A B S T R A C T

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COMPARATIVE FEEDLOT PERFORMANCE OF PUREBRED HEREFORD STEERS OF COMPREST AND CONVENTIONAL TYPE

Submitted by

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In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado

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Abstract

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Introduction

The importance of beef type is amply demonstrated by the attention it receives in our showrings, auctions and livestock markets. There have been continuous changes in beef type, largely brought about by breeders' attempts to respond to changing market demands.

In recent years an extreme degree of compactness in body conformation has been observed in a few purebred herds of Hereford cattle. Variation in body type or conformation is easily distinguished in these herds. One group consists of small, very compact, short-legged, thick animals and another group of larger, more rangy animals representative of the conformation found in many purebred herds.

This comprest type in the Hereford breed is believed to be a mutant, probably due to a single dominant gene. These cattle can be identified at birth, appearing shorter in head, neck, body and legs than the conventional type Herefords. This identification is distinct throughout the life of the animal (18).

Comprest strains originated as such on the T O Ranch at Raton, New Mexico around 1940. The two original comprest bulls were Clayton Domino 73rd and Clayton Domino 59th, whose names were changed, respectively, to Comprest Prince and Comprest Conqueror because there already were Clayton Dominos in Nebraska of different breeding. These two short-legged bulls were bred by Ed Johnson at T O Ranch, where Roy Armstrong obtained them and launched the comprest breeding so widely in demand in recent years (5).

Discussion

The association between type, feedlot gain and economy of gain has been of interest to all cattle producers. Previous investigations by workers at various experiment stations have dealt with variations of conventional type steers, not with the present clear-cut and distinct comprest type. In an attempt to secure additional information regarding feedlot performance of different types of steers, certain body measurements were taken to indicate type.

The present study was undertaken to investigate the feedlot performance of individually fed Hereford steers and comprest and conventional type. The major objectives were:

1. To test the progeny of different sires with respect to rate of gain and efficiency of feed utilization.

2. To test the steers of different type with respect to rate of gain and efficiency of feed utilization.

3. To attempt to find the degree of correlation between certain body measurements of steers and the rate of gains and efficiency of feed utilization.

The question has arisen if there is a type which, over a period of time, will prove more satisfactory in meeting the needs of the breeder, feeder and consumer.

Information on the comparative performance of different types, such as comprest and conventional, should be of value to cattlemen in their decision when choosing the type of cattle which will be most profitable. Along with this comparative performance must be considered the preference of the consumer as to the different sizes.

In order to study the comparative performance of purebred Hereford steers of comprest and conventional type, 27 steer calves sired by four bulls representing the two types were individually fed.

Initial individual weights, grades, body measurements and photographs were recorded at the beginning of the experiment. At twenty-eight day intervals thereafter the steers were weighed and body measurements taken. Slaughter weights were taken at 8 a.m. the morning the steers were slaughtered, after being withheld from feed for twenty-four hours. Two faculty members of the Colorado A and M Animal Husbandry Department graded the steers at slaughter time and forty-eight hours later graded the steer carcasses. Steers were slaughtered at a relatively constant degree of finish, which was a grade of good or better.

Summary

The following tables summarize the observations which have been made on the different types of steers. They are presented by types, Table 1, and by sires, Table 2.

Table 1.--SUMMARY OF FEEDLOT AND SLAUGHTER DATA BY TYPES.

Items compared	Average of steers of comprest type	Average of steers of conventional type
Number of steers	5	22
Initial age, days	238.80	246.27
Initial weight, lbs.	355.00	448.40
Initial grade	4.70*	4.25*
Days on feed	191.20	193.81
Daily gain, lbs.	1.70	2.11
T.D.N. per lb. gain	5.14	5.20
Age at slaughter	430.00	440.09
Slaughter weight, lbs.	683.00	857.50
Slaughter grade	4.52	4.31
Cold carcass grade	4.52	4.28
Dressing per cent	57.11	59.37

* Numerical grades - fancy 6, choice 5, good 4, medium 3.

Table 2.--SUMMARY OF FEEDLOT AND SLAUGHTER DATA BY SIRES.

Items compared	Sire A		Sire B	Sire C	Sire D
	Comprest	Conventional	Conventional	Conventional	Conventional
Number of steers	5	3	6	3	10
Initial age, days	238.80	234.00	244.83	257.66	247.40
Initial weight, lbs.	355.00	451.66	415.83	465.00	462.00
Initial grade	4.70	5.16	3.91	4.66	4.05
Days on feed	191.20	193.33	203.83	198.00	186.70
Daily gain, lbs.	1.70	1.84	2.05	2.05	2.25
T.D.N. per lb. gain	5.14	5.38	5.19	5.33	5.11
Age at slaughter	430.00	427.33	448.67	455.67	434.00
Slaughter weight, lbs.	683.00	808.33	835.83	870.00	881.50
Slaughter grade	4.52	4.44	4.16	4.33	4.36
Cold carcass grade	4.52	4.44	4.33	4.33	4.19
Dressing per cent	57.11	59.67	58.71	59.63	59.42

In evaluating differences in steer types by the scoring method, it was found that the comprest type steers graded higher as feeder calves and again as slaughter steers than did the conventional type steers. Variations in initial grade and slaughter grade were greater in the conventional type steers than in the comprest type steers. However, as a prediction of future performance, scoring or grading of feeder steer conformation did not reveal differences of steers as far as later gain or efficiency was concerned in this study. This is in agreement with work performed by Knapp, Black and Phillips (7).

This study is contrary to findings by Hultz and Wheeler who reported low-set steers showing a greater daily gain than rangy type steers (4). Their classification, however, was within the conventional type not with comprest vs conventional type s teers.

A correlation between efficiency and average daily gain as reported by Winters and McMahon (23) is spurious because the denominator component of the ratio is the same as the variable with which it is being correlated. Therefore, efficiency cannot be gauged by average daily gains.

In this study, pounds of T.D.N. required per pound of gain showed no significant difference between types. Likewise the number of days on feed did not differ significantly between types. The greater difference appeared within sires of the same type in the number of days required to reach a relatively constant degree of finish.

The differences in slaughter weights of the two types were highly significant. The comprest type steers reached the desired finish at a much lighter weight than did the conventional type steers. While no measure of consumer preference was made in this study, it is generally assumed that consumers prefer a lighter carcass and this may be a factor in favor of a comprest type.

Variations in slaughter and carcass grades were greater within types than between the two types. The high correlation between slaughter grade and carcass grade would indicate that there were little differences observed in grades at slaughter and the carcass grades, thus suggesting that slaughter grade is a very good measure of the carcass quality of a steer.

Contrary to Washburn's study (20, the conventional type steers in this experiment averaged higher in dressing per cent by sire groups in all cases than did the comprest type steers. It was believed that a factor affecting dressing percentage was overlooked in this experiment at the time of slaughter, namely shrinkage. It may have been possible that the reason for the differences in dressing per cent of the two types may be accounted for by the differences in shrinkage during the twenty-four hour fasting period prior to slaughter.

A significant negative correlation was found between slaughter grade and days fed. This may have been caused by a tendency to slaughter remaining steers before they had reached the grade or degree of fatness of other earlier fattening steers. Another explanation may be that slaughtering should have started at an earlier date to secure more uniform slaughtering grades. Contrary to evidence presented by other investigators, no significant correlation was found between dressing per cent and slaughter grade in this study. Therefore it is reasonable to believe that a high dressing per cent is not entirely dependent upon a high slaughter grade.

Differences in body conformation of the two types of steers at completion of the feeding period were observed in the ratio of weight to wither height, ratio of heart girth to wither height and the ratio of circumference of hind quarters or round to wither height. Conventional type steers had a larger weight to wither height ratio than the comprest steers. The comprest type steers had a greater average ratio of heart girth to wither height and also ratio of circumference of hind quarters to wither height than did the conventional type steers. Body measurements and ratios of body measurements leave much to be desired when used in predictions of such factors as dressing per cent and efficiency of feed utilization.

Efficiency was not significantly correlated with age or weight, in this study, either between types or between sires of the same type. It is evident from this lack of correlation that the lighter, comprest type steers were as efficient as the larger conventional type steers, and age had no affect on efficiency of feed utilization.

Evidence of a much quieter temperament in the compress type steers than in the conventional type steers was observed in this experiment.

Within the limitations of this study, such as small numbers in the comprest type due to failure of one bull to perform as expected, and small numbers in some sire groups, it may be concluded from this initial investigation that overall conclusive evidence of the superiority of either comprest or conventional type in feedlot performance does not exist.

THESIS

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COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY JAMES E. INGALLS

ENTITLED COMPARATIVE FEEDLOT PERFORMANCE OF INDIVIDUALLY FED PUREBRED HEREFORD STEERS OF COMPREST AND CONVENTIONAL TYPE

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

CREDITS

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Chapter I

INTRODUCTION

Beef type is considered of primary importance by producers. This is amply demonstrated by the attention it receives in our show-rings, auctions and livestock markets. There have been continuous changes in beef type, largely brought about by breeders' attempts to respond to changing market demands.

In recent years an extreme degree of compactness in body conformation has been observed in a few purebred herds of Hereford cattle. Variation in body type or conformation is easily distinguished in these herds. One group consists of small, very compact, short-legged, thick animals and another group of larger, more rangy animals representative of the conformation found in many purebred herds.

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Compreſt strains (5) originated as such on the T O Ranch at Raton, New Mexico around 1940. The two original compreſt bulls were Clayton Domino 73rd and Clayton Domino 59th, whose names were changed respectively to Compreſt Prince and Compreſt Conqueror because there were already Clayton Dominos in Nebraska of different breeding. These two short-legged bulls were bred by Ed Johnson at T O Ranch, where Roy Armstrong obtained them and launched the compreſt breeding so widely in demand in recent years. The sire of Compreſt Prince and Compreſt Conqueror was Colorado Domino 68th, and his sire was Colorado 21st. The 21st was a son of Prince Domino 1st by Prince Domino, and his dam was Duchess Aster by Beau Aster.

The association between type, feedlot gain and economy of gain has been of interest to cattle producers. Previous investigations by workers at various experiment stations have dealt with variations of conventional type steers, not with the present clear-cut and distinct compreſt type. In an attempt to secure additional information regarding feedlot performance of different types of steers, certain body measurements were taken to indicate type.

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Chapter II

REVIEW OF LITERATURE

A small type animal has been described as one in which height and length are small in comparison to depth and width.

A large type animal is one in which the reverse condition exists (11).

Evaluating type

Knapp, Black and Phillips (7) in a study reported in 1939, found that scoring as a technique in evaluation of differences of animals is subject to considerable error and is probably of doubtful value when differences are small. When the population to be studied shows large differences, the scoring technique is undoubtedly the simplest way to evaluate differences in conformation.

Lush (12), 1932, has stated that conformation is often the only basis available for judgment and should at all times be given consideration. However, the data indicate that no score card based on conformation would ever be so accurate that the future performance of individual steers could be predicted from it with but few mistakes. Form and function in these respects are not closely enough correlated.

