight advantage of the steers over the heifers was less than the difference in slaughter weight because steers had a slightly higher percentage of digestive content than heifers. The difference in net body weight due to sex was significant at the 1 percent level only when cattle were slaughtered after 275 days of feeding. When compared at stages of similar finish, differences of 113 to 132 pounds were significant between steers and heifers.

In order to determine whether or not heifers deposited a larger proportion of fat on the digestive organs than steers, the caul and ruffle fat was removed and the results were expressed as percent of slaughter weight as shown in Tables 7 and 8. The percentage of caul and ruffle fat was higher in heifers at all stages of fattening except Kill 2, the differences due to sex were not significant at the levels used in testing differences. The results in Table 8 show that when cattle of similar finish were compared the differences in percentage caul and ruffle fat were negligible.

The percentage of caul and ruffle fat was significantly higher in cattle slaughtered after 170 days of feeding than in cattle slaughtered after 121 days of feeding. There was no significant difference in percentage caul and ruffle fat

in cattle slaughtered after 225 days compared with 170 days of feeding. In cattle slaughtered after 275 days of feeding the percentage of caul and ruffle fat was significantly higher than in cattle slaughtered after 225 days of feeding. The largest increase in percentage of caul and ruffle fat took place between 121 and 170 days of feeding.

When grading feeder cattle many of the items considered are those which indicate potential slaughter or carcass grade when properly fattened. It seems justifiable to assume, therefore, that a choice feeder calf which grades less than choice as a slaughter animal is unfinished. Tables1-4 and Tables 1-4 of the Appendix show that cattle of both sexes when slaughtered after 121 days of feeding graded lower as slaughter cattle than as feeders. Steers graded lower as slaughter cattle than as feeders when slaughtered after 170 days of feeding, while heifers slaughtered at the same time graded slightly higher for slaughter than as feeders. The difference in slaughter grades attributable to sex was small and reached significance at the 5 percent level only when cattle were slaughtered after 225 days of feeding.

Slaughter grades increased in calves of both sexes as feeding progressed.

Carcass Data

Averages of hot carcass shrink, carcass weights, dressing percentages and carcass grades are shown in Tables 9 and 10.

In all kills steer carcasses, on the average, were heavier than those of heifers, although the difference due to

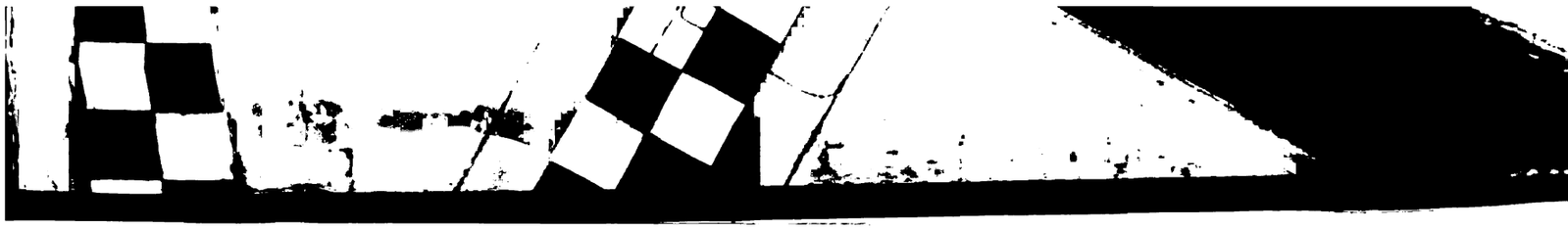


Table 9. Carcass Data (By Kills)

Sex	Number of Cattle	Average Days on Feed	Carcass Shrink (% hot Carcass)	Cold Carcass Weight (lbs.)	Dressing Percentage (cold carcass Slaug. wt.)	Carcass Grade
Steers, Kill 1	9	121	2.1	363.9	58.2	G
Heifers, Kill 1	9	121	1.8	355.8	59.3	G +*
Difference, Strs. over Hefs.			0.3	8.1	-1.1	
Steers, Kill 2	9	170	1.7	436.0	59.4	Ch -
Heifers, Kill 2	9	170	1.9	413.4	60.8	Ch*
Difference, Strs. over Hefs.			-0.2	22.6	-1.4*	
Steers, Kill 3	9	225	2.1	487.3	60.4	Ch
Heifers, Kill 3	9	225	1.8	466.6	62.1	P -
Difference, Strs. over Hefs.			0.3	20.7	-1.7**	
Steers, Kill 4	9	275	1.7	555.8	62.3	Ch +
Heifers, Kill 4	9	275	1.8	513.0	62.8	Ch +
Difference, Strs. over Hefs.			-0.1	42.8*	-0.5	
Averages						
Steers	36		1.9	460.6*	60.1	
Heifers	36		1.8	437.2	61.3**	

* Significant at the 5 percent level.
** Significant at the 1 percent level.

Table 10. Carcass Data (Cattle of similar finish).

Sex	Number of Cattle	Average Days on Feed	Carcass Shrink (% hot Carcass)	Cold Carcass Weight (lbs.)	Dressing Percentage (cold carcass Slaug. wt.)	Carcass Grade
Steers, Kill 2	9	170	1.7	436.0	59.4	Ch -
Heifers, Kill 1	9	121	1.8	355.8	59.3	G +
Difference, Strs. over Hefs.		49	-0.1	80.2**	0.1	
Steers, Kill 3	9	225	2.1	487.3	60.4	Ch
Heifers, Kill 2	9	170	1.9	413.4	60.8	Ch
Difference, Strs. over Hefs.		55	0.2	73.9**	-0.4	
Steers, Kill 4	9	275	1.7	555.8	62.3	Ch +
Heifers, Kill 3	9	225	1.8	466.6	62.1	P -
Difference, Strs. over Hefs.		50	-0.1	89.2**	0.1	
Averages Steers	27		1.8	493.0**	60.7	
Heifers	27		1.8	411.9	60.7	

* Significant at the 5 percent level.

** Significant at the 1 percent level.

sex was not significant. However, when slaughtered after 275 days of feeding the difference in carcass weight due to sex was significant at the 5 percent level in favor of the steers. The average carcass weight for steers was greater than those of heifers in each kill of each trial, except in Kill 1 of Trial 2 when heifer carcasses were slightly heavier than those of steers. It is of interest to note that the percentage difference in weights decreased as the finished product was approached. Steers were 10.5, 8.8 and 8.3 percent heavier than heifers in slaughter weights, in net body weight and in the carcass, respectively.

Steers were significantly heavier than heifers in all comparisons when cattle of similar finish were compared. These results indicated that heavier weights were necessary for steers to attain a given finish than for heifers.

Heifer carcasses shrank slightly less during 48 hours after slaughter as shown in Table 9. Carcasses in Kill 4 shrank less than carcasses in other kills. Neither sex nor length of feeding period had any significant effect on hot carcass shrink.

Dressing percentages were computed on the basis of slaughter weight and cold carcass weight, averages of these results are shown in Table 9, while dressing percentages are shown in Tables 1-4 of the Appendix. There was no significant difference in dressing percentages due to sex when cattle were slaughtered after 121 and 275 days of feeding. When cattle were slaughtered after 170 and 225 days of feeding,

dressing percentages of heifers were significantly higher than those of steers. The average dressing percentages of heifers were higher than those of steers in each kill and each trial, except in Kill 1 of Trial 2 when dressing percentages of steers were slightly higher than those of heifers. The average yield of all heifers was 1.2 percent more than steers slaughtered at a similar time.

The results obtained when cattle of similar finish were compared showed that sex affected dressing percentage but little as shown in Table 10.

There were significant increases in dressing percentages in cattle of both sexes as feeding progressed. Differences between Kills 1, 2, 3 and 4 were significant at the 1 percent level. The largest increase in dressing percentage took place in cattle of both sexes between 121 and 170 days of feeding.

One of the measures that heifers mature at earlier ages than steers is that heifer carcasses will grade higher than carcasses of steers of similar ages that received similar treatment. The results obtained in this study supported the above assumption. The largest difference in carcass grades due to sex was observed when cattle were slaughtered after 121 and 170 days of feeding (significant at the 5 percent level). Heifer carcasses graded higher than those of steers in each kill of each trial, except in Kill 4 of Trial 1 when steer carcasses graded slightly higher than heifer carcasses.

Results in Table 10 show that there was no significant difference in carcass grades when calves of similar finish were compared. Carcass grades were equal when heifers slaughtered after 170 days of feeding were compared with steers slaughtered after 225 days of feeding. In the other two comparisons, there was only one-third of a grade difference due to sex one in favor of steers and one in favor of heifers, which is considered by many meat men to be very close grading.

Cattle of both sexes graded consistently higher in the carcass as feeding progressed, except for the last kill of heifers. As explained earlier, there were some individual heifers in the last kill which performed in quite an irregular manner.

Cutting Tests

The carcasses were divided into wholesale cuts by the Chicago Method leaving one rib on the hindquarter, and with details recommended by the Cooperative Meat Conference. The results of cutting test were expressed as percentages of cold carcass weight. Averages of cutting tests are shown in Tables 11, 12, 13 and 14.

The hindquarter in heifers comprised a larger percentage of the carcass than in the case of steers in each kill of each trial. The proportion of hindquarter in steer carcasses decreased while in heifer carcasses it remained practically constant as feeding progressed. The difference in the proportion of hindquarter due to sex increased as feeding pro-

Table 11. Percentage Wholesale Cut Yield - Hindquarter. (Cold Carcass Basis)

Sex	Number of Cattle	Average Days on Feed	Hind-quarter	Round (less rump)	Rump	Loin (less K. Knob)	Flank	Kidney Knob
Steers, Kill 1	9	121	49.1	21.3	4.7	16.5	4.4	2.5
Heifers, Kill 1	9	121	49.6	20.1	4.8	16.4	5.5	2.6
Difference Strs. over Hefs.			-0.5	1.2**	0.1	0.1	-1.1**	-0.1
Steers, Kill 2	9	170	48.7	19.5	4.8	16.6	5.2	2.2
Heifers, Kill 2	9	170	49.3	19.1	4.6	16.9	5.8	2.6
Difference Strs. over Hefs.			-0.6	0.4	0.2	-0.3	-0.6	-0.4
Steers, Kill 3	9	225	48.6	20.0	4.7	16.3	5.4	2.2
Heifers, Kill 3	9	225	49.6	18.2	4.7	16.9	5.6	3.1
Difference Strs. over Hefs.			-1.0*	1.8**	0.0	-0.6*	-1.1**	-0.9
Steers, Kill 4	9	275	48.5	18.7	4.6	16.5	5.2	2.7
Heifers, Kill 4	9	275	49.7	18.3	4.9	16.8	6.6	3.0
Difference Strs. over Hefs.			-1.2**	0.4	-0.3	-0.3	-1.4**	-0.3
Averages								
Steers			48.7	19.9**	4.7	16.5	5.0	2.4
Heifers			49.6**	18.9	4.8	16.8*	5.9**	2.8

* Significant at the 5 percent level.
** Significant at the 1 percent level.