Relationship between type and performance

Hultz and Wheeler (4)[3], 1927, found that low-set steers made the greatest average gains and the most economical gains. However, other studies indicate that small type steers do not gain more rapidly and efficiently than those of large types.

Woodward, Clark and Cummings (24)[4], 1942, in a study of large and small type Herefords, undertook to determine whether the use of large type Hereford bulls would produce a more desirable and more profitable type of beef cattle than the use of small type Hereford bulls, when used on grade Hereford cows. In this experiment it was concluded that the large type heifers were significantly heavier at both birth and weaning than were the small type. The large type calves made larger daily gains from birth to weaning. For the four years of the experiment, the large type steer calves averaged heavier when they went into the feedlot and in all cases made somewhat faster gains. In all but the last year, the larger type calves required slightly less feed to produce 100 pounds of gain. This is substantiated by Stanley and McCall (17)[13], 1945.

In comparing three types of feeder steers, Knox and Kroger (11)[5], 1946, report in a study extending over nine years and using about 350 yearling Hereford steers of similar condition, that steers classified as rangy when they were put on feed, weighed more, gained more and yielded a higher dressing percentage than the compact steers. The medium type was intermediate in each case. Amount of gain was found to be correlated with initial weight. However, when corrected for initial weight, the difference in gain made by steers of the three types was no longer significant, although slightly in favor of the rangy cattle. The rangy steers consistently yielded a higher average dressing percentage than either of the other types. The average carcass grades were the same for each type. From the results of this work, however, it appears that the development of rapidly gaining strains will be more difficult if size is reduced by too greatly restricting height and length to secure compactness.

Watson (21)[6], 1932, states that rangy calves make more rapid gains than the very low-set type calves. Calves with large paunch circumference in proportion to their height are more rapid gainers although they yield a lower dressing per cent. Lower set calves have less shrinkage both in feedlot and in the yards at market.

Winters and McMahon (23)[7], 1933, made a correlation study of steers fed individually and proposed a method of record of performance based on this result. The study showed a rather high correlation between average daily gain and efficiency of gains. From this they concluded that average daily gains may be used as an indicator of efficiency of gain.

Relationship between measurements
and performance in beef cattle

Tomhave and Severson (19), 1915, stated that the object of body measurements was to gather data by which a statistical study could be made, especially to determine:

1. The correlation between certain body measurements and gains in live weight.

2. The relationship of the same measurements to each other at the beginning and close of a feeding trial to demonstrate the changes produced by fattening on the form of a steer.

Misner (13), 1941, found in taking measurements and body weights of 100 cows, that the coefficients of correlation between the different measurements and the actual weight of the animals indicated that the heart girth was more closely correlated with the actual weight than any other measurement; closely followed by correlation between weight and length of body from shoulder point to end of pin bone. These correlations were 0.97 and 0.89 respectively. Misner concludes that the size of the animal does not necessarily have a bearing on the efficiency with which different animals use feed in producing milk or fat.

Lush (12), 1932, found the correlations between measurements of feeder steers and subsequent gains, dressing percentages and values of the dressed beef are low but statistically significant. The most important measurements for high dressing per cent and meat value are a large heart girth in connection with a shallow chest, a wide loin and large flank girth, head narrow at eyes, and short height over hips. Maximum gains are associated with long body, tall at withers, with a large paunch girth but small flank girth and narrow at the loin. There is a slight but real general tendency for the fleshy but small-boned steer to have a high dressing per cent and more desirable cuts of meat. Observed gains (final-initial weight) are most effected by differences in fill.

In correlations of body measurements with rate and economy of gain Black, Knapp and Cook (2), 1938, found height at withers is, strictly speaking, a skeletal measurement and shows a negative correlation with all the factors studied. The correlation between height at withers and efficiency of gain is significantly negative. The taller, rangier type of animal, therefore, has a slight tendency to put on gain less economically than the shorter, blockier type. However, there was no significant correlation between height at withers and rapidity of gain. In other studies made by the same writers, length of body had a much higher correlation with efficiency of gain than did height at withers. It may be concluded therefore, that length of body is associated more closely with efficiency of gain than is height at withers. Width of shoulder and width of chest show positive relationship with all the factors studied. The correlations involving width of shoulder are consistently higher for efficiency of gain and lower for the carcass characteristics of the slaughter animal than the correlations involving width of chest.

Severson and Gerlaugh (15), 1917, found the initial weight of a steer weighing 700 to 1100 pounds has no positive correlation with subsequent feedlot gain. However, a marked correlation exists between gain in live weight and increase in body measurements such as circumference of chest, circumference of rear flank, width of thurls and length from hip to buttocks. Less marked correlation exists between gain and width of fore flank, depth of chest, and length of head. The hind quarters of a steer are a more important factor in determining the gaining capacity of a steer than are the fore quarters. Length of head, depth of chest, and circumference of paunch show less degree of correlation with gain than is generally accredited to them by the opinion of practical men.

Watson (21), 1932, stated the body measurements showing the greatest percentage of increase during the fattening period were width of loin, heart girth, width at hips, paunch girth and length of body. Increase in width was greater than increase in length of body.

Wright (25), 1933, stated that in cattle it appears that there is a very strong correlation between all skeletal measurements. There seems also to be strong correlation between different elements of the muscular system in thickness. Studies on poultry and rabbits indicate that even within the skeletal system, the skull, the forelimbs and the hind limbs form systems within which components vary together but between which there is some independence. Factors affecting all alike were, however, the most important.

<u>Evaluating efficiency</u>

Knapp, Phillips, Black and Clark (9), 1942, stated that with a carefully conducted experiment, a total feeding period of 140 days or more would be required to determine efficiency of the animals. Secondly, the selection of a number of animals between six and ten would be acceptable from the standpoint of yielding a fairly large amount of information per sire tested. This number would distinguish between bulls if differences exist.

Knapp and Baker (10)8, 1943, showed by variance analysis that on limited feeding the sire groups were significantly more alike than would be expected by chance whereas on unlimited feeding the sire groups were significantly different from each other.

Black and Knapp (1),[9] 1936, found average daily gain and economy of gain are positively correlated for the period from weaning to slaughter. Also, grades of animals show a higher correlation with economy of gain than with average daily gain. However, both are significant. Returns above feed cost were found to be highly correlated with average daily gain, economy of gain, slaughter grade and carcass grade.

Winters and McMahon (23), 1933, reported a correlation of 0.34 between rate and efficiency of gain, indicating that a correlation of 0.50 or less may be expected when all animals are fed the same period, but when time is variable the correlation is higher.

Kleiber (6),[10] 1936, in discussing problems involved in feeding for efficiency of feed utilization, pointed out that there was no fundamental relationship between body size and efficiency of feed utilization. He further showed that absolute rate of gain could be used as a measure of efficiency only when comparing animals of the same size. Relative food capacity was indicated to be a major determinant of total efficiency and relative gain a good index of relative feed capacity.

Brody (3), 1935, concurred with Kleiber by stating that energetic efficiency may not depend on body weight alone but pointed out that there may be less management overhead involved in producing the same amount of product from fewer animals of large size than from a larger number of smaller animals.

Knapp, Baker, Quesenberry, and Clark (8), 1941, in work at Montana concluded:

1. It has been shown that inherited differences between the progeny of various sires may be demonstrated by weaning weights, daily gain in the feedlot, efficiency of gain in the feedlot and dressing percentage.

2. Ultimate efficiency of gain, or rate of gain in the feedlot cannot be accurately predicted from the previous rate of gain during the suckling period or from scores on conformation at weaning time. It is acknowledged, however, that score at weaning is valuable as an appraisal of conformation and until better methods are devised, score at weaning should be part of a performance program.

3. Daily gain and efficiency of gain are not highly correlated in a time constant population.

4. Score at weaning had a low predictive value for final slaughter grade or carcass grade when slaughtered at an average weight of 900 pounds.

5. A program for progeny testing beef cattle for efficient beef production should be based on rate and efficiency of gain in the feedlot, dressing per cent, slaughter and carcass grades, and also the uniformity of the offspring in these points.

In individual feeding of steers for three years Winters (22), 1936, found the two single factors showing the highest correlation with net profit were daily gains and final appraised value (sale price); the correlation coefficients were 0.807 and 0.823 respectively.

Washburn (20), 1948, in a study of efficiency of compact and conventional type Shorthorn steers, by means of digestion balance trials and analysis of standard carcass cuts following slaughter concludes: Limited data of a preliminary nature showed no appreciable difference between steer types with respect to food capacity per unit of body weight and digestibility of nutrients. Conventional type animals, however, exhibited greater ability than compacts to utilize digested dry matter during growth. A rapid decline in efficiency of gain from growth to fattening was observed for both types, each reaching the same level at the time the animals were visually judged finished. Seventy days longer feeding was required to finish the conventional type steers.

All carcasses graded choice. Conventional type carried more fat, and the compact type had relatively heavier bone.

Chapter III

MATERIALS AND METHODS

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The purebred Hereford beef calves used in this experiment were bred and raised to weaning age at the San Juan Basin Substation at Fort Lewis A and M College near Durango, La Plata County, in southwestern Colorado. This region is known as the San Juan Basin. The elevation at Fort Lewis is 7,610 feet. The annual mean temperature is 43.2 degrees, with a high of 85 degrees and low of -19 degrees Fahrenheit. Annual mean precipitation is 18.78 inches. Forage types are determined by Utah White Oak which occurs in dense stands and Pinon type occuring in scattered clumps. Most frequent vegetative species are sedges, prairie junegrass, Letterman needlegrass, bluestem wheatgrass and nodding brome. Kentucky bluegrass occurs in the moist openings and along stream banks.

One phase of the breeding program at the San Juan Basin Substation was designed for the purpose of testing the feedlot performance of progeny of two conventional type bulls and two comprest type bulls. The cows were allotted in numbers to these bulls to better the chances of balancing numbers of comprest and conventional type calves for experimentation. The reason for no comparisons between sires of comprest type resulted from failure of one bull to perform as expected.

All the male progeny of the four experimental bulls, the majority born in May and June 1947, were castrated while still nursing. The calves were weaned December 15, 1947 and transported by truck to Fort Collins, Colorado, where the feeding project was conducted at the college farm. Because the calves had not been dehorned prior to arrival, a delay of one month was necessitated.

Quarters for the calves were a dry lot sloping to the south from an adjoining shed, with a southern exposure. A concrete floor in feedway and under the steers was provided. Individual stanchions were installed. Steers were randomly assigned to stalls. A short length of chain on the stanchion was snapped into a numbered neck chain on each steer at 5 p.m. This allowed some freedom for movement throughout the night but prevented the steer from eating any but his own feed. Individual feeding troughs were permanently installed from which the steer had a free choice of ration from 5 p.m. to 8 a.m. Shavings were used freely as bedding and proved more satisfactory than straw for this purpose. The steers were released at 8 a.m. into the adjoining lot. Water was provided from hydrants. Boxes containing mineralized block salt and loose common salt were accessible to the steers at all times.

The ration consisted of a mixture of ground alfalfa hay 25 per cent, dry beet pulp 30 per cent, cracked corn 15 per cent, rolled barley 15 per cent, and soy bean meal 15 per cent. Percentage figures are by weight. Total digestible nutrients of the above ration were computed from Morrison's Standard (20th edition) tables and found to be 70.085 per cent (14).[12] This checks closely with a laboratory analysis of the ration. All calculations were based on this figure.

Ingredients to comprise 1000 pounds of the above mixture were weighed separately and thoroughly mixed in a vertical auger type mixer for twenty minutes.

Method of feeding

During the entire feeding period the steers were hand fed. They were brought up to full feed in a period of three weeks. The objective was to approximate self-feeding by giving the animal slightly more than he would eat by 8 a.m. Feed was weighed into individual barrels, with the corresponding number of each steer in front of his stanchion. Uneaten residue was weighed back every fourteen days until a month preceding slaughter when a weekly weighback was necessitated.

Weighing

The initial weights were taken on the morning of January 17, 1948 at 8 o'clock a.m., the day the steers were started on experiment. Weights were taken every twenty-eight days thereafter. Final weights were taken the morning of slaughter day at 8 a.m. after the steers were withheld from feed for twenty-four hours.

<u>Socring and classifying</u>

At the same time initial weights were taken, each steer was scored and classified as to type by three judges from the college Animal Husbandry staff. A numerical value corresponding to feeder grades was used with fancy scoring six, choice five, good four, and medium three. An average of the judge's scores was assigned each steer. Type was designated as either compress or conventional.

<u>Length of feeding period</u>

The length of time on feed varied from 173 to 212 days, depending upon the time necessary for individual steers to grade good or better.

<u>Body measurements</u>

Nineteen body measurements were taken on each steer at twenty-eight day intervals. Instruments used were a steel tape, small arm calipers and large calipers with built-in spirit level. All measurements were recorded in centimeters.

The steer was allowed to stand in as nearly a natural position as possible, upon a concrete floor, while being measured. Two measurements were recorded and an average computed. The same individuals took the same measurements for the duration of the experiment. A recorder was provided for the person taking the measurements.

The following measurements were taken:

1. Length of head - this was taken with small arm calipers from the highest point on the poll to the end of the muzzle.

2. Width of head - this was taken with small arm calipers at the greatest width of head at a point level with the eyes.

3. Circumference of muzzle - measured with a steel tape placed at the lateral depressions of the corners of the mouth at the largest part of the muzzle.

4. Circumference of cannon bone - measured with a steel tape which was placed around the cannon bone, midway between knee and fetlock joint on the foreleg.

5. Length of cannon bone - measured with a steel tape from joint of knee to top of dewclaw on back of foreleg.

6. Circumference of heart girth - taken with steel tape drawn snugly around the body, just behind the front legs.

7. Circumference of paunch - measured with steel tape placed around the body at its greatest circumference.

8. Circumference of flank - measured with steel tape drawn snugly around the body at its smallest circumference in front of the ilium and in the highest point in the rear flank.

9. Point of ilium through the flank to tuber ischii - measured with steel tape from point of hip (ilium) under the flank to pin bone (tuber ischii) on same side of animal.

10. Patella to patella - the patella or round measurement was taken with the steel tape, measuring from the anterior external point of one patella, the first fixed point, posteriorly and horizontally about the hind quarters to a corresponding point on the opposite patella, the second fixed point.

11. Hip height - this measurement was taken with the large calipers, which has a built in spirit level in one moveable arm. The second arm was removed for this and the following two measurements. The upright bar was placed on concrete floor with horizontal bar level, and at a point across the back of the animal midway between the hooks (ilium).

12. Wither height - measured with the upright bar of large calipers on concrete floor and the horizontal bar level, at a point directly above and directly in line with front legs, being sure the animal was standing squarely on all four feet with the head held in a normal position.

13. Height of chest - measured with the upright bar of large calipers and the horizontal bar level, at a point on the chest floor immediately back of front legs.

14. Length of body - this measurement was taken with the large calipers from lateral tuberosity of humerus to tuber ischii, with the animal standing in a normal position.

15. Width of chest - this was measured with large calipers at the greatest width of chest, just behind the shoulders.

16. Length of pelvis - this measurement was taken with small-arm calipers from the extreme posterior point of the pin bone (tuber ischii) to the extreme anterior point of the hook bone (ilium) on the same side.

17. Width at hooks - this was measured with small-arm calipers from the extreme lateral point of the hooks (ilium) on one side to the corresponding point on the other side.

18. Width of loin - this was measured with the small-arm calipers, the bars pressing snugly against the flesh midway from the forward edge of the last rib.

19. Pelvis width - measured with small-arm calipers pressed snugly against each side of the pelvis.

Photographs

The use of photographs as a permanent record of each steer was employed at the beginning of the experiment, and at the completion of the feeding trial.

A chute was built with one side constructed in the form of a grid with horizontal and vertical bars 12 inches apart. This later was modified by adding three horizontal bars at intervals midway between the three lower horizontal bars to prevent young calves from inserting their heads between the 12 inch bars. Each end of the chute was equipped with swinging and locking gates.

The first photographs were taken with a thirty-five millimeter camera. This proved satisfactory in most instances but some shadow is evident on the underline of a few steers.

The photographs taken preceding slaughter at the end of the feeding trial included the use of a flash bulb, which made considerable improvement by eliminating shadows. A numbering device adjacent to the grid gives a permanent record of the number of the steer being photographed. Photographs of feeder calves and as slaughter steers appear in the following figures 1 to 6.

Grading at end of feeding trial

Two competent judges from the college Animal Husbandry staff graded the steers the morning they were slaughtered. To arrive at this grade the following modified Bureau of Animal Industry slaughter cattle grading chart was used. STOP DO Page 40

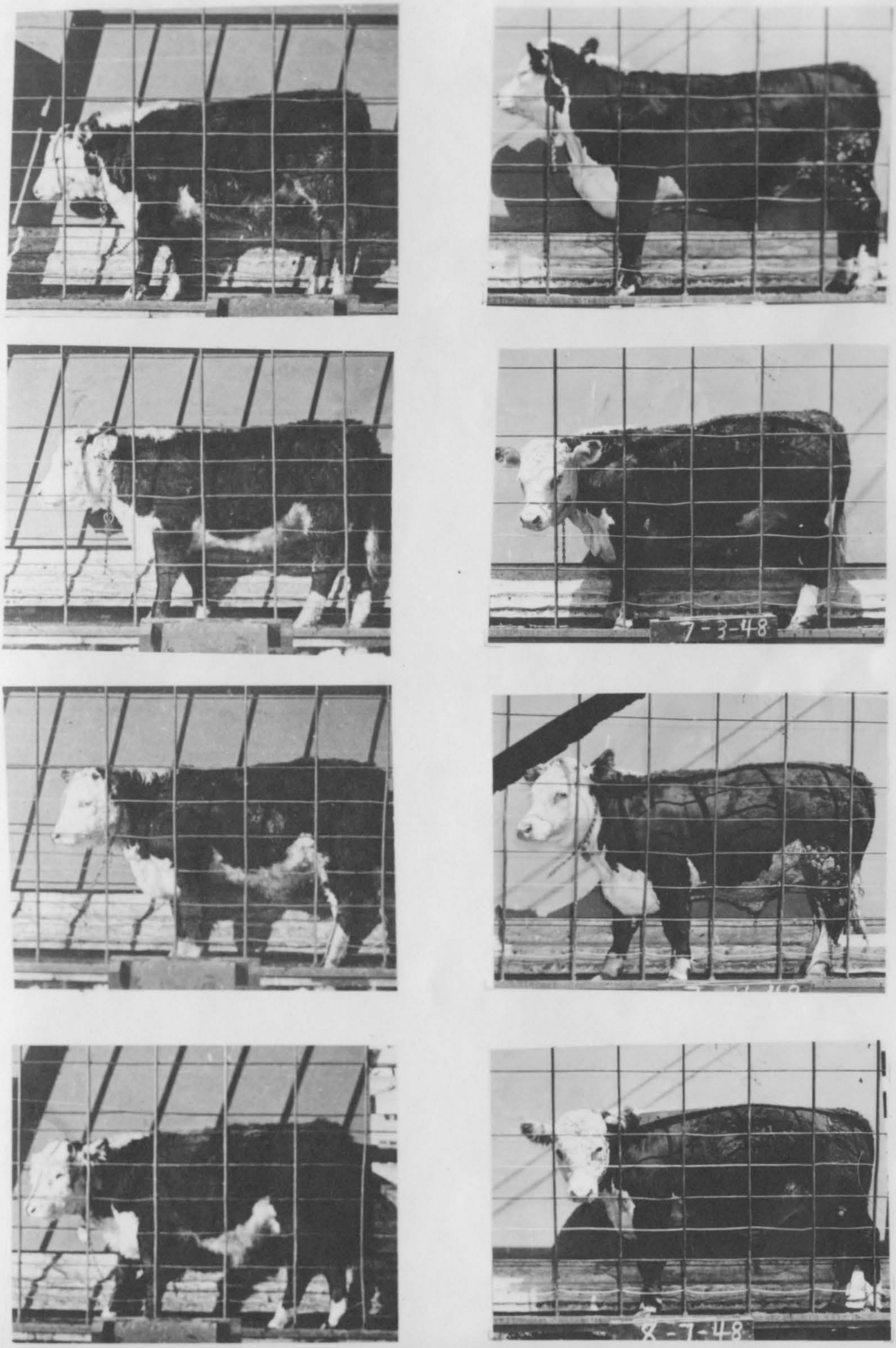

Figure 1.--Small type or "Comprest" steers sired by Bull A; as feeder calves and as slaughter steers.