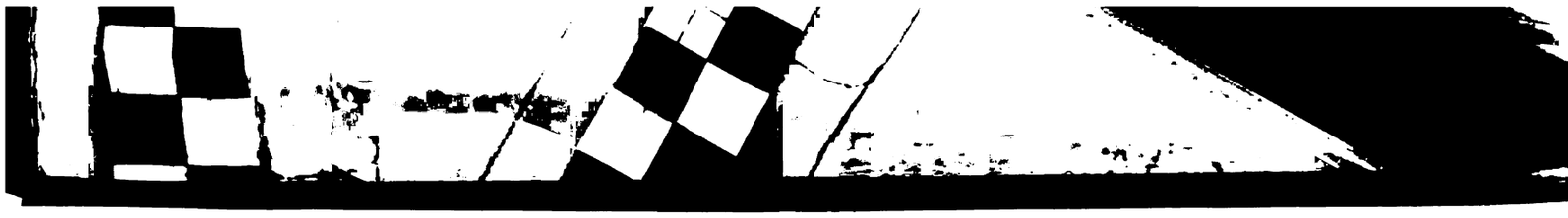


Table 12. Percentage Wholesale Cut Yield of Cattle of Similar Finish - Hindquarter. (Cold Carcass Basis).

Sex	Number of Cattle	Average Days on Feed	Hind-quarter	Round (less rump)	Rump	Loin (less K.Knob)	Flank	Kidney Knob
Steers, Kill 2	9	170	48.7	19.5	4.8	16.6	5.2	2.2
Heifers, Kill 1	9	121	49.6	20.1	4.8	16.4	5.5	2.6
Difference Strs. over Hefs.		49	-0.9	-0.6	0.0	0.2	-0.3	-0.4
Steers, Kill 3	9	225	48.6	20.0	4.7	16.3	5.4	2.2
Heifers, Kill 2	9	170	49.3	19.1	4.6	16.9	5.8	2.6
Difference Strs. over Hefs.		55	-0.7	0.9	0.1	-0.6	-0.4	-0.4
Steers, Kill 4	9	275	48.5	18.7	4.6	16.5	5.2	2.7
Heifers, Kill 3	9	225	49.6	18.2	4.7	16.9	5.6	3.1
Difference Strs. over Hefs.		50	-1.1*	0.5	-0.1	-0.4	-0.4*	-0.4
Averages								
Steers			48.6	19.4	4.7	16.5	5.3	2.4
Heifers			49.5*	19.1	4.7	16.7	5.9*	2.8

* Significant at the 5 percent level.

gressed resulting in significant difference at the third kill and high significance both at the fourth kill and for all cattle slaughtered.

When carcasses from cattle of similar finish were compared in Table 12 there were irregular differences in percentages of hindquarter as finish increased, but the difference was significant for the fattest cattle, and for the total cattle compared a significant difference of 0.9 per-cent was found.

The percentage of round averaged higher in nine steer carcasses than in nine heifer carcasses at each of four kills, but the difference was significant only at the first and third kills. When compared more closely by kills in each trial, steers cut out on the average a larger percentage of round than heifer carcasses in each kill of each trial, except in Kill 4 of Trial 3, when the proportion of round was slightly higher in heifer carcasses. The over all average gave 36 steers a significant advantage of one percent more round than the 36 heifers. The proportion of round decreased in cattle of both sexes with increasing fatness, from an average of 20.7 percent in Kill 1 to 18.5 in Kill 4.

Referring to Table 12, comparing rounds of cattle with similar finish, differences between the sexes were small. The average difference for 27 steers was only 0.3 percent more than the 27 heifers, and no differences were significant. In fact the heifers averaged 0.6 percent more round than the steers at the stage of least finish. There was less drop in

Table 13. Percentage Wholesale Cut Yield - Forequarter. (Cold Carcass Basis).

Sex	Number of Cattle	Average Days on Feed	Fore-quarter	Ribs	Chuck	Plate	Shank
Steers, Kill 1	9	121	50.9	8.5	26.8	10.8	4.0
Heifers, Kill 1	9	121	50.4	9.1	25.7	11.1	3.7
Difference Strs. over Hefs.			0.5	-0.6**	1.1**	-0.3	0.3*
Steers, Kill 2	9	170	51.3	8.7	26.2	11.5	3.7
Heifers, Kill 2	9	170	50.7	9.2	25.7	11.6	3.3
Difference Strs. over Hefs.			0.6	-0.5**	0.5	-0.1	0.4**
Steers, Kill 3	9	225	51.4	9.1	26.6	11.4	3.5
Heifers, Kill 3	9	225	50.4	9.4	25.3	11.6	3.1
Difference Strs. over Hefs.			1.0*	-0.3	1.3**	-0.2	0.4**
Steers, Kill 4	9	275	51.5	9.4	26.1	10.8	3.4
Heifers, Kill 4	9	275	50.3	9.4	25.4	11.8	3.0
Difference Strs. over Hefs.			1.2**	0.0	0.7*	-1.0	0.4**
Averages Steers	36		51.3**	8.9	26.4**	11.1	3.7**
Heifers	36		50.5	9.3**	25.5	11.5	3.3

* Significant at the 5 percent level.

** Significant at the 1 percent level.

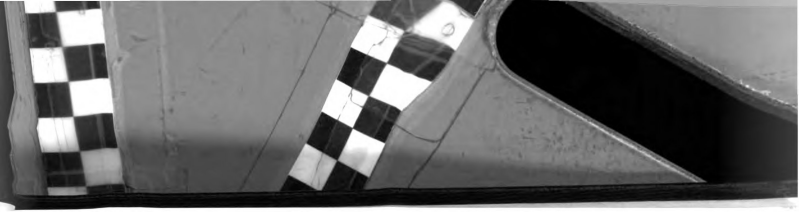


Table 14. Percentage Wholesale Cut Yield of Cattle of Similar Finish - Forequarter. (Cold Carcass Basis).

Sex	Number of Cattle	Average Days on Feed	Fore-quarter	Ribs	Chuck	Plate	Shank
Steers, Kill 2	9	170	51.3	8.7	26.2	11.5	3.7
Heifers, Kill 1	9	121	50.4	9.1	25.7	11.1	3.7
Difference Strs. over Hefs.		49	0.9	-0.4	0.5	0.4	0.0
Steers, Kill 3	9	225	51.4	9.1	26.6	11.4	3.5
Heifers, Kill 2	9	170	50.7	9.2	25.7	11.6	3.3
Difference Strs. over Hefs.		55	0.7	-0.1	0.9*	-0.2	0.2
Steers, Kill 4	9	275	51.5	9.4	26.1	10.8	3.4
Heifers, Kill 3	9	225	50.4	9.4	25.3	11.6	3.1
Difference Strs. over Hefs.		50	1.1*	0.0	0.8	-0.8	0.3*
Averages Steers	27		51.4*	9.1	26.3*	11.2	3.5*
Heifers	27		50.5	9.2	25.6	11.4	3.4

* Significant at the 5 percent level.

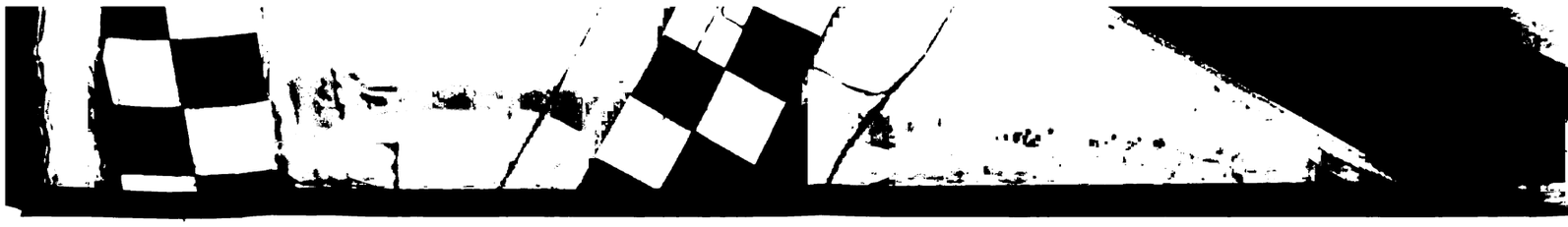
** Significant at the 1 percent level.

round percentage, namely only 1.3 percent, from the least fat to the fattest pair of kills matched for finish in Table 12 than was found in Table 11 where the thin steers in Kill 1 and the fat heifers in Kill 4 were included.

There were very small differences in rump cuts as percentage of carcass, either between the sexes, or among the kills. The highest percentage was 4.8 percent and the lowest was 4.6 percent. When matched for finish by kills, the percentages averaged exactly the same for 27 steers and 27 heifers.

Heifer carcasses contained larger percentages of kidney knob, although differences due to sex were not significant either by kills or at similar finish. The average proportion of kidney knob was larger in heifer carcasses than in steers in each kill of each trial, except in Kill 1 of Trial 3 when it was slightly higher in steer carcasses.

The percentage of loin (kidney knob removed) was significantly higher by 0.6 percent in heifer carcasses than in steer carcasses when cattle were slaughtered after 225 days of feeding. Also comparing all steers and heifers in the four kills together, a difference of 0.3 percent was significantly greater for heifers. When matched for finish the difference was 0.2 percent and was not significant. Heifers in Kill 1 had slightly less percentage loin than steers in either Kill 1 or Kill 2, but the heifers excelled in all other comparisons in the two tables. There was no consistent change in percentage of loin with increased finish on the cattle.



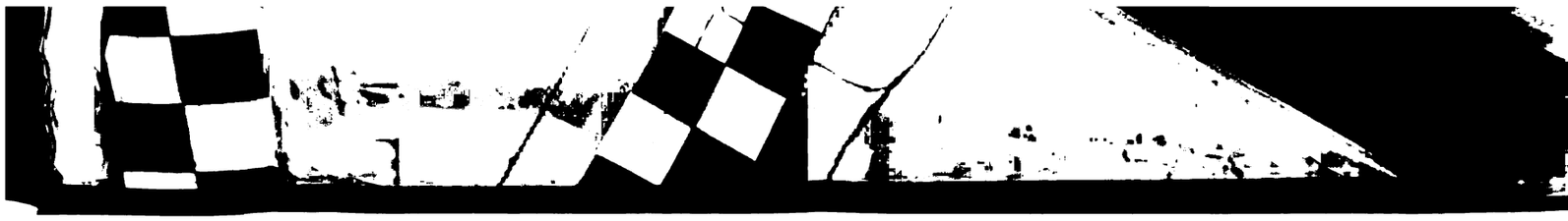
The proportion of flank was slightly larger in heifer carcasses than in steer carcasses at each kill, and also in each trial for each kill. The differences were significant for the first, third and fourth kills and when the total number of each sex were compared. When matched for finish in Table 12, the differences were smaller and were significant only for the fattest group. The 27 heifers matched with 27 steers averaged 0.6 percent more flank. Changes in percentage flank with increased fattening were very small.