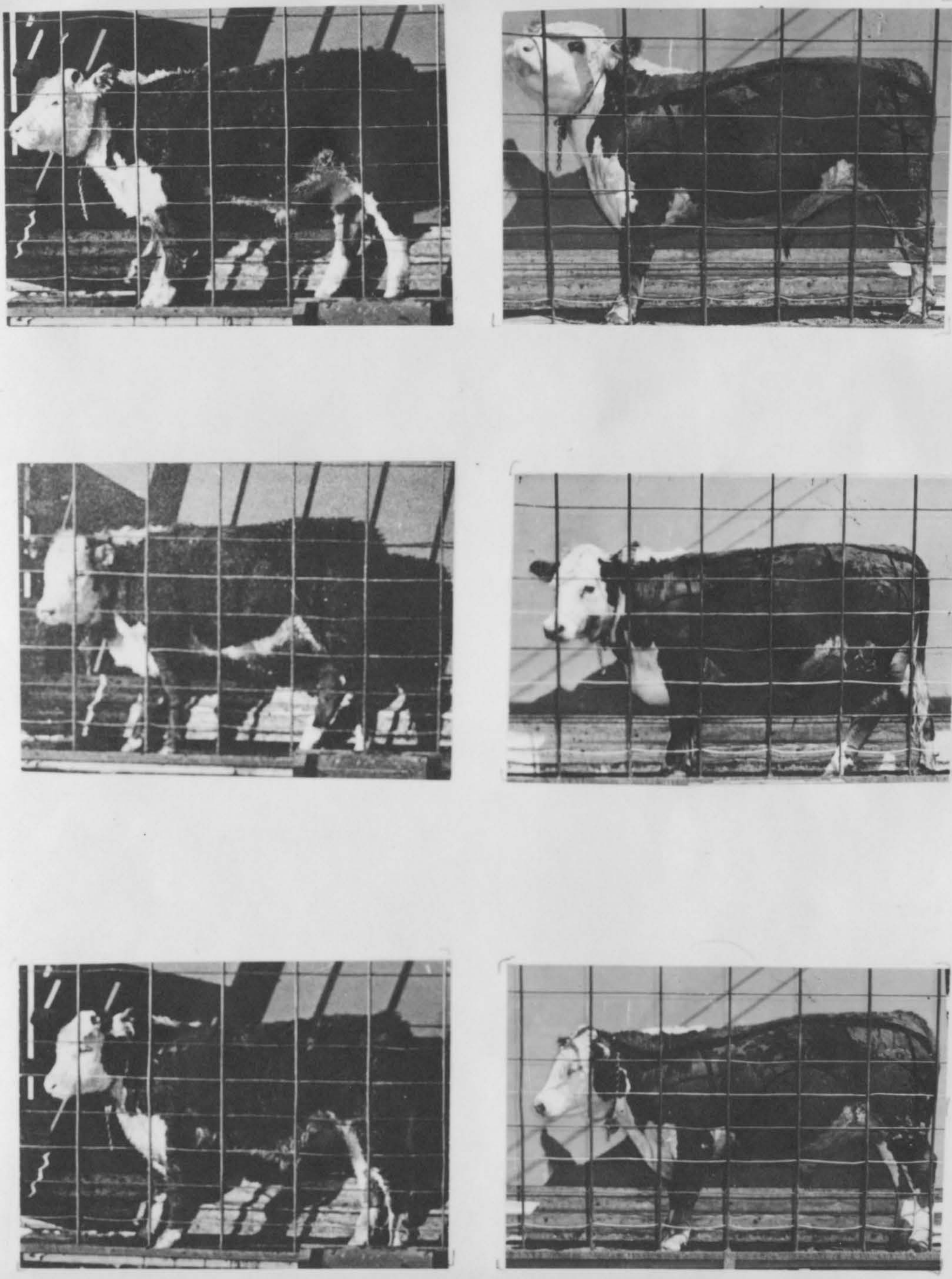

Figure 2.--Conventional steers sired by Bull A; as feeder calves and as slaughter steers.

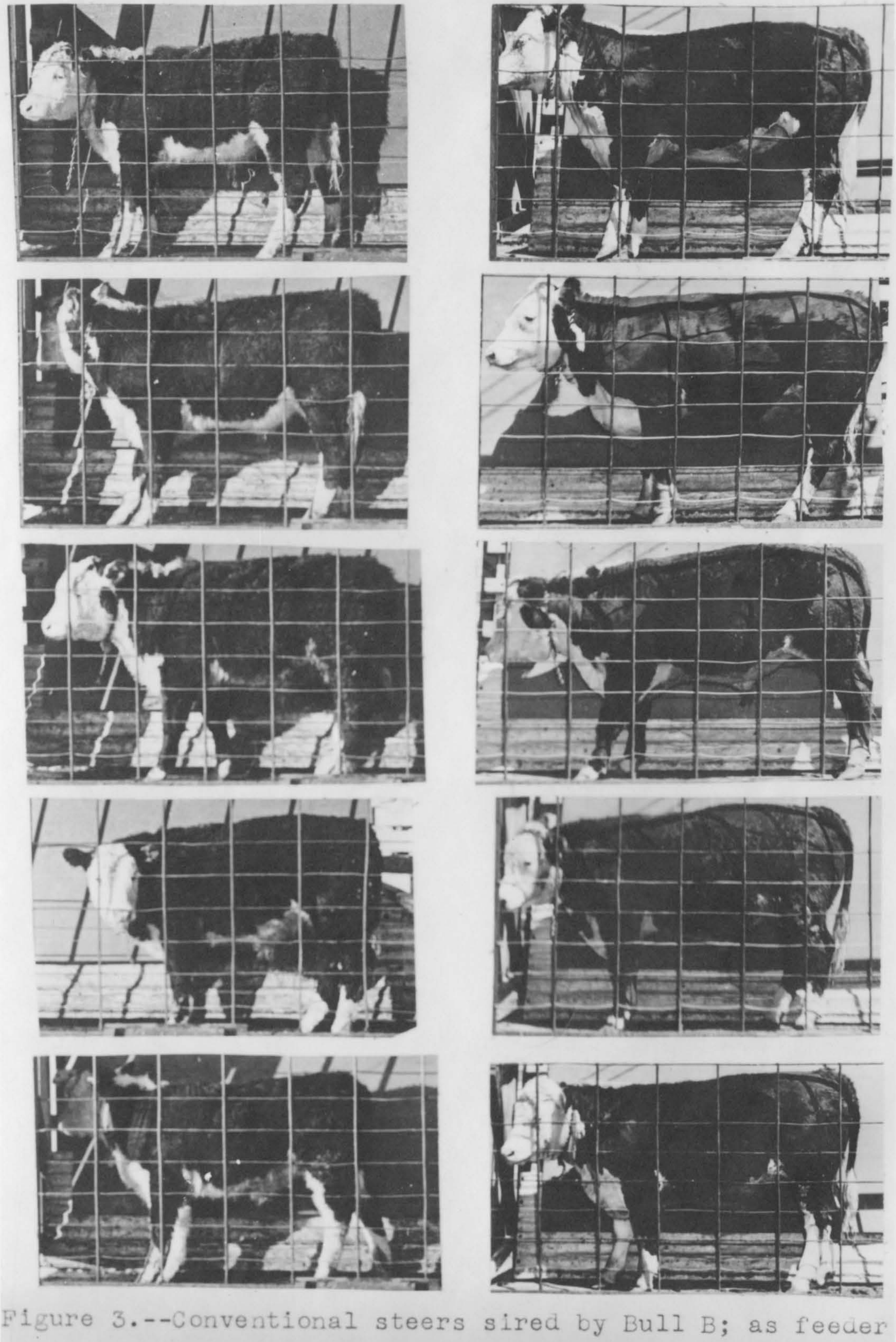

Figure 3.--Conventional steers sired by Bull B; as feeder calves and as slaughter steers.

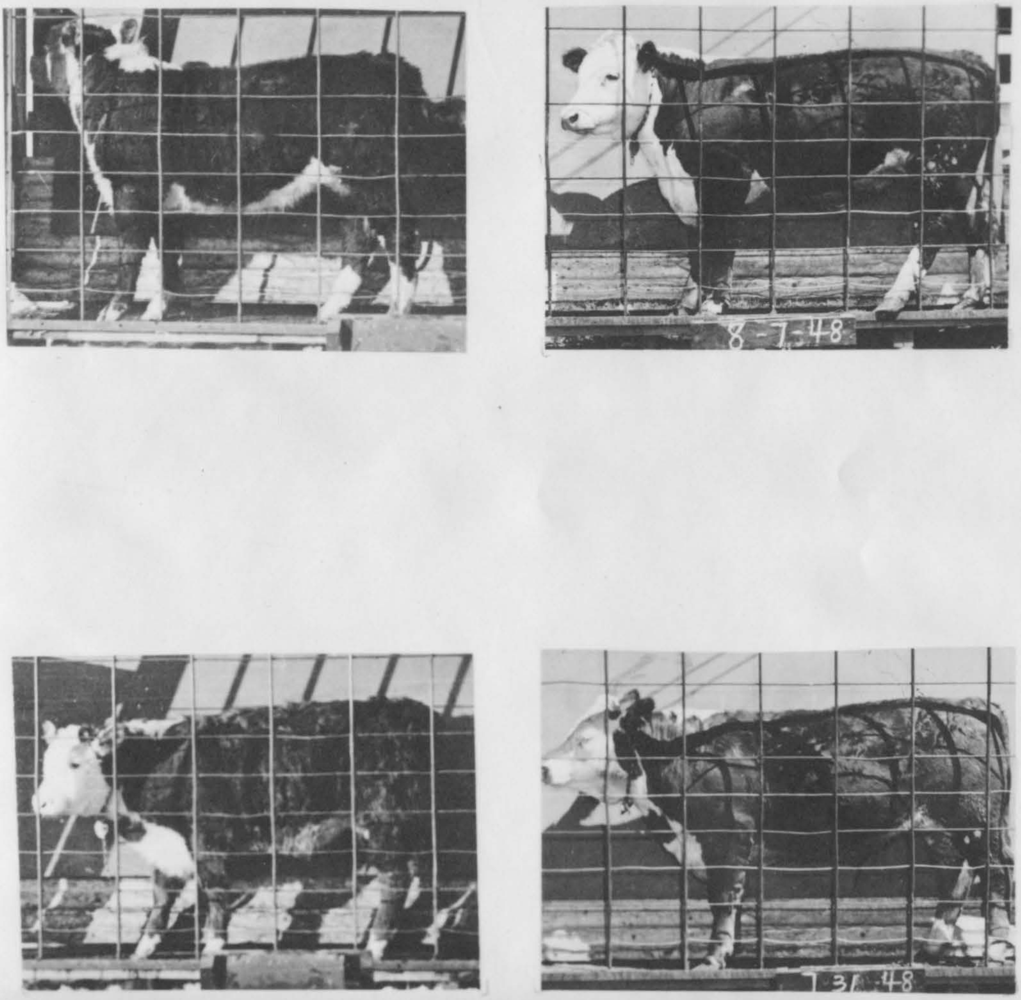

Figure 4.--Conventional Steers sired by Bull C; as feeder calves and as slaughter steers.