The proportion of wholesale rib cut was significantly larger in heifer carcasses than in steer carcasses when calves were slaughtered after 121 and 170 days of feeding. Although when calves were fed for longer periods the magnitude of the difference due to sex decreased. The average proportion of wholesale rib cut was higher in heifer carcasses than in those of steers in each kill of each trial, except in Kill 4 of Trials 1 and 3 when the wholesale rib cut constituted a slightly larger proportion of steer carcasses.

In cattle of similar finish the proportion of wholesale rib cut was slightly higher in heifer carcasses than in steer carcasses. The small difference observed in calves of similar finish indicated that the proportion of wholesale rib cut in the carcass was influenced more by degree of finish rather than by sex.

There was an increase in the proportion of wholesale rib cut in the carcass in calves of both sexes as feeding progressed.

There was a slight increase in the percentage of plate in heifer carcasses with increased fatness, but there was no



definite increase in the percentage plate in steer carcasses. The percentage of plate was higher in heifer carcasses than in steers at each kill although not significant.

Table 13 shows that the chuck in steer carcasses constituted a significantly larger percentage than in heifers when cattle were slaughtered at Kills 1, 3 and 4, and also a higher percentage but not significant in Kill 2. The average percentage of chuck in the carcass was larger in steers than in heifers in each kill of each trial.

When cattle of similar finish were compared in Table 14 the proportion of chuck was larger in steer carcasses than in heifer carcasses, but with a significant difference only at the middle stage of finish. Increased finish had no consistent effect on the proportion of chuck in the carcass.

The percentage of shank was significantly larger in steer carcasses than in heifer carcasses in all kills, also in each kill of each trial. There was a gradual decrease in the percentage of shank with increased finish.

When cattle were compared on the basis of finish the results showed smaller differences in the proportion of shank due to sex, and significant only at the fourth kill and for all matched kills.

Carcass Physical Composition

Physical separations were made into bone, lean and fat from each right half carcass. The results of these analyses along with the meat to bone ratio are shown in Tables 15 and 16.

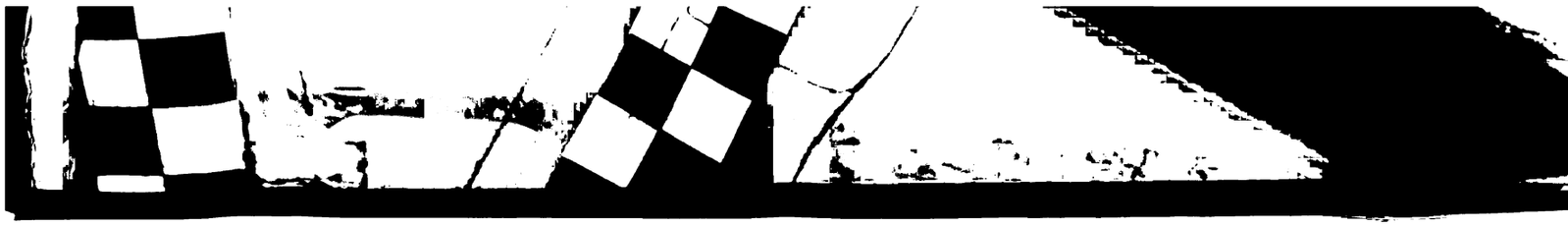


Table 15. Carcass Physical Composition and Meat to Bone Ratio.

Sex	Number of Cattle	Average Days on Feed	Separable Fat (% cold carcass wt.)	Separable Lean (% cold carcass wt.)	Bone (% cold carcass wt.)	Meat to Bone Ratio
Steers, Kill 1	9	121	18.3	62.2	18.0	4.5
Heifers, Kill 1	9	121	22.8	59.3	16.4	5.0
Difference Strs. over Hefs.			-4.5**	2.9*	1.6**	-0.5*
Steers, Kill 2	9	170	24.4	58.0	16.8	4.9
Heifers, Kill 2	9	170	27.0	57.3	14.9	5.7
Difference Strs. over Hefs.			-2.6	0.7	1.9**	-0.8**
Steers, Kill 3	9	225	26.1	56.5	16.6	5.0
Heifers, Kill 3	9	225	30.2	54.3	14.5	5.8
Difference Strs. over Hefs.			-4.1**	2.2	2.1**	-0.8**
Steers, Kill 4	9	275	30.6	53.9	14.9	5.7
Heifers, Kill 4	9	275	32.0	53.7	13.8	6.2
Difference Strs. over Hefs.			-1.4	0.2	1.1*	-0.5*
Average Steers	36		24.9	57.7*	16.6**	5.0
Heifers	36		28.0**	56.2	14.9	5.7**

* Significant at the 5 percent level.

** Significant at the 1 percent level.

Table 16. Carcass Physical Composition and Meat to Bone Ratio in Cattle of Similar Finish.

Sex	Number of Cattle	Average Days on Feed	Separable Fat (% cold carcass wt.)	Separable Lean (% cold carcass wt.)	Bone (% cold carcass wt.)	Meat to Bone Ratio
Steers, Kill 2	9	170	24.4	58.0	16.8	4.9
Heifers, Kill 1	9	121	22.8	59.3	16.4	5.0
Difference Strs. over Hefs.		49	1.6	-1.3	0.4	-0.1
Steers, Kill 3	9	225	26.1	56.5	16.6	5.0
Heifers, Kill 2	9	170	27.0	57.3	14.9	5.7
Difference Strs. over Hefs.		55	-0.9	-0.8	1.7*	-0.7*
Steers, Kill 4	9	275	30.6	53.9	14.9	5.7
Heifers, Kill 3	9	225	30.2	54.3	14.5	5.8
Difference Strs. over Hefs.		50	0.4	-0.4	0.4	-0.1
Averages						
Steers	27		27.0	56.1	16.1*	5.2
Heifers	27		26.7	57.0	15.3	5.5*

* Significant at the 5 percent level.
** Significant at the 1 percent level.

The proportion of fat in heifer carcasses was significantly larger than in steer carcasses when cattle were slaughtered after 121 and 225 days of feeding. The proportion of fat in heifer carcasses was also larger when calves were slaughtered after 170 days and 275 days of feeding, but the difference between the sexes was not significant at the levels used in testing differences. The average proportion of fat was larger in heifer carcasses than in steer carcasses in each kill of each trial, except in Kill 4 of Trial 2 when steer carcasses contained a slightly larger proportion of fat. All heifers together had a highly significant average of 3.1 percent more separable fat than the steers.

The separable fat content shown in Table 16 gives another check on the attempt to slaughter steers and heifers at similar degrees of finish, or fatness. Differences of 0.4, 0.9 and 1.6 percent, with total separable fat percentages averaging from 22.8 to 30.6 percent in the different kills, indicates rather good success in timing.

When cattle were slaughtered after 121 days of feeding and also when all cattle are compared together, steer carcasses contained a significantly larger proportion of lean than heifer carcasses. Steer carcasses also contained a larger proportion of lean when cattle were slaughtered after 170, 225 and 275 days of feeding, but the difference due to sex was too small to be significant at the levels used in testing differences. The average proportion of lean was larger in steer carcasses in each kill of each trial, except in Kill 4

of Trial 3 when the proportion of lean was slightly higher in heifer carcasses.

The proportion of lean in the carcasses of cattle of similar finish was slightly larger in heifer carcasses than in steers but not significant, as shown in Table 16. The results showed that the proportion of lean in the carcasses of cattle was largely dependent on degree of finish rather than on the sex of the animal.

The proportion of lean in the carcass of cattle of both sexes decreased with increasing fatness.

Steer carcasses contained a significantly larger proportion of bone in all kills. The smallest difference in the proportion of bone due to sex was observed when cattle were slaughtered after 275 days of feeding.

In cattle of similar finish the proportion of bone was higher in steer carcasses than in heifer carcasses, but the difference was significant only when steers slaughtered after 225 days of feeding were compared with heifers slaughtered after 170 days of feeding. These results indicated that the proportion of bone in the carcass was influenced by both degree of finish and sex. The percentage of bone decreased with increasing finish.

The meat to bone ratio was significantly higher in heifers in each kill. The largest difference in the meat to bone ratio due to sex was observed when cattle were slaughtered after 170 and 225 days of feeding, being 0.8 higher in heifers in each case.

Table 17. Physical Composition of Wholesale Cuts. (Results are expressed as percentages of cold carcass weight.)

Days on Feed	121			170			Average	
Number of Cattle	9	9		9	9			
Sex:	Steers	Heifers	Difference Steers over Heifers	Steers	Heifers	Difference Steers over Heifers	Steers	Heifers
Round, less rump								
Fat	1.8	1.9	-0.1	2.2	2.3	-0.1		
Lean	14.9	14.6	0.3	13.3	13.2	0.1		
Bone	4.3	4.0	0.3*	3.9	3.5	0.4*		
Rump								
Fat	1.1	1.3	-0.2*	1.2	1.4	-0.2*		
Lean	2.6	2.5	0.1	2.5	2.3	0.2		
Bone	1.0	1.0	0.0	1.0	0.9	0.1		
Loin, less kidney								
Fat	3.3	4.1	-0.8**	4.6	4.9	-0.3		
Lean	10.8	10.1	0.7	9.9	10.1	-0.2		
Bone	2.3	2.1	0.2*	2.1	1.9	0.2*		
Flank								
Fat	2.2	3.3	-1.1**	2.8	3.7	-0.9**		
Lean	2.1	2.1	0.0	2.2	2.0	0.2		
Ribs								
Fat	1.6	2.0	-0.4*	2.2	2.3	-0.1		
Lean	5.1	5.0	0.1	4.6	5.0	-0.4		
Bone	1.8	1.8	0.0	1.7	1.7	0.0		
Chuck								
Fat	3.5	4.1	-0.6	4.7	5.0	-0.3		
Lean	18.4	17.2	1.2**	17.2	16.6	0.6		
Bone	4.7	4.2	0.5**	4.4	3.8	0.6**		
Plate								
Fat	2.9	3.7	-0.8	4.0	4.2	-0.2		
Lean	6.0	5.7	0.3	5.9	5.8	0.1		
Bone	1.9	1.7	0.2	1.6	1.5	0.1		
Shank								
Fat	0.3	0.3	0.0	0.2	0.2	0.0		
Lean	1.9	1.7	0.2	1.7	1.6	0.1		
Bone	1.8	1.7	0.1*	1.8	1.4	0.4**		

See next page.

* Significant at the 5 percent level.
** Significant at the 1 percent level.

Table 17 (cont.). Physical Composition of Wholesale Cuts.
(Results are expressed as percentages of cold carcass weight.)

Days on Feed	225			275			Average	
Number of Cattle	9	9		9	9			
Sex:	Steers	Heifers	Difference Steers over Heifers	Steers	Heifers	Difference Steers over Heifers	Steers	Heifers
Round, less rump								
Fat	2.6	2.3	0.3	2.8	2.7	0.1	2.4	2.3
Lean	13.4	12.4	1.0**	12.4	12.4	0.0	13.5**	13.2
Bone	3.9	3.3	0.6**	3.5	3.3	0.2	3.9**	3.5
Rump								
Fat	1.4	1.6	-0.2*	1.5	1.8	-0.3**	1.3	1.5**
Lean	2.2	2.2	0.0	2.2	2.2	0.0	2.4	2.3
Bone	1.0	0.8	0.2	0.9	.10	-0.1	1.0	1.0
Loin, less kidney								
Fat	4.7	5.3	-0.6*	5.5	5.7	-0.2	4.5	5.0**
Lean	9.3	9.5	-0.2	9.1	9.3	-0.2	9.8	9.8
Bone	2.2	2.0	0.2*	1.9	1.8	0.1	2.1	2.0
Flank								
Fat	3.0	4.2	-1.2**	3.2	4.3	-1.1**	2.8	3.9**
Lean	2.2	2.1	0.1	2.1	2.1	0.0	2.2	2.1
Ribs								
Fat	2.4	2.8	-0.4*	2.9	2.8	0.1	2.3	2.5*
Lean	4.8	4.8	0.0	4.7	4.8	-0.1	4.8	4.9
Bone	1.7	1.7	0.0	1.7	1.6	0.1	1.7	1.7
Chuck								
Fat	5.1	5.6	-0.5	5.9	6.0	-0.1	4.8	5.2
Lean	17.1	16.0	1.1*	16.2	15.9	0.3	17.2	16.4**
Bone	4.4	3.7	0.7**	3.8	3.5	0.3	4.3	3.8**
Plate								
Fat	4.4	4.8	-0.4	5.0	5.3	-0.3	4.1	4.5
Lean	5.3	5.2	0.1	5.1	5.2	-0.1	5.6	5.5
Bone	1.7	1.4	0.3	1.4	1.4	0.0	1.7	1.5
Shank								
Fat	0.3	0.3	0.0	0.3	0.3	0.0	0.3	0.3
Lean	1.6	1.5	0.1	1.6	1.4	0.2	1.7	1.6
Bone	1.7	1.4	0.3**	1.6	1.4	0.2*	1.7	1.5**

* Significant at the 5 percent level.
**Significant at the 1 percent level.

Table 18. Physical Composition of Wholesale Cuts from Cattle of Similar Finish. (Results are expressed as percentages of cold carcass weight.)

Days on Feed	170	121	49	225	170	55	275	225	50		
Number of Cattle	9	9	Difference Steers over	9	9	Difference Steers over	9	9	Difference Steers over	Averages	
Sex	Strs	Hefs	Heifers	Strs	Hefs	Heifers	Strs	Hefs	Heifers	Steers	Heifers
Round, less rump											
Fat	2.2	1.9	0.3	2.6	2.3	0.3	2.8	2.3	0.5	2.5	2.2
Lean	13.3	14.6	-1.3	13.4	13.2	0.2	12.4	12.4	0.0	13.0	13.4
Bone	3.9	4.0	-0.1	3.9	3.5	0.4	3.5	3.3	0.2	3.8	3.6
Rump											
Fat	1.2	1.3	-0.1	1.4	1.4	0.0	1.5	1.6	-0.1	1.4	1.4
Lean	2.5	2.5	0.0	2.2	2.3	-0.1	2.2	2.2	0.0	2.3	2.3
Bone	1.0	1.0	0.0	1.0	0.9	0.1	0.9	0.8	0.1	1.0	0.9
Loin, less Kidney											
Fat	4.6	4.1	0.5	4.7	4.9	-0.2	5.5	5.3	0.2	4.9	4.8
Lean	9.9	10.1	-0.2	9.3	10.1	-0.8	9.1	9.5	-0.4	9.4	9.9
Bone	2.1	2.1	0.0	2.2	1.9	0.3	1.9	2.0	-0.1	2.1	2.0
Flank											
Fat	2.8	3.3	-0.5	3.0	3.7	-0.7	3.2	4.2	-1.0*	3.0	3.7*
Lean	2.2	2.1	0.1	2.2	2.0	0.2	2.1	2.1	0.0	2.2	2.1
Rib											
Fat	2.2	2.0	0.2	2.4	2.3	0.1	2.9	2.8	0.1	2.5	2.4
Lean	4.6	5.0	-0.4	4.8	5.0	-0.2	4.7	4.8	-0.1	4.7	4.9
Bone	1.7	1.8	-0.1	1.7	1.7	0.0	1.7	1.7	0.0	1.7	1.7
Chuck											
Fat	4.7	4.1	0.6	5.1	5.0	0.1	5.9	5.6	0.3	5.2	4.9
Lean	17.2	17.2	0.0	17.1	16.6	0.5*	16.2	16.0	0.2	16.8*	16.6
Bone	4.4	4.2	0.2	4.4	3.8	0.6*	3.8	3.7	0.1	4.2*	3.9
Plate											
Fat	4.4	3.7	0.3	4.4	4.2	0.2	5.0	4.8	0.2	4.5	4.2
Lean	5.9	5.7	0.2	5.3	5.8	-0.5	5.1	5.2	-0.1	5.4	5.6
Bone	1.6	1.7	-0.1	1.7	1.5	0.2	1.4	1.4	0.0	1.6	1.5
Shank											
Fat	0.2	0.3	-0.1	0.3	0.2	0.1	0.3	0.3	0.0	0.3	0.3
Lean	1.7	1.7	0.0	1.6	1.6	0.0	1.6	1.5	0.1	1.6	1.6
Bone	1.8	1.7	0.1	1.7	1.4	0.3*	1.6	1.4	0.2	1.7*	1.5

* Significant at the 5 percent level.

In cattle of similar finish the meat to bone ratio was larger in heifers than in steers. The difference in the meat to bone ratio, attributable to sex, was significant when steers slaughtered after 225 days of feeding were compared with heifers slaughtered after 170 days of feeding. These results indicated that the meat to bone ratio in cattle carcasses was dependent on both degree of finish and sex.

The meat to bone ratio increased in cattle of both sexes as feeding progressed.

Physical Composition of Wholesale Cuts

The wholesale cuts of the right half of each carcass were separated into fat, lean and bone. Averages of the physical composition of the wholesale cuts are shown in Tables 17 and 18. The results are expressed as percentages of the cold carcass weight.

Fat is the most variable constituent in the carcass and in the wholesale cut, and the percentages of lean and bone vary inversely with the percentages of fat. For this reason, fat and its variations were given the most consideration in the following discussion.

There was no significant nor consistent difference in the proportion of round fat in the carcass due to sex.

With increasing fatness the percentage of round fat increased in cattle of both sexes, except when heifers slaughtered after 225 days of feeding were compared with heifers slaughtered after 170 days of feeding.

In cattle of similar finish round fat comprised a slightly larger percentage of steer carcasses. The difference in the proportion of round fat was largest, but not significant when heifers slaughtered after 225 days of feeding were compared with steers slaughtered after 275 days of feeding.

The percentages for round lean and bone were larger in steer carcasses than in heifer carcasses slaughtered at the same time. The difference in the proportion of round lean due to sex was too small to be significant at the levels used in testing differences. However, the bone in the rounds of steers accounted for a significantly larger proportion of the carcass than in heifers, except in cattle slaughtered after 275 days of feeding.

It can be seen in Table 18 that there was very little difference in the proportion of rump fat when cattle of similar finish were compared. There was a consistent increase in rump fat with finish indicating that degree of finish had more influence than sex on the proportion of fat in the rump cut.

Sex did not have any consistent or significant effect on the proportion of lean in the rump.

Neither sex nor degree of finish had any appreciable effect on the percentage of rump bone in the carcass as shown in Tables 17 and 18.

Loin fat in heifer carcasses comprised a significantly larger proportion of the carcass than in steers when cattle were slaughtered after 121 and 225 days of feeding. The

proportion of loin fat was larger in heifer carcasses than in steer carcasses when cattle were slaughtered after 170 and 275 days of feeding, although the difference due to sex was not significant.

Results tabulated in Table 18 show that the difference in percentage of loin fat was not consistently different in carcasses when cattle of similar finish were compared.

Loin fat accounted for a higher percentage of the carcass in cattle of both sexes as feeding progressed. The largest increase in the proportion of loin fat took place between 121 and 170 days of feeding, which indicated that fat deposition in the loin took place at a faster rate during the earlier stages of feeding. On the basis of these results it is safe to assume that the proportion of fat in the loin without the kidney was largely dependent on the degree of finish rather than sex.

There was no significant difference in the percentage of loin lean attributable to sex, although at similar finish heifer loins contained slightly more lean at each stage when cattle were slaughtered after 121, 170 and 225 days of feeding. With cattle of similar finish the difference in the proportion of loin bone was neither consistent nor significant.

The percentage of flank fat in heifer carcasses was significantly larger in all kills.

In cattle of similar finish the percentage of flank fat was significantly larger in heifer carcasses than in steer carcasses, when steers of Kill 4 were compared with heifers

of Kill 3 and for total cattle of each sex as shown in Table 18. The proportion of flank fat in the carcass of both sexes increased as feeding progressed. These results showed that both degree of finish and sex influenced the proportion of flank fat in the carcass.