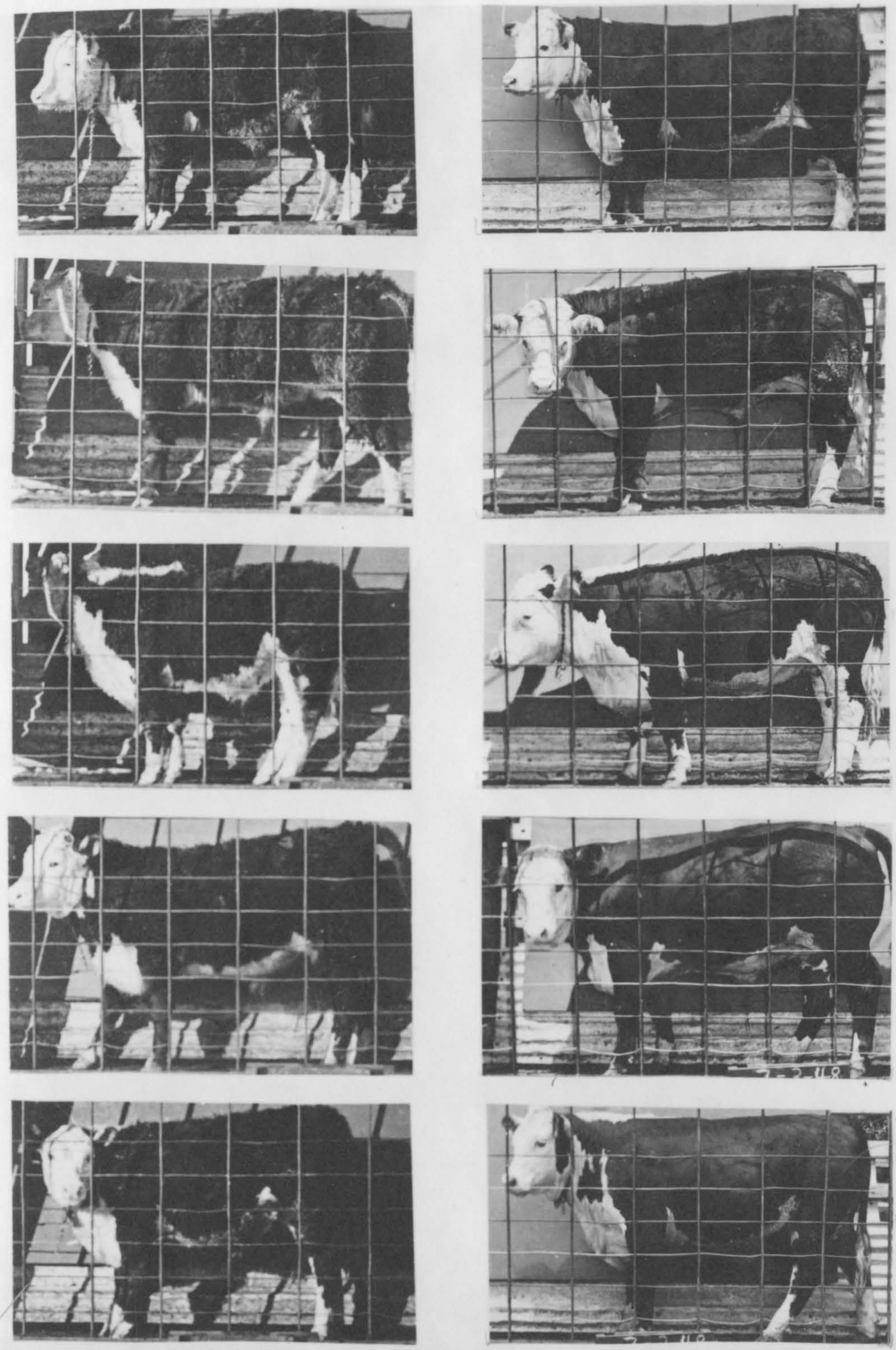

Figure 5.--Conventional steers sired by Bull D; as feeder calves and as slaughter steers.

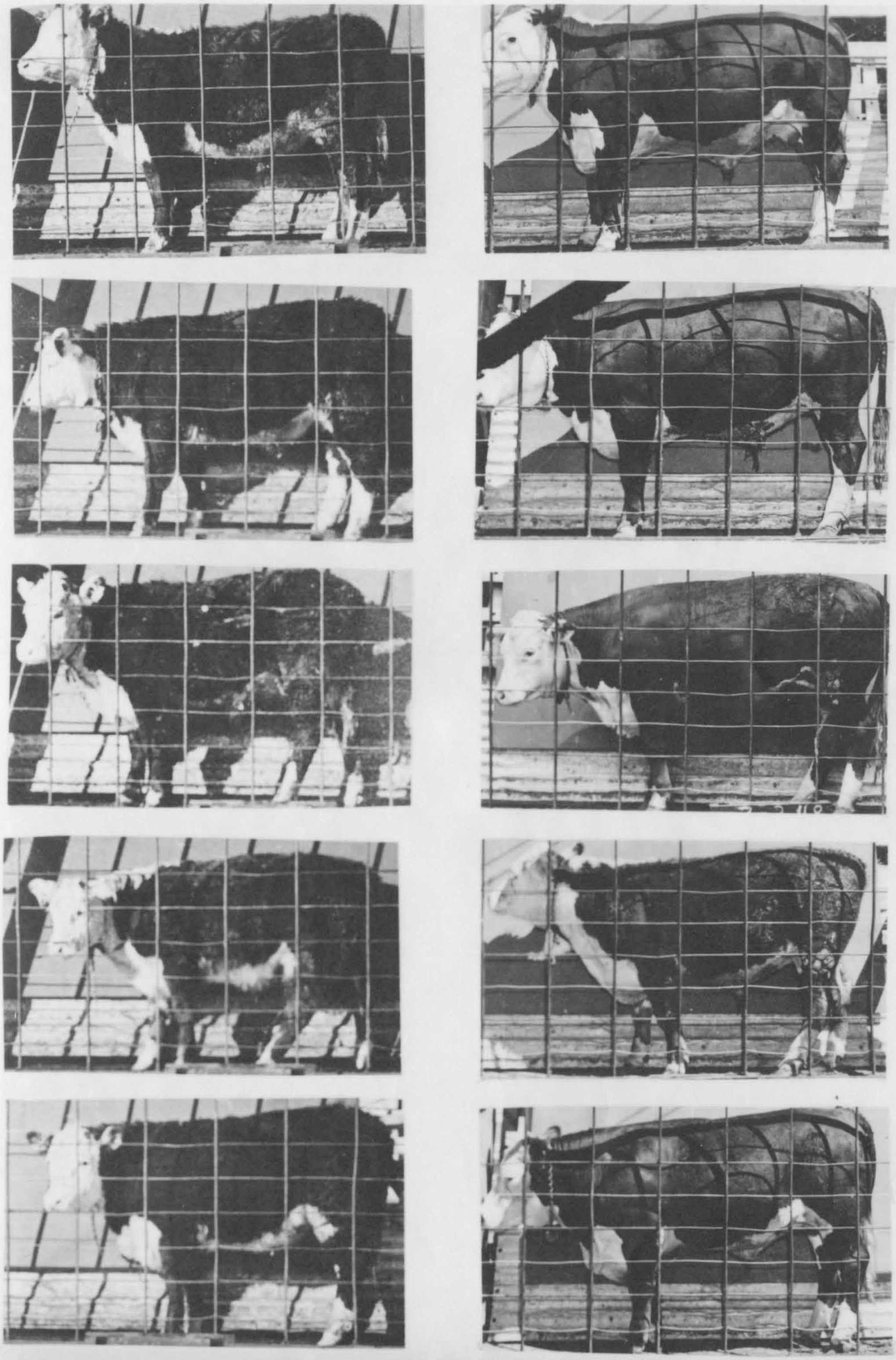

Figure 6.--Conventional steers sired by Bull D; as feeder calves and as slaughter steers.

SLAUGHTER CATTLE GRADING CHART

GRADE	PRIME	CHOICE	GOOD	MEDIUM	COMMON
CONFORMATION Compactness	Very Compact	Compact	Moderately compact	Slightly rangy	Rangy
Legs	Very short	Short	Moderately short	Slightly short	Long
Width of body	Very wide	Wide	Moderately wide	Slightly narrow	Narrow
Crops	Very full	Full	Moderately full	Slightly deficient	Deficient
Loin	Very thick	Thick	Moderately thick	Slightly thin	Thin
Rump	Very full	Full	Moderately full	Slightly deficient	Deficient
Round	Plump	Full	Moderately full	Slightly deficient	Deficient
CONDITION Thickness of fat	Very thick	Thick	Moderately thick	Slightly thin	Thin
QUALITY Smoothness and Refinement	Very refined	Refined	Moderately refined	Slightly coarse	Coarse

Score ______________________

Some problems encountered during the course of the feeding experiment were bloat and footrot. Two steers were eliminated due to constant bloating. One of these was a conventional type steer and the other a comprest type steer. Veterinarians treated all cases of footrot with 50 grams of Sodium-Sulfathiazole intravenously. Most symptoms disappeared within twenty-four hours after treatment.

Statistical analysis

The data were analyzed according to the variance and covariance procedures described by Snedecor (16). The .05 level of probability was used as a criterion for determining the significance of differences.

Covariance analysis may give a truer picture of variance ratios when the variables are correlated and it is wished to isolate the variance in one variable independent of the second. The example of slaughter grade and dressing per cent may show these two traits closely interrelated, largely resulting from degree of fatness. However, it may be of interest to study how much variation in one variable would persist independent of the related variable. A detailed example of calculation isolating the variable dressing percent independent of slaughter grade is found in appendix Table 2.

Degrees of freedom

Degrees of freedom simply refer to the number of independent comparisons. In the totals one may compare any one observation with each one of the rest, therefore n-1 comparisons or twenty-six degrees of freedom exist.

Only one comparison is possible between the two types, therefore, one degree of freedom. Within types there are twenty-two animals or twenty-one comparisons between individuals of conventional type and five animals of comprest type or four degrees of freedom. Between sires of the same type of steers, the degrees of freedom would be three for the four sires of conventional type and no degrees of freedom for the one bull which sired some steers of comprest type. Within sires within types there are ten conventional animals by the first sire or nine degrees of freedom; six conventional animals by the second sire or five degrees of freedom; three conventional animals by the third sire or two degrees of freedom; three conventional animals by the fourth sire or two degrees of freedom and five comprest animals by the fourth sire or four degrees of freedom.

Meaning of F

In the example of covariance X = slaughter grade, Y = dressing per cent the variance of slaughter grade is divided by the variance within slaughter grade; this ratio is called F. The significance of F is based on probability of certain ratios occuring and therefore may be interpreted thus: when the F value is equal to, or greater than, the F given in the table for the degrees of freedom indicated at .05 level, one may say that the probability is if this experiment were to be repeated the results would be similar in ninety-five cases out of one hundred.

Chapter IV

ANALYSIS OF DATA

The following tables summarize the observations which have been made on the different types of steers. They are presented by types, Table 1, and by sires, Table 2. Individual steer data are presented in Table 3.

Table 1.--SUMMARY OF FEEDLOT AND SLAUGHTER DATA BY TYPES.

Items compared	Average of steers of comprest type	Average of steers of conventional type
Number of steers	5	22
Initial age, days	238.80	246.27
Initial weight, lbs.	355.00	448.40
Initial grade	4.70*	4.25*
Days on feed	191.20	193.81
Daily gain, lbs.	1.70	2.11
T.D.N. per lb. gain	5.14	5.20
Age at slaughter	430.00	440.09
Slaughter weight, lbs.	683.00	857.50
Slaughter grade	4.52	4.31
Cold carcass grade	4.52	4.28
Dressing per cent	57.11	59.37

* Numerical grades - Fancy 6, Choice 5, Good 4, Medium 3.

Table 2.--SUMMARY OF FEEDLOT AND SLAUGHTER DATA BY SIRES.

Items compared	Sire A		Sire B	Sire C	Sire D
	Compress	Conventional	Conventional	Conventional	Conventional
Number of steers	5	3	6	3	10
Initial age, days	238.80	234.00	244.83	257.66	247.40
Initial weight, lbs.	355.00	451.66	415.83	465.00	462.00
Initial grade	4.70	5.16	3.91	4.66	4.05
Days on feed	191.20	193.33	203.83	198.00	186.70
Daily gain, lbs.	1.70	1.84	2.05	2.05	2.25
T.D.N. per lb. gain	5.14	5.38	5.19	5.33	5.11
Age at slaughter	430.00	427.33	448.67	455.67	434.00
Slaughter weight, lbs.	683.00	808.33	835.83	870.00	881.50
Slaughter grade	4.52	4.44	4.16	4.33	4.36
Cold carcass grade	4.52	4.44	4.33	4.33	4.19
Dressing per cent	57.11	59.67	58.71	59.63	59.42

Table 3.--SUMMARY OF FEEDLOT AND SLAUGHTER DATA BY INDIVIDUAL STEERS.

Steer No.	Initial weight lbs.	Initial age, days	Initial grade	Days on feed	Daily gain, lbs.	T.D.N. per lb. gain	Slaughter wt. lbs.	Slaughter age days	Slaughter grade	Cold carcass grade	Dressing per cent	Sire
1041*	340	224	4.00	178	1.66	5.02	635	402	4.33	4.66	56.65	A
1018*	350	244	4.00	205	1.93	4.98	745	449	4.66	4.66	56.44	A
1025*	370	239	5.00	184	1.63	5.42	670	423	4.33	4.33	58.28	A
1021*	360	242	5.50	184	1.60	5.23	655	426	4.66	4.66	57.14	A
1016*	355	245	5.00	205	1.73	5.04	710	450	4.66	4.33	57.04	A
1037	400	229	4.50	205	1.78	5.27	765	434	4.66	4.66	60.26	A
1040	455	228	6.00	191	1.86	5.03	810	419	4.33	4.00	58.15	A
1013	500	245	5.00	184	1.90 4?	5.85	850	429	4.33	4.66	60.59	A
1006	340	246	3.00	212	1.98	4.86	760	458	4.00	4.00	59.34	B
1010	440	245	4.00	205	2.39	4.89	930	450	4.33	4.33	58.49	B
986	435	258	4.50	198	1.92	5.37	815	456	4.33	4.66	60.31	B
1020	440	243	4.00	198	1.89	5.61	815	441	4.00	4.00	58.99	B
996	490	253	4.50	198	1.97	5.51	880	451	4.33	4.66	58.52	B
1043	350	224	3.50	212	2.19	4.92	815	436	4.00	4.33	58.59	B
978	480	260	5.00	205	1.80	5.67	850	465	4.00	4.33	58.71	C
982	480	258	4.50	191	2.20	5.04	900	449	4.33	4.33	60.39	C
992	435	255	4.50	198	2.15	5.26	860	453	4.66	4.33	59.80	C
988	575	256	4.00	173	2.60	5.00	1025	429	4.66	4.66	60.68	D
984	470	258	5.00	198	1.97	5.76	860	456	4.00	4.00	60.41	D
990	480	255	4.00	184	2.31	4.91	905	439	4.66	4.00	60.52	D
1012	500	245	5.00	184	2.20	5.51	905	429	4.33	4.00	59.59	D
1001	485	248	4.00	178	2.33	5.15	900	426	4.33	4.33	60.33	D
1026	375	237	3.50	198	1.94	5.16	760	435	4.00	4.00	58.82	D
1002	475	248	4.50	178	2.33	4.97	890	426	4.33	4.00	58.20	D
1005	390	246	4.00	178	2.22	4.69	785	424	4.33	4.33	57.45	D
1015	455	245	3.00	191	2.41	5.01	915	436	4.33	4.33	60.49	D
1029	415	236	3.50	205	2.22	4.92	870	441	4.66	4.33	57.70	D

* Compress type steers

Significance of observed differences between sires and types

The comprest steers differed significantly from the conventional steers as judged visually both as feeder calves and at slaughter time. Differences in initial weights were significant, independent of age differences.

Initial grades of comprest steers were significantly higher than the grades of conventional steers. However, the sire of the comprest steers also sired three conventional steers whose grades were significantly higher than all others. At slaughter time, the comprest steers graded higher than the conventional type steers but the difference was not significant. A greater difference in slaughter grades between sires than between types was found but again the difference was not significant.

Days on feed differed very little between types and was not significant. However, the difference between sires within types was significant.

Comprest type steers showed a lower average daily gain than the conventional type steers, but average daily feed consumption was significantly lower.

Total digestible nutrients required per pound of gain were about equal for the two types of steers. Some variation occurred between sire groups but differences were not significant.

Cold carcass grades remained the same as slaughter grades for the comprest type steers, while on the average they dropped slightly for the conventional type steers. However, one sire group of carcass grades of conventional type were higher than the respective slaughter grades.

Conventional type steers averaged higher in dressing per cent than did steers of comprest type.

Variance and covariance studies of grades, weights, efficiencies and measurements

Thirteen variance and covariance studies, with the correlation coefficients, were made of the various factors observed. These studies were broken down into the following subclasses: Between types, within types, between sire groups of the same type, and within sire groups of the same type.

The first study, Table 4, was of initial body weights on initial grades. This was studied in order to check the possibility that the grades given an animal may be dependent to some extent on the weight of the animal at the time it was graded. In the total population the weights were not highly correlated with the grades. Because there were only the two type groups, a correlation between them would be perfect. Within types the correlation was significant. Between sire progeny of the same type a negative correlation was found, but this was not significant. A highly significant correlation was found within sires of steers of the same type. A highly signi-

Table 4.--VARIANCE AND COVARIANCE ANALYSIS OF INITIAL WEIGHTS (Y) ON INITIAL GRADES (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	13.50	237.50	108,916.67	.195	25	104,738.43	---------	----	---------
Between types	1	0.83	-171.25	35,547.85	----	1	44,541.52	44,541.52**	0.83	35,547.85**
Within types	25	12.67	408.75	73,368.82	.423*	24	60,196.91	2,617.26	0.51	2,934.75
Between sires within types	3	4.11	-103.58	9,071.32	-.536	3	26,539.26	8,846.42**	1.3694*	3,023.77
Within sires within types	22	8.56	512.33	64,297.50	.690**	21	33,657.65	1,602.75	0.3894	2,922.61

* Significant at .05 level

** Significant at .01 level

ficant difference in initial weights was found between types and between sires of the same type. Also, differences in initial grades were significant between sires of the same type.

The correlation between final weights and final grades was significant for within types and within sires within types Table 5. As in the study of initial weights on initial grades, where the variability due to grades had been removed, the difference in weights between types was found to be highly significant. The same was true of the differences between sires of the same type.

Average daily gain was very highly correlated with average daily feed consumption Table 6. When variability due to average daily feed consumption had been removed there was no significant difference in average daily gain of types or between sires of the same type.

This appeared to be about the only method by which some evaluation could be made concerning the degree which some animals may utilize a greater percentage of their feed intake for weight increase. Correlations between efficiency and rate of gain which have frequently been used for this purpose are spurious because the denominator component of the ratio is the same as the variable with which it is being correlated.

A highly significant negative correlation was found in the study between slaughter grade and days on

Table 5.--VARIANCE AND COVARIANCE ANALYSIS OF FINAL WEIGHTS (Y) ON FINAL GRADES (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms(X)	ms(Y)
Totals	26	1.51	8.13	218,974.08	.014	25	218,930.29	---------	----	----------
Between types	1	0.18	-151.43	124,056.08	----	1	75,685.02	75,685.02**	0.18	124,056.08**
Within types	25	1.33	159.56	94,918.00	.450*	24	143,245.21	5,968.55	0.05	3,796.72
Between sires within types	3	0.21	13.15	16,297.99	.399	3	83,795.26	27,931.75**	0.06	5,432.66
Within sires within types	22	1.11	146.41	78,620.01	.493*	21	59,450.01	2,830.95	0.06	3,573.63

* Significant at .05 level

** Significant at .01 level

Table 6.--VARIANCE AND COVARIANCE ANALYSIS OF AVERAGE DAILY GAIN (Y) ON AVERAGE DAILY FEED CONSUMPTION (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	38.94	7.50	1.81	.892**	25	0.37	----	----	----
Between types	1	19.56	3.63	0.68	----	1	0.00	0.00	19.56**	0.67**
Within types	25	19.38	3.87	1.13	.823**	24	0.37	0.15	0.77	0.04
Between sires within types	3	6.39	1.66	0.44	.989*	3	0.04	0.01	2.13*	0.15*
Within sires within types	22	12.99	2.21	0.69	.732**	21	0.33	0.01	0.59	0.03

* Significant at .05 level

** Significant at .01 level

feed, both for total population and within steer types Table 7. A negative correlation was found between sires of the same type and within these sires but it was not significant. When the variability due to days on feed had been removed, the differences between types were not significant. The variance analysis shows a significant difference in days fed between sires of the same type. This relationship is of interest to indicate whether there may have been a tendency as the experiment progressed, to limit the time of slaughter such that grades of individual steers might in some cases be influenced. This might cause some to be slaughtered too early, others too late so far as a uniform degree of fatness is concerned.

Carcass grade and days on feed showed a negative correlation for the total population and the same for within steer types but it was not significant Table 8. A positive, but not significant, correlation was found between sires of the same type and within sires of the same type. As reported above, days on feed showed a significant difference between sires of the same type. This relationship was of interest as in the preceding study because slaughter grade and carcass grade were found to be highly correlated.

The correlation between carcass grade and slaughter grade was significant for all categories except between sires of the same type where a slight, but not

Table 7.--VARIANCE AND COVARIANCE ANALYSIS OF SLAUGHTER GRADE (Y) ON DAYS FED (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	3450.00	-16.72	1.51	-.732**	25	1.43	----	------	----
Between types	1	27.93	- 2.27	0.18	-----	1	0.16	0.16	27.93	0.18
Within types	25	3422.07	-14.45	1.33	-.678**	24	1.27	0.05	136.88	0.05
Between sires within types	3	1161.67	-12.42	0.21	-.804	3	0.15	0.04	387.22*	0.06
Within sires within types	22	2260.40	- 2.03	1.11	-.040	21	1.12	0.05	102.75	0.05

* Significant at .05 level

** Significant at .01 level

Table 8.--VARIANCE AND COVARIANCE ANALYSIS OF CARCASS GRADE (Y) ON DAYS FED (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	3450.00	- 5.94	1.74	-.076	25	1.73	----	------	----
Between types	1	27.93	- 2.59	0.24	----	1	0.23	0.23	27.92	0.24
Within types	25	3422.07	- 3.35	1.50	-.046	24	1.50	0.06	136.88	0.06
Between sires within types	3	1161.67	9.24	0.17	.665	3	0.23	0.07	387.22*	0.05
Within sires within types	22	2260.40	12.59	1.33	.228	21	1.27	0.06	102.75	0.06

* Significant at .05 level

significant, negative correlation was evident Table 9. When the variability due to slaughter grade had been removed, the difference between steer types was not significant for carcass grades, nor was the difference between sires within types significant. This study serves to give a measure of the extent to which grading the live animal may be a prediction of the grade of the carcass which could be obtained.

No significant correlation was shown between dressing per cent and slaughter grade Table 10. However, a significant difference was apparent between steer types, both in dressing per cent and slaughter grade, but between sires of the same type no difference was found in either factor.