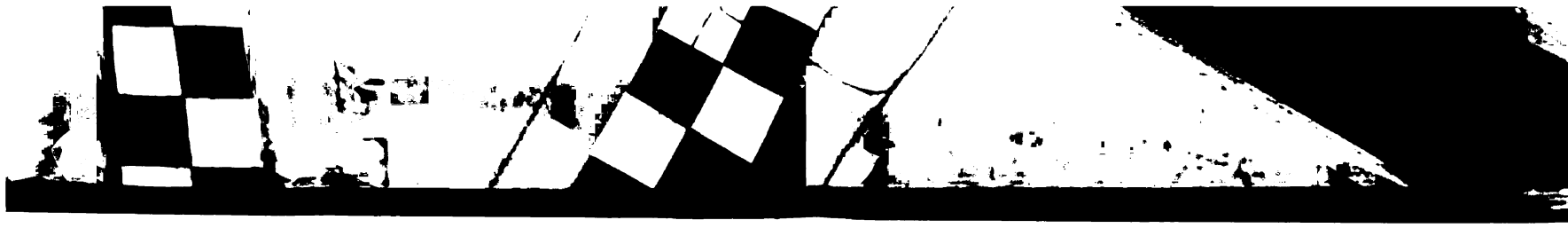
The percentage of lean in the flank was not affected considerably by sex or degree of finish.

The wholesale rib fat in heifer carcasses comprised a significantly higher percentage of the carcass than in steers when cattle were slaughtered after 121 days and 225 days of feeding. After 170 and 275 days of feeding the wholesale rib fat constituted a larger proportion of heifer carcasses, but the difference due to sex was not significant.

There was practically no difference due to sex in the proportion of wholesale rib fat in the carcasses of cattle of similar finish. The proportion of wholesale rib fat in the carcass increased in cattle of both sexes as feeding progressed. These results indicated that the proportion of wholesale rib fat in the carcass was largely dependent on the finish of the cattle.

There were no significant differences in the proportions of wholesale rib lean or bone due to sex.

There were no significant differences in the proportions of plate or chuck fat in the carcass due to sex, but heifers averaged higher at each kill. In cattle of similar finish, steer chucks and plates contained more fat at each stage, but the difference was not significant.



Both the proportion of chuck fat and the proportion of plate fat in the carcass increased in cattle of both sexes quite rapidly as feeding progressed.

Steer chucks contained more lean at each kill, the difference being significant at the first and third kills. In cattle of similar finish, differences were not significant. Steer chucks contained a higher percentage of carcass bone, with significance in the first three kills. At similar finish, steer chuck bone was slightly higher but significant only at the middle stage. The percentage of plate bone was higher in steer carcasses both when cattle were matched by kills and finish. The percentage of plate lean in the carcass was higher in steer carcass when cattle were compared by kills but higher in heifer carcasses when cattle were matched by finish.

The edible portion of the shank is very small and changes but little during the fattening process. Therefore, only the bone of the shank was considered in this discussion.

The proportion of shank bone accounted for a significantly larger proportion of steer carcasses than of heifer carcasses in all kills. Differences were larger when cattle were slaughtered after 170 and 225 days of feeding, and after 225 days of feeding the difference in the proportion of shank bone decreased.

In cattle of similar finish the proportion of shank bone in the carcasses of steers was significantly larger than in those of heifers. These results indicated that, generally,

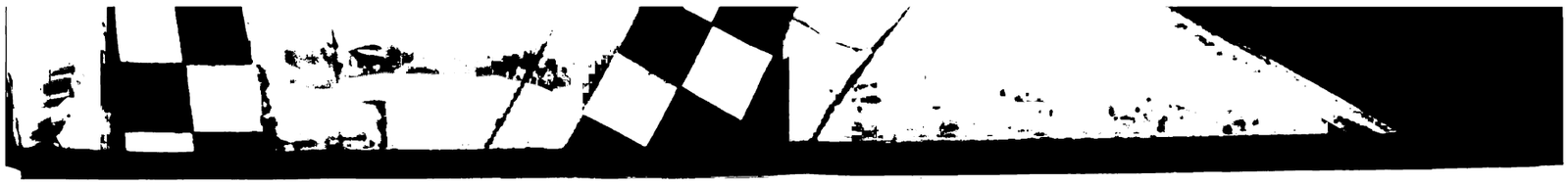


Table 19. Chemical Composition of Carcass Boneless Meat. (Results are expressed as percentage of carcass boneless meat wt.)

Sex	Number of Calves	Average Days on Feed	Ether Extract	Protein	Moisture	Ash
Steers, Kill 1	9	121	21.2	17.5	60.0	0.9
Heifers, Kill 1	9	121	27.2	15.9	55.6	0.8
Difference Strs. over Hefs.			-6.0**	1.6**	4.4**	0.1
Steers, Kill 2	9	170	28.9	16.0	53.9	0.7
Heifers, Kill 2	9	170	30.5	15.3	52.3	0.8
Difference Strs. over Hefs.			-1.6	0.7*	1.6	-0.1
Steers, Kill 3	9	225	29.0	15.9	53.9	0.7
Heifers, Kill 3	9	225	34.0	15.0	49.8	0.7
Difference Strs. over Hefs.			-5.0**	0.9**	4.1**	0.0
Steers, Kill 4	9	275	33.6	15.0	50.1	0.8
Heifers, Kill 4	9	275	34.9	14.7	49.1	0.8
Difference Strs. over Hefs.			-1.3	0.3	1.0	0.0
Averages						
Steers	36		28.2	16.1**	54.5**	0.8
Heifers	36		31.7**	15.2	51.7	0.8

* Significant at the 5 percent level.

** Significant at the 1 percent level.

Table 20. Chemical Composition of Carcass Boneless Meat of Cattle of Similar Finish. (Results are expressed as percentage of carcass boneless meat wt.)

Sex	Number of Calves	Average Days on Feed	Ether Extract	Protein	Moisture	Ash
Steers, Kill 2	9	170	28.9	16.0	53.9	0.7
Heifers, Kill 1	9	121	27.2	15.9	55.6	0.8
Difference Strs. over Hefs.		49	1.7	0.1	-1.7	-0.1
Steers, Kill 3	9	225	29.0	15.9	53.9	0.7
Heifers, Kill 2	9	170	30.5	15.3	52.3	0.8
Difference Strs. over Hefs.		55	-0.5	0.6	1.6	-0.1
Steers, Kill 4	9	275	33.6	15.0	50.1	0.8
Heifers, Kill 3	9	225	34.0	15.0	49.8	0.7
Difference Strs. over		50	-0.4	0.0	0.3	0.1
Averages						
Steers	27		30.3	15.6	52.9	0.7
Heifers	27		30.6	15.4	52.6	0.8

heifer carcasses contain a smaller proportion of shank than steer carcasses.

The proportion of shank bone in the carcass decreased in cattle of both sexes as feeding progressed more so in steers than in heifers. These results showed that the proportion of shank bone in the carcasses of calves was dependent on both degree of finish and sex.

Carcass Chemical Composition

In order to make a basic comparison of cattle used in these experiments, chemical analyses were carried out on a uniform sample from the right half of each carcass. These analyses were carried out at the United States Department of Agriculture Research Station at Beltsville, Maryland.

Fatness in beef cattle is a measure of finish. The three methods used to measure fatness in beef cattle are, namely: sensory (sight and feel), physical (separation of visible fat from other body components) and chemical (ether extract determination). The reliability of these methods increases in the order named. The chemical method is the most accurate because it measures fat that cannot be measured accurately by any other existing method.

The percentage of ether extract in the edible portion, lean and fat, of the carcass followed a trend similar to that followed by the percentage of separable fat in the carcass. That is, the percentage of ether extract in the edible portion of the carcass was significantly higher in heifers than in

Table 21. Average number of days fed, weights, gains and net energy requirements of steer and heifer cattle on increasing degrees of finish.

Degree of finish (ether extract in analyzed side)	No. Cattle		Days Fed		Final Feed Lot Weight		Total Gain		Daily Gain		Net energy in feed eaten per 100 lbs. gain	
	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.
percent	no.	no.	no.	no.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	therms	therms
12.0-15.9	4	1	116	126	604	550	212	197	1.84	1.56	465	477
16.0-19.9	8	0	179		748		364		2.03		459	
20.0-23.9	5	9	189	144	769	646	391	270	2.07	1.88	470	467
24.0-27.9	11	11	201	206	809	723	422	370	2.10	1.80	483	504
28.0-31.9	6	10	258	226	883	795	507	420	1.97	1.86	540	521
32.0-35.9	2	5	259	234	972	842	572	473	2.21	2.02	493	503

The data in this table were taken from Table 1 of G. A. Branaman's et al. Article The Relation of Degree of Finish in Cattle to Production and Meat Factors. Proc. Am. Soc. of Am. Prod. Nov. (1936) by permission of the authors.

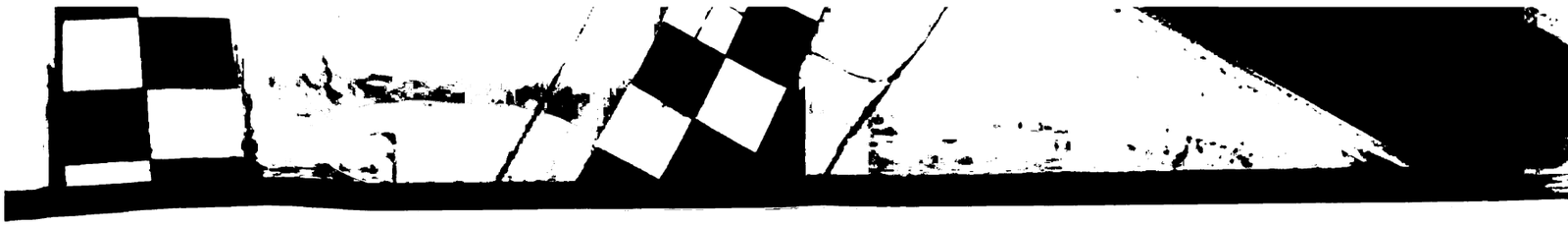
Table 22 Average ratios of edible meat to bone in sides, firmness of lean meat and marbling of rib "eye" of steer and heifer cattle of increasing degrees of finish. Average percentages of fat (ether extract) in edible portion of nine-ten-eleven-rib cuts are also shown.

Degree of finish (ether extract in analyzed side)	Cattle		Ratio of edible meat to bone in side		Firmness of lean as graded		Marbling of rib "eye" as graded		Ether extract in edible portion nine-ten-eleven rib cut	
	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.	Strs.	Hefs.
percent	No.	No.			index*		index**			
12.0-15.9	4	1	4.1:1	4.3:1	18.5	22.0	21.5	22.0	19.5	18.4
16.0-.9.9	8	0	4.5:1		14.3		16.0		27.8	
20.0-23.9	5	9	4.8:1	5.2:1	13.6	13.8	14.4	14.5	35.0	32.0
24.0-27.9	11	11	5.3:1	5.7:1	9.6	10.6	10.9	10.4	39.4	37.0
28.0-31.9	6	10	5.5:1	6.1:1	7.0	8.2	10.0	8.2	43.3	42.6
32.0-35.9	2	5	6.4:1	6.1:1	7.0	7.6	4.0	6.4	47.9	44.8

* In a scale of index values ranging from 1 to 43, 1 represents maximum and 43 minimum firmness.