Ratios of body measurements

The following tables 11 and 12 summarize certain body measurement ratios which have been made on the different types of steers at slaughter time. They are presented by types and by sires. Previous studies referred to in the review of literature indicated that these might be some of the more interesting ratios. The ratio of round circumference to wither height was suggested by Dr. H. R. Guilbert as a result of some of his unpublished data which indicate that this ratio is a useful one for differentiating types.

Table 9.--VARIANCE AND COVARIANCE ANALYSIS OF CARCASS GRADE (Y) ON SLAUGHTER GRADE (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	1.51	0.76	1.74	.470**	25	1.36	----	----	----
Between types	1	0.18	0.21	0.24	----	1	0.09	0.09	0.18	0.24
Within types	25	1.33	0.55	1.50	.391*	24	1.27	0.05	0.05	0.06
Between sires within types	3	0.21	-0.02	0.17	-.048	3	0.23	0.07	0.07	0.05
Within sires within types	22	1.11	0.57	1.33	.469*	21	1.04	0.04	0.05	0.06

* Significant at .05 level

** Significant at .01 level

Table 10.--VARIANCE AND COVARIANCE ANALYSIS OF DRESSING PER CENT (Y) ON SLAUGHTER GRADE (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	1.51	-1.05	46.06	-.126	25	45.32	-----	----	-----
Between types	1	0.18	-1.97	20.97	----	1	20.86	20.86**	0.18	20.97**
Within types	25	1.33	0.92	25.09	.158	24	24.46	1.02	0.05	1.00
Between sires within types	3	0.21	0.44	1.15	.913	3	0.71	0.24	0.06	0.38
Within sires within types	22	1.11	0.48	23.94	.090	21	23.75	1.13	0.05	1.08

** Significant at .01 level

Table 11.--SUMMARY OF BODY MEASUREMENT RATIOS AT SLAUGHTER TIME BY TYPES.

Ratio	Average of steers of compress type	Average of steers of conventional type
$\frac{\text{Weight}}{\text{Wither height}}$	6.78	7.61
$\frac{\text{Heart girth}}{\text{Wither height}}$	1.61	1.55
$\frac{\text{Round circumference}}{\text{Wither height}}$	.91	.89

Table 12.--SUMMARY OF BODY MEASUREMENT RATIOS AT SLAUGHTER TIME BY SIRES.

	Sire A		Sire B	Sire C	Sire D
Ratio	Compress	Conventional	Conventional	Conventional	Conventional
$\frac{\text{Weight}}{\text{Wither height}}$	6.78	7.41	7.45	7.65	7.76
$\frac{\text{Heart girth}}{\text{Wither height}}$	1.61	1.57	1.53	1.53	1.56
$\frac{\text{Round circumference}}{\text{Wither height}}$	.91	.87	.90	.89	.88

Slaughter grade and the ratio of weight to wither height are significantly correlated throughout the study with the exceptions of between sires of the same type Table 13. The ratios of weight to wither height varied greatly between types. Nevertheless, after this variability had been removed it was found that the slaughter grades between types still differed significantly.

The correlation between slaughter grade and the ratio of heart girth to wither height was very high for the total population. It was also significant for within types Table 14. As in the previous analysis, the types differed significantly in the ratio of heart girth to wither height, but when this variability had been removed, the slaughter grades showed no significant difference.

The correlation between dressing per cent and the ratio of heart girth to wither height was not significant in any instance Table 15. The variability between types due to the ratio was highly significant, and when this variability was removed it was found that variability between types due to dressing per cent was still highly significant.

With one exception, the correlation between dressing per cent and the ratio of the round measurement to wither height were all negative and in no respect were these correlations significant Table 16. Significant differences were found between types in this study but

Table 13.--VARIANCE AND COVARIANCE ANALYSIS OF SLAUGHTER GRADE (Y) ON RATIO OF WEIGHT TO WITHER HEIGHT (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	6.29	0.41	1.51	.422*	25	1.24	----	----	----
Between types	1	2.79	-0.72	0.18	----	1	0.28	0.28**	2.78**	0.18
Within types	25	3.50	1.13	1.33	.522**	24	0.96	0.04	0.14	0.05
Between sires within types	3	0.50	0.15	0.21	.457	3	0.16	0.05	0.16	0.06
Within sires within types	22	3.00	0.98	1.11	.534**	21	0.80	0.03	0.13	0.05

* Significant at .05 level

** Significant at .01 level

Table 14.--VARIANCE AND COVARIANCE ANALYSIS OF SLAUGHTER GRADE (Y) ON RATIO OF HEART GIRTH TO WITHER HEIGHT (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	0.03	0.12	1.51	.513**	25	~~1.11~~	----	----	----
Between types	1	0.01	0.05	0.18	----	1	0.00	0.00	0.01**	0.18
Within types	25	0.02	0.07	1.33	.402*	24	1.11	0.05	0.00	0.05
Between sires within types	3	0.00	0.02	0.21	.762	3	0.17	0.06	0.00	0.06
Within sires within types	22	0.02	0.05	1.11	.404	21	0.94	0.04	0.00	0.05

* Significant at .05 level

** Significant at .01 level

Table 15.--VARIANCE AND COVARIANCE ANALYSIS OF DRESSING PER CENT (Y) ON RATIO OF HEART GIRTH TO WITHER HEIGHT (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	0.0368	-0.4337	46.0570	-.333	25	40.9458	-------	------	-------
Between types	1	0.0139	-0.5421	20.9681	----	1	16.3700	16.3700**	0.0139**	20.9681**
Within types	25	0.0229	0.1084	25.0889	.143	24	24.5758	1.0239	0.0009	1.0035
Between sires within types	3	0.0047	0.0342	1.1478	.498	3	0.9372	0.3124	0.0015	0.3826
Within sires within types	22	0.0182	0.0742	23.9411	.112	21	23.6386	1.1125	0.0008	1.0882

** Significant at .01 level

Table 16.--VARIANCE AND COVARIANCE ANALYSIS OF DRESSING PER CENT (Y) ON RATIO OF CIRCUMFERENCE OF ROUND TO WITHER HEIGHT (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	0.0205	-0.2515	46.0570	-.258	25	42.9716	-------	------	-------
Between types	1	0.0021	-0.2111	20.9681	----	1	17.9714	17.9714**	0.0021	20.9681**
Within types	25	0.0184	-0.0404	25.0889	-.059	24	25.0002	1.0416	0.0007	1.0035
Between sires within types	3	0.0034	-0.0463	1.1478	-.741	3	1.0614	0.3538	0.0011	0.3826
Within sires within types	22	0.0150	0.0059	23.9411	.030	21	23.9388	1.1399	0.0006	1.0882

** Significant at .01 level

between sires of the same type no difference existed.

Relationship between age and efficiency and between weight and efficiency

The difference in ages between types was slight but not significant. Both before and after this small amount of variability was removed, no significant difference was found in the efficiency between types Table 17. Although there was some variability in ages between sire groups of the same type, the variation in efficiency proved insignificant. Efficiency and age were not significantly correlated.

The types differed very highly with reference to weight. Both before and after this variability had been removed the efficiency between types did not vary. No significant difference within types appeared either in weight or efficiency Table 18. No significant correlation between weight and efficiency was found; however, the correlation between sire groups within types was found to be negative.

The following diagrams show:

1. Regression of efficiency on age by types.
2. Regression of efficiency on weight by types.

Table 17.--VARIANCE AND COVARIANCE ANALYSIS OF EFFICIENCY (Y) ON AGE (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	5,504.67	35.90	2.4121	.308	25	2.1780	------	------	------
Between types	1	414.85	0.46	0.0151	----	1	0.0277	0.0277	414.85	0.0151
Within types	25	5,089.82	35.44	2.3970	.317	24	2.1503	0.0895	203.59	0.095
Between sires within types	3	2,016.24	8.45	0.2333	.322	3	0.2236	0.0745	672.08*	0.0777
Within sires within types	22	3,073.58	26.99	2.1637	.335	21	1.9267	0.0917	139.70	0.0983

* Significant at .05 level

Table 18.--VARIANCE AND COVARIANCE ANALYSIS OF EFFICIENCY (Y) ON WEIGHT (X).

Variability due to	D/F	Squares and cross products			r	Errors of estimate			Variance analysis	
		x^2	xy	y^2		D/F	ss	ms	ms (X)	ms (Y)
Totals	26	218,974.08	27.80	2.4121	.037	25	2.4086	------	----------	------
Between types	1	124,056.08	39.69	0.0151	----	1	0.0130	0.0130	124,056.58**	0.0151
Within types	25	94,918.00	-11.89	2.3970	-.025	24	2.3956	0.0998	3,796.72	0.0978
Between sires within types	3	16,297.99	-34.97	0.2333	-.469	3	0.2386	0.0795	5,432.66	0.0383
Within sires within types	22	98,620.00	23.08	2.1637	.058	21	2.1570	0.1027	3,575.63	0.0957

** Significant at .01 level

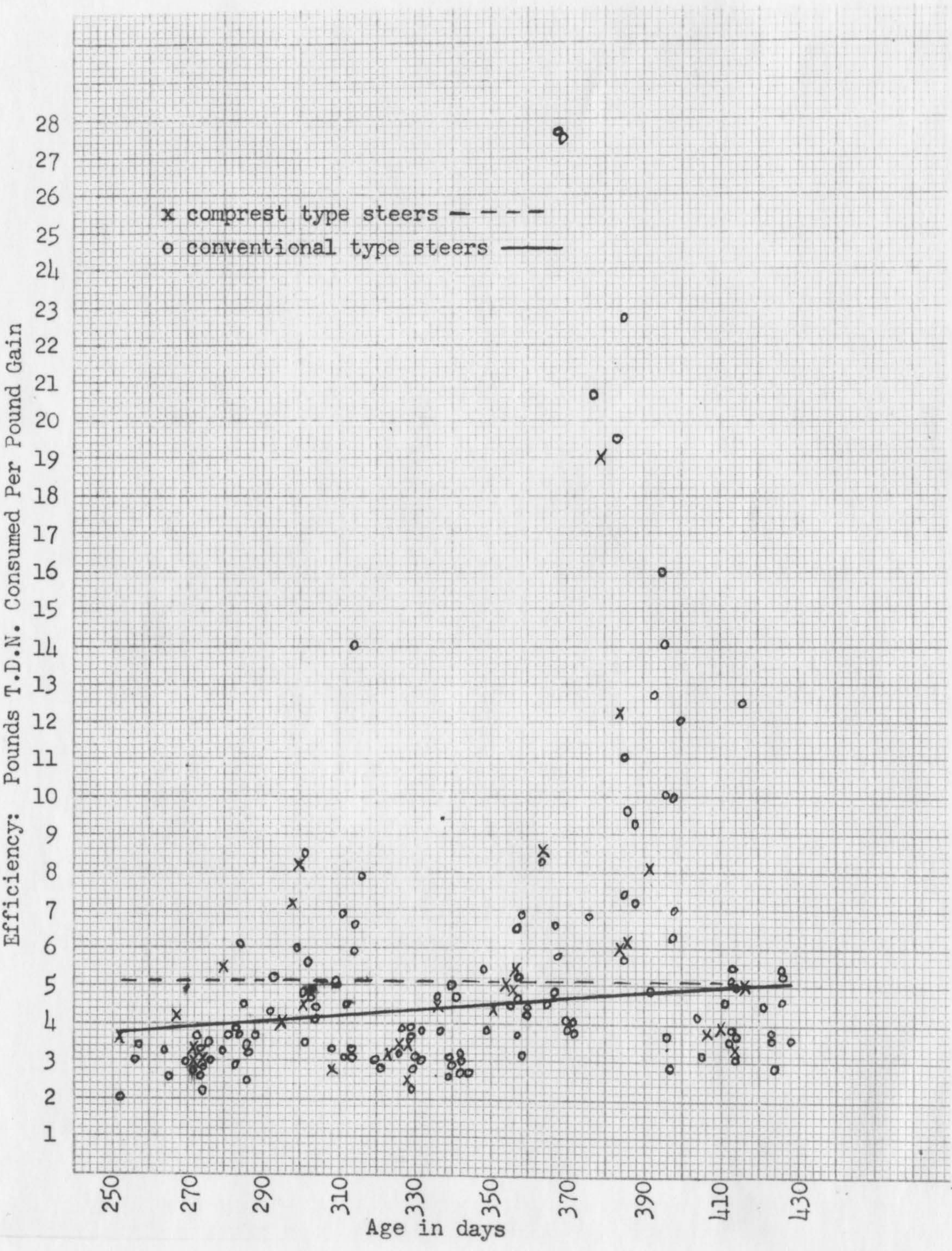

Fig. 7.--Linear regression of efficiency on age of comprest and conventional type steers