** In a scale of index values ranging from 1 to 43, 1 represents maximum and 43 minimum amount of marbling.

The data in this table were taken from Table 3 of G. A. Branaman's et al. Article The Relation of Degree of Finish in Cattle to Production and Meat Factors. Proc. Am. Soc. of Am. Prod. Nov. (1936) by permission of the authors.



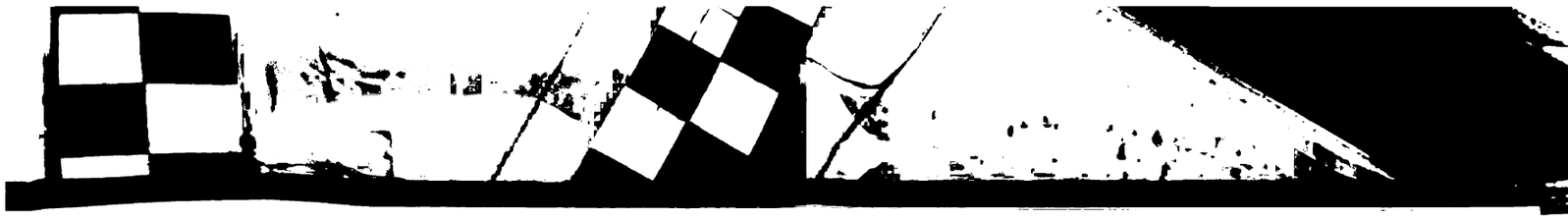
steers when cattle were slaughtered after 121 and 225 days of feeding. Also after 170 and 275 days of feeding the percentage was higher than in steer carcasses, but the differences were not significant. The average percentage of ether extract in the edible portion of the carcass was higher in heifers than in steers in each kill of each trial.

When cattle were matched by grades for finish, only small differences were found in the percentage of ether extract in the carcass due to sex. The results showed that the percentage of ether extract in the edible portion of the carcass was largely dependent on degree of finish rather than sex.

Correlation analyses showed that there was a close relationship between the percentage of ether extract in the edible portion of the carcass and the separable fat in the carcass, see Table 7 of the Appendix. These results indicated that separable fat was a fairly accurate measure of fat in beef carcasses, even though it does not measure all of the fat in the carcass.

The cattle used in these experiments were grouped according to the percentage of ether extract in the right side of the carcass by Branaman, et al., (1936). Tables 21 and 22 correspond to Tables 1 and 3 in the publications cited and they show the relationship between the ether extract content of the right side of the carcass and certain production and meat factors. The authors used a different approach to analyze some of the factors involved.

Moisture and protein are closely associated in biological systems. Therefore, any factor that causes one to vary should



affect the other as well. These two constituents followed a trend opposite to that of ether extract. The percentages of moisture and protein in the edible portion of the carcass were significantly higher in steers than in heifers when cattle were slaughtered after 121 and 225 days of feeding. When cattle were slaughtered after 170 and 275 days of feeding the percentages of moisture and protein in the edible portion of the carcass were higher in steers than in heifers, although the differences were too small to be significant at the levels used in testing differences.

In cattle of similar finish there was practically no difference in the percentages of moisture and protein in the edible portion of the carcass. The results indicated that the percentages of moisture and protein in boneless meat were largely dependent on degree of finish rather than sex.

The percentages of moisture and protein in the edible portion of the carcass decreased with increasing age and fatness.

Neither sex nor length of feeding period had any significant effect on the percentage of ash in the edible portion of the carcasses.

Results for the four measures of fatness used in these experiments are shown in Tables 23 and 24, and Tables 1-4 of the Appendix, each increasing in reliability from left to right.

Results in Table 23, comparing steers and heifers at each kill show that each measure was higher for heifers than

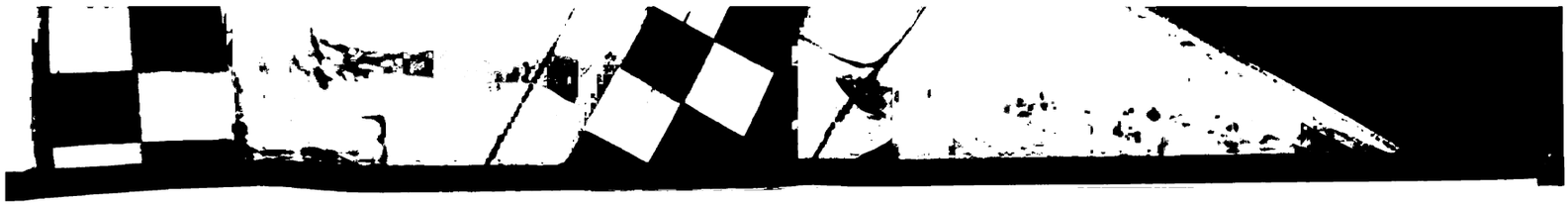


Table 23. Measures of Fatness (By Kills).

Sex	Days on Feed	Slaughter Grade	Carcass Grade	Separable Fat (% of Carcass)	Ether Extract (% boneless meat)
Steers, Kill 1	121	G	G	18.3	21.2
Heifers, Kill 1	121	G ⁄	G ⁄	22.8	27.2
Difference Strs over Hefs.		-1/3 grade	-1/3 grade	-4.5**	-6.0**
Steers, Kill 2	170	Ch -	Ch -	24.4	28.9
Heifers, Kill 2	170	Ch	Ch*	27.0	30.5
Difference Strs over Hefs.		-1/3 grade	-1/3 grade	-2.6	-1.6
Steers, Kill 3	225	Ch	Ch	26.1	29.0
Heifers, Kill 3	225	P -*	P -	30.2	34.0
Difference Strs. over Hefs.		-2/3 grade	-1/3 grade	-4.1**	-5.0**
Steers, Kill 4	250	Ch ⁄	Ch ⁄	30.6	33.6
Heifers, Kill 4	250	P -	Ch ⁄	32.0	34.9
Difference Strs. over Hefs.		-1/3 grade	0 grade	-1.4	-1.3
Average Steers				24.9	28.2
Heifers				28.0**	31.7**

* Significant at the 5 percent level.

** Significant at the 1 percent level.

Table 24. Measures of Fatness (Cattle of Similar Finish).

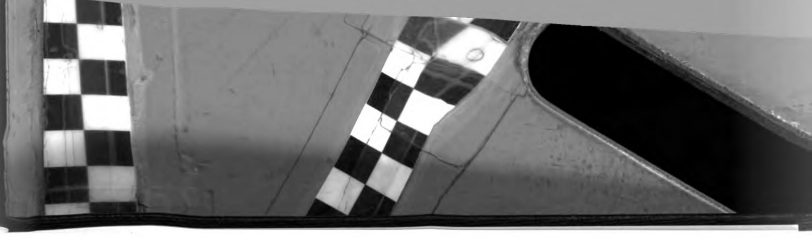
Sex	Days on Feed	Slaughter Grade	Carcass Grade	Separable Fat (% of Carcass)	Ether Extract (% boneless meat)
Steers, Kill 2	170	Ch -	Ch -	24.4	28.9
Heifers, Kill 1	121	G ✓	G ✓	22.8	27.2
Difference Strs. over Hefs.	49	1/3 grade	1/3 grade	1.6	1.7
Steers, Kill 3	225	Ch	Ch	26.1	29.0
Heifers, Kill 2	170	Ch	Ch	27.0	30.5
Difference Strs. over Hefs.	55	0 grade	0 grade	-0.9	-1.5
Steers, Kill 4	275	Ch ✓	Ch ✓	30.6	33.6
Heifers, Kill 3	225	P -	P -	30.2	34.0
Difference Strs. over Hefs.	50	-1/3 grade	-1/3 grade	0.4	-0.4
Averages Steers				27.0	30.3
Heifers				26.7	30.6

for steers except for carcass grade in Kill 4. The difference due to sex was significant for slaughter grades only in Kill 3, carcass grades in Kills 1 and 2 and for separable fat and ether extract in Kills 1 and 3. There was a gradual increase in fatness measured by each method from Kill 1 to Kill 4, except in slaughter and carcass grade for Kill 4 heifers.

An attempt was made to space kills so that steers of the succeeding kill would be at a similar stage of fatness as that of the heifers in the previous kill. Results were tabulated in Table 24 to show how much success had been achieved. The results show one third grade difference in both slaughter cattle grades and carcass grades in favor of the steers when Kill 2 steers were compared with Kill 1 heifers. Both slaughter and carcass grades were equal for cattle of the two sexes when Kill 3 steers were compared with Kill 2 heifers. However, when Kill 4 steers were compared with Kill 3 heifers the heifers graded one third grade higher both as slaughter cattle and as carcass beef.

On the basis of carcass separable fat and also ether extract, steers and heifers were closely matched when Kill 4 steers were compared with Kill 3 heifers. When Kill 2 steers were compared with Kill 1 heifers, steer carcasses contained slightly more separable fat and ether extract than those of heifers. When Kill 3 steers were matched with Kill 2 heifers, heifer carcasses contained slightly more separable fat and also more ether extract.

Correlation coefficients for some of these factors are shown in Table 7 of the appendix with very high correlation.



SUMMARY AND CONCLUSIONS

The effects of length of feeding period and sex on the performance and carcass characteristics of steer and heifer calves were studied in three experiments. Equal numbers of steers and heifers were individually full-fed a ration consisting of corn, cottonseed meal, corn silage and mixed alfalfa hay. Cattle were slaughtered at four different stages of finish ranging from Good to Low Prime, on the basis of grades previous to 1950, in an attempt to match the two sexes for fatness and grade. The average feeding periods for the 4 kills were 121, 170, 225 and 275 days.

Slaughter grades were used to determine the time for slaughter, and these grades were used, together with dressing percentages, carcass grades, separable carcass fat and ether extract content of the right half carcass, to check the accuracy of matching the cattle for finish. Each of these comparisons showed that heifers were very similar in finish to steers that were fed approximately 50 days longer.

On the average, steers were heavier than heifers at the beginning of each experiment and showed an increased weight advantage at the time of slaughter. The faster daily gains made by steers, except in Kill 1, accounted for the increased weight advantage. The average initial weight for all steers was 384 pounds, and for all heifers it was 367 pounds. The average slaughter weight for steers in Kill 4 was 892, and for heifers 816 pounds.

Cattle of both sexes maintained high and similar rates of gain early in the feeding period. The trend of heifer gains dropped after the first 84 days of feeding, while the steers maintained a high rate of gain for 140 days. The rate of gain of heifers dropped faster than those of steers, so that for nine steers and nine heifers in Kill 4, slaughtered at 275 days, the difference in rate of gain was one-fourth pound per day in favor of the steers.

With increasing body weights and decreasing rates of gain the daily gain made for each hundred pounds of body weight dropped more rapidly than the rate of gain.

During the first 112 days of feeding daily TDN consumption for cattle of both sexes increased very rapidly and showed very small differences due to sex. There was almost a 50 percent increase in daily TDN consumed by all cattle from the 28th to the 112th day. After 112 days the daily TDN consumption of steers was almost level, while that of heifers dropped as feeding progressed.

Total digestible nutrients consumed per hundred pounds of body weight varied but little in amount for the first 112 days, however, after this period a consistent decrease was observed. There was not a consistent difference between the sexes.

Heifers required more TDN per pound of gain than steers, except in Kill 1, when cattle were compared by kills, with the difference due to sex reaching a maximum of 0.4 pound for cattle of Kill 4. From Kill 1 to Kill 4 there was an increase

for steers of 0.8 pound of TDN per pound of gain and 1.2 pounds of TDN for heifers. When cattle of similar finish were compared at slaughter time, there were very small differences that were not significant, and with steers requiring slightly more feed.

Another comparison was made using a predicting equation derived according to Fisher's Statistical Methods for Research Workers and the results obtained by using this equation showed that nutrient requirement for gain was more affected by increasing fatness than by increased body weight.

Shrink from feedlot to slaughter was not consistent for either sex or group of cattle. The percentage digestive content at slaughter was slightly higher in steers than in heifers which reduced the weight advantage of the steers when empty body weight was considered. There was a slight indication that the percentage of digestive content decreased with increasing fatness. The results showed that fat deposition on the digestive tract of cattle, caul and ruffle fat, was dependent on degree of finish rather than sex. Differences between the sexes were small and not consistent, steers increased 50 percent and heifers 40 percent in killing fat from Kill 1 to Kill 4.

It is of interest to note that on the average all steers were 10.5, 8.8 and 8.3 percent heavier than heifers in slaughter weights, empty body weights and carcass weights respectively, which indicated that the percentage of offal was higher in steers than in heifers.

When cattle were compared by kills dressing percentages of heifers, based on slaughter and cold carcass weights, were higher than those of steers in each kill, with significant differences of 1.4 and 1.7 percent higher in Kills 2 and 3, respectively. When cattle were compared on the basis of similar finish, the dressing percentages of 27 steers and 27 heifers averaged the same.

The percentage of hindquarter decreased 0.5 percent in steer carcasses with increasing finish from the first to the fourth kill, while the percentage remained fairly constant for heifer carcasses. Heifer carcasses contained a larger proportion of hindquarter than steer carcasses in each kill, with significant differences of 1.0 and 1.2 percent more in Kills 3 and 4, respectively. Matching the cattle on the basis of finish did not affect the differences materially. On the basis of these results it was concluded that, on the average, the percentage of hindquarter is higher in heifer carcasses than in those of steers, and the reverse is true of the forequarter.

With increasing finish there were significant increases in the percentages of flank and rib cut, and a slight but not consistent increase in the percentage of kidney knob based on averages of all cattle slaughtered; while the percentages of round and shank decreased significantly. The percentages of chuck, loin, rump and plate were almost constant in each kill.

When cattle were compared by kills steer carcasses contained significantly higher percentages of chuck and shank, while heifer carcasses contained significantly higher per-

centages of loin, flank and rib cut, and slightly higher percentages, but not significant, of kidney knob and plate. Sex had no appreciable effect on the percentage of rump in the carcass. When cattle were matched for similar finish steer carcasses contained significantly higher percentages of chuck and shank, while heifer carcasses contained a significantly higher percentage of flank, otherwise there were no significant differences in wholesale cuts.

On the basis of these results it was concluded that only the percentages of hindquarter, forequarter, flank, chuck and shank were influenced by sex, while percentages of round, loin, kidney knob and rib cut were largely influenced by degree of finish. The percentages of rump and plate in the carcass were not significantly affected by either degree of finish or sex.

The separable fat content of heifer carcasses was higher than that of steers at each kill when cattle were compared by kills. Differences of 4.5 and 4.1 for Kills 1 and 3, respectively, were highly significant. However, when cattle were matched according to finish, steer carcasses averaged 27 percent in separable fat and heifers 26.7 percent. Steer carcasses were slightly higher in separable lean than those of heifers in each kill, with the difference of 2.9 for Kill 1 being significant at the 5 percent level. The results for cattle of similar finish showed heifers to be slightly higher in separable lean than steers. The percentage of bone was significantly higher in steer carcasses both when cattle were

compared by kills and matched for finish. The results indicated that, except for bone, the physical composition of cattle carcasses was largely influenced by degree of finish, and in the case of bone, it was influenced by both finish and sex.

The average increase in the proportion of meat to bone in the carcass increased approximately 25 percent, in the two sexes of cattle from Kill 1 through Kill 4, a highly significant difference. When cattle were compared by kills the meat to bone ratio was larger for heifer carcasses, with differences for Kills 2 and 3 being significant at the 1 percent level and those of Kills 1 and 4 being significant at the 5 percent level. The differences for cattle matched for finish were smaller, but when Kill 3 steers were compared with Kill 2 heifers the difference of 0.7 percent, in favor of the heifers, was significant at the 5 percent level. The meat to bone ratio was influenced by degree of finish and sex.

The percentage of fat, as percent of the carcass, in each wholesale cut increased significantly with increasing finish, except in the shank. There were significant decreases in the percentage lean in all wholesale cuts from Kill 1 through Kill 4, except in the round, rump and flank. Significant decreases occured for bone, except in the rump and rib cut.

When cattle of the two sexes were compared by kills the only significant variation in separable lean in wholesale cuts as percentage of the carcass was more lean in steer chucks. The percentages of loin fat, rump fat, rib fat and flank fat were significantly higher in heifer carcasses. The percentages

of round bone, loin bone, chuck bone and shank bone were significantly higher in steer carcasses. There were no significant differences in percentages of fat, lean and bone in wholesale cuts when cattle were matched for finish, except that heifer carcasses contained a significantly higher percentage of flank fat, and steer carcasses contained significantly higher percentages of chuck bone and shank bone.

The boneless meat of heifer carcasses contained a higher percentage of ether extract than steers in each kill when cattle were compared by kills, with highly significant differences due to sex being 6.0 and 5.0 percent for Kills 1 and 3, respectively. In cattle of similar finish the ether extract content was slightly higher in the boneless meat of heifer carcasses but not significant.

The percentages of protein and moisture in carcass boneless meat were higher in steers in each kill and significantly higher in Kills 2 and 3. In cattle of similar finish these percentages were still higher for steer although not significant. According to these results, sex has no significant influence on the chemical composition of carcass boneless meat in yearling cattle of similar grade.

The four measures of fatness used in these experiments, namely: slaughter grade, carcass grade, separable carcass fat and ether extract content of carcass boneless meat, showed steers and heifers to be very closely matched for finish when steers were fed approximately 50 days longer than heifers.

APPENDIX

Table 1. Measures of Fatness, Kill 1 Steers and Heifers

Calf No.	Days on Feed	Feeder Grade	Slaughter Grade	Carcass Grade	Dressing percent	Separable Fat (% of Carcass)	Ether Extract (% of Boneless Meat)
STEERS							
Trial 1							
14	126	-	M ≠	G -	56.9	13.1	17.0
16	126	Ch ≠	G ≠	G ≠	58.1	16.7	21.0
18	126	F -	G	G -	58.7	12.3	15.2
Trial 2							
16	105	Ch -	G -	G -	58.4	15.7	19.1
23	105	Ch ≠	G	M ≠	56.7	13.3	15.9
28	105	F -	Ch -	Ch	58.4	24.6	26.4
Trial 3							
16	132	Ch ≠	G	G	58.2	18.7	20.1
17	132	Ch	Ch	Ch	60.0	27.8	31.9
39	132	Ch	Ch -	G -	58.1	22.4	23.9
Average, 9 Steers							
	121	Ch ≠	G	G	58.2	18.3	21.2
HEIFERS							
Trial 1							
4	126	G ≠	G -	M ≠	58.3	14.3	16.4
6	126	Ch	Ch -	Ch -	59.6	21.6	27.1
13	126	G ≠	G ≠	Ch -	59.3	19.9	25.8
Trial 2							
5	105	F -	Ch -	Ch	58.6	23.4	26.0
9	105	Ch	G ≠	Ch -	61.4	25.3	28.1
11	105	Ch	G	G	60.2	22.7	25.0
Trial 3							
4	132	F -	Ch	Ch	59.9	26.8	30.4
6	132	Ch	Ch -	Ch	59.0	27.0	31.0
11	132	Ch -	G	G	57.6	24.4	34.6
Average, 9 Heifers							
	170	Ch -	G ≠*	G ≠	59.3	22.8**	27.2**

* Significant at 5 percent level

**Significant at 1 percent level

APPENDIX

Table 2. Measures of Fatness, Kill 2 Steers and Heifers

Calf No.	Days on Feed	Feeder Grade	Slaughter Grade	Carcass Grade	Dressing percent	Separable Fat (% of Careass)	Ether Extract (% of Boneless Meat)
STEERS							
Trial 1							
21	175	Ch	Ch	Ch	59.2	21.4	30.2
23	175	Ch -	Ch -	Ch -	59.5	17.5	23.9
26	175	Ch -	G	G ≠	58.7	17.5	23.4
Trial 2							
17	154	Ch -	G ≠	Ch -	60.3	28.5	31.6
26	154	F	Ch	Ch	60.1	27.9	30.8
27	154	G ≠	G ≠	Ch -	58.1	29.5	32.0
Trial 3							
14	182	F -	Ch ≠	Ch ≠	61.6	27.6	32.0
15	182	Ch ≠	G ≠	G	56.7	24.9	27.6
24	182	Ch	Ch	Ch -	60.1	24.4	28.7
Average, 9 Steers							
	170	Ch	Ch -	Ch -	59.4	24.4	28.9
HEIFERS							
Trial 1							
8	175	Ch	Ch	Ch -	61.0	21.3	28.1
10	175	G ≠	G	Ch	60.6	19.3	29.5
11	175	Ch	Ch -	Ch ≠	60.2	23.1	25.5
Trial 2							
1	154	Ch ≠	Ch ≠	Ch ≠	61.4	29.0	30.0
7	154	Ch -	Ch	Ch	61.0	31.8	34.0
12	154	Ch	Ch -	Ch	60.2	31.3	35.0
Trial 3							
1	182	F -	Ch ≠	Ch ≠	60.9	31.6	35.1
5	182	F -	Ch ≠	Ch ≠	60.2	28.7	30.9
12	182	Ch -	G ≠	Ch -	62.0	26.7	25.9
Average, 9 Heifers							
	170	Ch	Ch*	Ch	60.8*	27.0	30.5

* Significant at 5 percent level

APPENDIX

Table 3. Measures of Fatness, Kill 3 Steers and Heifers

Calf No.	Days on Feed	Feeder Grade	Slaughter Grade	Carcass Grade	Dressing percent	Separable Fat (% of Carcass)	Ether Extract (% of Boneless Meat)
STEERS							
Trial 1							
17	224	Ch	P -	P -	59.4	30.5	33.0
22	224	Ch	Ch -	Ch -	58.4	21.1	24.0
27	224	Ch	G ✓	G ✓	59.4	20.9	24.0
Trial 2							
18	203	Ch ✓	Ch -	G ✓	58.7	23.9	26.7
24	203	Ch	Ch -	Ch	58.8	25.2	29.1
25	203	Ch ✓	Ch	P -	63.2	32.2	35.1
Trial 3							
13	247	F -	Ch	Ch ✓	61.4	30.1	32.3
18	247	Ch	G ✓	Ch -	60.2	19.7	21.9
20	247	Ch	Ch ✓	P -	64.4	31.5	34.8
Average, 9 Steers							
	225	Ch ✓	Ch	Ch	60.4	26.1	29.0
HEIFERS							
Trial 1							
3	224	Ch -	Ch	P -	60.5	28.2	30.8
5	224	F -	P -	Ch ✓	60.2	25.7	29.9
7	224	G ✓	Ch ✓	P -	60.6	29.3	33.6
Trial 2							
3	203	F	P	P	63.4	32.3	37.6
4	203	Ch -	Ch	P -	63.1	31.7	36.0
15	203	Ch -	Ch ✓	Ch ✓	62.6	34.1	38.3
Trial 3							
0	247	Ch -	Ch -	Ch -	61.9	25.3	27.7
3	247	G	Ch ✓	Ch	62.9	31.0	34.3
9	247	Ch ✓	P	P -	64.0	34.2	38.1
Average, 9 Heifers							
	225	Ch -	P -	P -*	62.1**	30.2**	34.0**

*Significant at 5 percent level

**Significant at 1 percent level.

APPENDIX

Table 4. Measures of Fatness, Kill 4 Steers and Heifers

Calf No.	Days on Feed	Feeder Grade	Slaughter Grade	Carcass Grade	Dressing percent	Separable Fat (% of Carcass)	Ether Extract (% of Boneless Meat)
STEERS							
Trial 1							
19	273	Ch	Ch	P -	60.8	30.0	33.7
20	273	Ch ≠	P -	P -	63.5	30.8	34.2
24	273	G ≠	G ≠	Ch -	59.3	21.2	25.3
Trial 2							
19	259	Ch -	P	Ch ≠	62.9	34.9	38.0
22	259	Ch -	P -	P -	64.9	37.1	39.6
29	259	Ch	P -	P -	61.3	30.7	33.4
Trial 3							
0	294	Ch	Ch ≠	Ch ≠	63.2	31.2	34.3
19	294	Ch -	Ch	Ch ≠	61.4	29.5	32.2
21	294	Ch	P -	Ch ≠	63.1	29.9	32.1
Average, 9 Steers							
	275	Ch -	Ch ≠	Ch ≠	62.3	30.6	33.6
HEIFERS							
Trial 1							
1	273	Ch -	P -	P -	62.7	33.6	36.0
2	273	Ch -	Ch -	Ch -	60.7	24.8	29.1
9	273	Ch -	Ch ≠	P -	63.7	29.6	32.8
Trial 2							
6	259	Ch ≠	P	P -	62.9	34.5	36.1
10	259	Ch -	P -	P -	65.3	33.7	36.4
13	259	Ch -	P	P -	63.4	35.3	38.6
Trial 3							
2	294	Ch -	Ch ≠	Ch	61.2	30.4	32.5
7	294	Ch ≠	P	P -	65.3	33.7	36.4
8	294	Ch ≠	Ch	Ch	63.7	28.3	32.6
Average, 9 Heifers							
	275	Ch -	Ch ≠	P -	62.8	32.0	34.9

APPENDIX

Table 5. Feed Consumed Per Hundred Pounds Gain

Steer No.	Days on Feed	Ground Corn	Cottonseed Meal	Corn Silage	Alfalfa mixed Hay	Beet Pulp	Cane Molasses
Trial 1							
14	126	This steer's record incomplete.					
16	126	413.6	60.7	233.2	100.4		
18	126	537.6	80.0	265.7	114.2		
21	175	495.0	71.5	289.7	114.4		
23	175	403.7	60.7	254.6	77.3		
26	175	432.4	63.2	248.3	107.3		
17	224	502.5	70.0	210.5	138.5		
22	224	444.1	61.0	196.7	110.6		
27	224	465.6	64.2	183.4	103.0		
19	273	539.8	71.5	181.5	115.6		
20	273	570.1	71.5	189.3	134.3		
24	273	553.0	73.4	177.3	111.0		
Trial 2							
16	105	300.8	50.1	175.5	102.6		
23	105	394.1	65.7	229.9	134.8		
28	105	404.1	67.3	235.7	137.5		
17	154	412.5	68.8	240.7	139.5		
26	154	450.1	75.0	262.6	152.1		
27	154	402.4	67.1	234.7	135.7		
18	203	378.0	63.0	200.0	133.4		
24	203	410.3	68.4	219.9	144.1		
25	203	412.1	68.7	219.7	144.7		
19	259	289.9	65.0	210.0	136.1		
22	259	457.0	76.2	245.7	159.6		
29	259	480.5	80.1	256.7	168.3		
Trial 3							
16	132	347.1	57.5	202.3	120.7		
17	132	311.6	51.6	181.6	108.1		
39	132	390.3	64.8	227.6	134.0		
14	182	364.9	60.6	212.7	125.1		
15	182	389.1	64.7	226.9	132.6		
24	182	352.3	58.5	205.4	120.6		
13	247	426.9	70.4	192.0	148.6	15.0	
18	247	393.1	64.8	184.1	137.1	12.3	
20	247	437.8	72.3	205.6	153.4	12.7	
0	294	467.0	78.2	180.3	153.6	30.3	3.4
19	294	391.8	65.8	152.8	128.4	25.5	2.9
21	294	442.9	74.1	169.2	146.8	28.1	3.2

APPENDIX

Table 6. Feed Consumed Per Hundred Pounds Gain

Heifer No.	Days on Feed	Ground Corn	Cottonseed Meal	Corn Silage	Alfalfa mixed Hay	Beet Pulp	Cane Molasses
Trial 1							
4	126	420.2	65.1	209.4	138.6		
6	126	428.9	58.7	259.1	96.0		
13	126	412.6	61.4	255.4	131.4		
8	175	472.7	71.5	286.8	107.6		
10	175	417.2	64.0	235.4	99.5		
11	175	419.0	64.0	242.2	92.1		
3	224	517.4	74.4	216.0	134.1		
5	224	503.8	72.7	239.0	134.0		
7	224	453.5	63.5	194.7	103.9		
1	273	557.9	75.7	191.6	131.1		
2	273	612.6	81.7	174.1	178.3		
9	273	527.7	71.5	184.8	140.4		
Trial 2							
5	105	352.4	58.7	205.6	120.0		
9	105	407.4	67.9	237.7	138.9		
11	105	374.0	62.3	218.2	127.8		
1	154	392.3	65.4	228.3	132.7		
7	154	413.3	68.9	241.1	139.6		
12	154	439.3	73.2	256.2	148.7		
3	203	451.9	75.3	240.3	159.1		
4	203	440.3	73.5	235.3	154.8		
15	203	415.8	69.3	217.0	147.6		
6	259	417.5	69.6	225.1	145.8		
10	259	430.8	71.8	232.1	150.3		
13	259	462.0	77.0	248.2	161.6		
Trial 3							
4	132	343.7	57.0	200.3	118.9		
6	132	358.0	59.7	208.9	123.3		
11	132	348.0	57.7	202.8	120.9		
1	182	418.4	69.5	244.0	142.8		
5	182	366.3	60.9	213.6	124.7		
12	182	428.2	71.1	249.6	146.8		
0	247	453.9	74.9	210.4	157.7	16.6	
3	247	432.7	71.5	201.8	150.4	13.6	
9	247	409.4	67.8	203.3	142.4	11.3	
2	294	446.4	75.0	166.8	146.0	30.4	3.4
7	294	500.1	83.6	206.2	167.0	27.7	3.0
8	294	499.5	84.0	206.0	164.4	30.6	3.2

APPENDIX

Table 7. Coefficients of Correlation

Relationship studied	Coefficient of correlation and probable error
Daily rate of gain with -	
Total digestible nutrients required per pound of gain	+ 0.79 ± .030
Slaughter grade with -	
Carcass grade	+ 0.90 ± .015
Dressing percentage with -	
Slaughter grade	- 0.75 ± .035
Carcass grade	- 0.97 ± .005
Carcass grade with -	
Separable fat	- 0.87 ± .020
Separable fat with -	
Dressing percentage	+ 0.77 ± .033
Ether extract content of boneless meat	+ 0.95 ± .008
Ether extract content of boneless meat with -	
Dressing percentage	+ 0.74 ± .036
Carcass grade	- 0.89 ± .018
Separable fat in 9-11 ribs with -	
Separable carcass fat	0.93 ± .011

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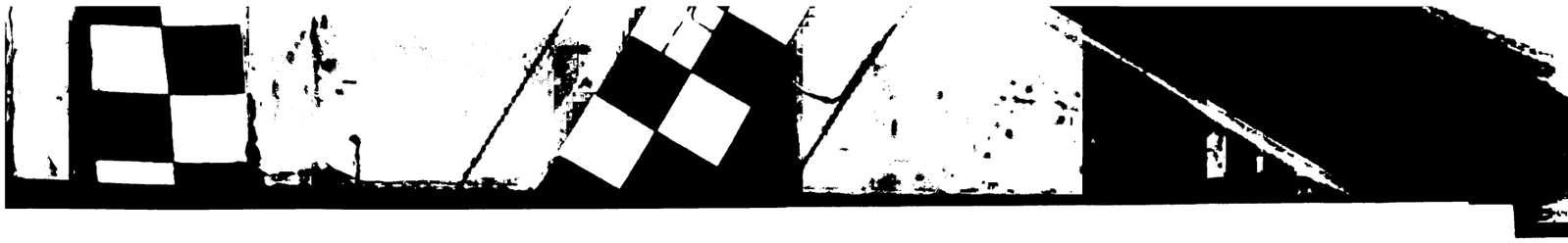

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