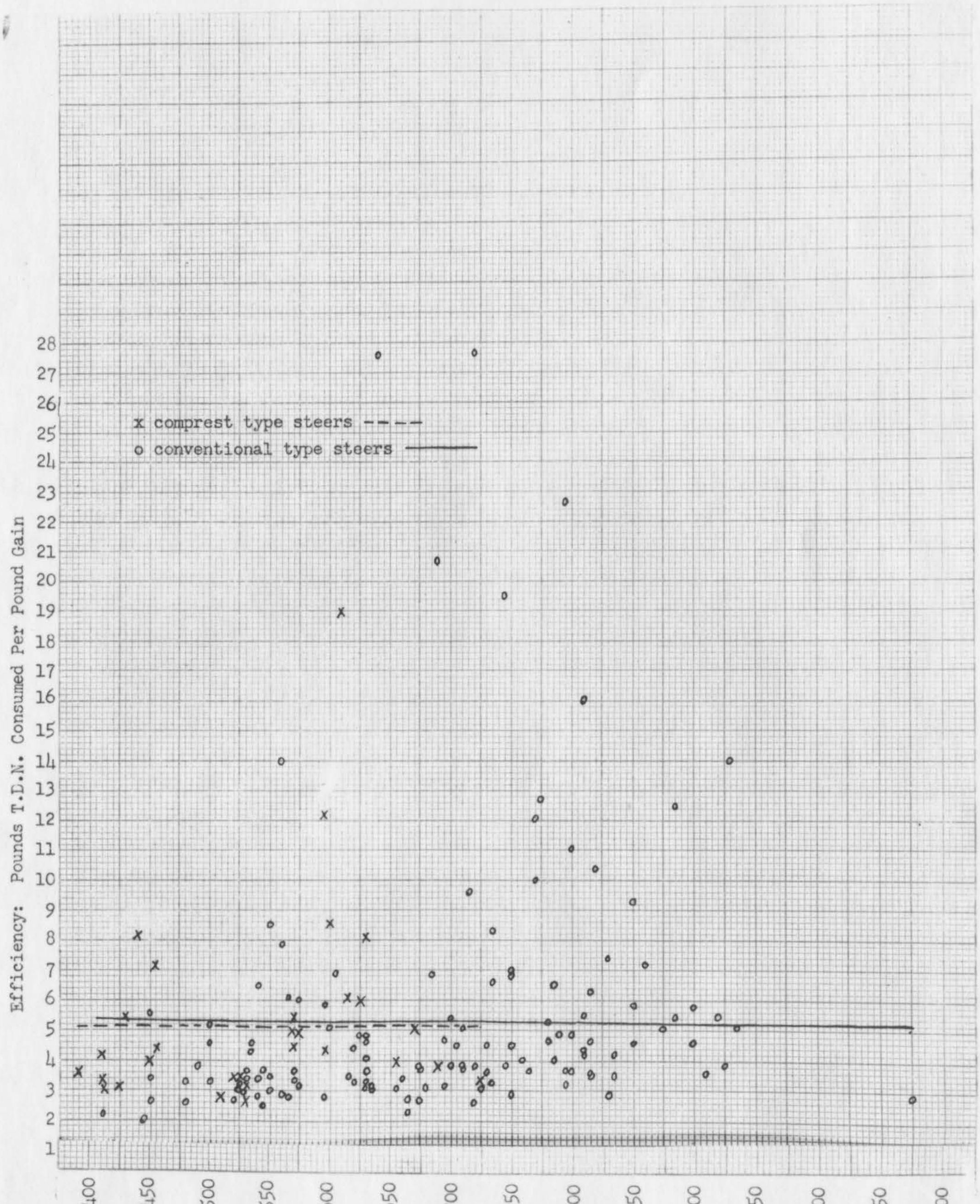

Fig. 8.--Linear regression of efficiency on weight of compress and conventional type steers

Chapter V

DISCUSSION

As a prediction of future performance, scoring or grading of feeder steer conformation did not reveal differences of animals as far as later gain or efficiency was concerned in this study. This is in agreement with work performed by Knapp, Black and Phillips (7) in 1939, and by Lush (12) in 1932.

In contrast to the findings by Hultz and Wheeler (4), 1927, who used low-set steers of conventional type in comparison with rangy steers of the same type, the comprest type steers in this study did not show a greater daily gain than conventional type steers. This conforms with studies by Woodward, Clark and Cummings (24), 1942, and Knox and Kroger (11) in 1946, who found that larger type steers averaged heavier into the feedlot, made somewhat faster feedlot gains and showed a higher dressing per cent than compact steers. Similarily these findings conform to those of Watson's (21) in 1932, who found that rangy type calves made more rapid gains than the very low-set type calves.

Contrary to the individually fed steers reported on by Winters and McMahon (23), 1933, efficiency could not be gauged by average daily gains. A correlation such as this is spurious because the denominator component of the ratio is the same as the variable with which it is being correlated. In this study pounds of T.D.N. required per pound of gain varied only slightly between types, while a much greater range in daily gain was evident as shown in Table 3. Therefore, daily gains in this study could not be used as a true indication of efficiency but served more as a reflection of amount of feed eaten. This was shown by the great differences in total feed consumed by the two types, while efficiency was nearly equal.

The number of days on feed differed little between the types, the greater difference appeared within sires of the same type in the number of days required to reach a relatively constant degree of finish. An interesting feature regarding one sire group was the fact that nearly 70 per cent of the steers in this group preceded to slaughter those of two other sire groups. The last steers to be slaughtered were, with two exceptions, in the above mentioned two sire groups. Contrary to Washburn's study (20), 1948, no significant difference in days on feed existed in this experiment.

As in initial weights, the differences in slaughter weights of the two types were distinct. The compress type steers reached the degree of desired finish at a much lighter weight than did the conventional type steers. While no measure of consumer preference was made in this study, it is generally accepted that consumers prefer a lighter carcass, and this may be a factor in favor of the comprest. Because of home freezers or limited refrigerated storage, a small carcass would, in many cases, receive preference over the much larger type carcass.

Variations in slaughter and carcass grades were greater within types than between the two types. However, the conventional type steers averaged higher in dressing per cent by sire groups in all cases than did the comprest type steers. This was contrary to Washburn's findings (20), 1948, where compact type averaged higher. It is believed that an interesting feature was overlooked in this experiment at the time of slaughter, namely shrinkage. It may be possible that the reason for the differences in dressing per cent of the two types may be accounted for by the differences in shrinkage during the twenty-four hour fasting period prior to slaughter.

The high correlation between slaughter grade and carcass grade would indicate that there were little differences observed in grades at slaughter and the carcass grades, thus suggesting that slaughter grade is a very good measure of the carcass quality of a steer. A significant negative correlation was found between slaughter grade and days fed. This may have been caused by a tendency to slaughter remaining steers before they had reached the grade or degree of fatness of other earlier fattening steers. Another explanation may be that slaughtering should have started at an earlier date to secure more uniform slaughter grades. Contrary to evidence presented by other investigators, no significant correlation was found between dressing per cent and slaughter grade in this study. Therefore, it is reasonable to believe that a high dressing per cent is not entirely dependent upon a high slaughter grade.

The most distinct differences in body conformation of the two types of steers at completion of the feeding period were observed in the ratio of weight to wither height, ratio of heart girth to wither height and the ratio of circumference of hind quarters or round to wither height.

Conventional type steers had a larger weight to wither height ratio than the comprest type steers. In contrast to expectation and previous work by others, the comprest type steers had a greater average ratio of heart girth to wither height and also ratio of circumference of hind quarters to wither height than did the conventional type steers. Body measurements and ratios of body measurements leave much to be desired when used in prediction of such factors as dressing per cent and efficiency. It was found in this study that no significant correlation existed between these ratios and the factors mentioned.

Contrary to findings by Washburn, et al (20), 1948, it was found in this study significant differences of efficiency between the two types did not occur, either when plotted against age or body weight. An explanation for this may be the fact that Washburn's period of investigation covered both a growth and a fattening phase, the latter beginning at an approximate age of eleven months. This experiment began when the steer calves were about six months of age and terminated when they were slightly over a year of age, thus a much smaller segment of the growth curve was observed.

Chapter VI

SUMMARY

In recent years there have been continuous changes in beef type largely brought about by breeders' attempts to respond to changing market and show-ring demands.

An extreme degree of compactness of body conformation has been observed in a few purebred herds of Hereford cattle in recent years. The type variations dealt with in this study indicate that this compactness is due to the occurrence of a single dominant gene.

The question has arisen if there is a type which over a period of time will prove more satisfactory in meeting the needs of the breeder, feeder and consumer.

Information on the comparative performance of different types, such as comprest and conventional, will be of great value to cattlemen in their decision when choosing the type of cattle which will be most profitable. Along with this comparative performance must be considered the preference of the consumers as to the different sizes.

This initial study was undertaken with the major objectives of testing the steers of comprest and conventional type with respect to rate of gain and efficiency of feed utilization, secondly, to find the degree of correlation between certain body measurements and rate of gain and efficiency. After a period of three or more years of repetition, it is believed that recommendations can be made to the breeder and producer as to the comparative feedlot performance of comprest and conventional type steers.

In order to study the comparative performance of purebred Hereford steers of comprest and conventional types, 27 steer calves sired by four bulls representing the two types were individually fed. The ration consisted of a mixture of the following ingredients: 25 per cent ground alfalfa hay, 30 per cent dry beet pulp, 15 per cent cracked corn, 15 per cent rolled barley and 15 per cent soy bean meal. The steers had access to this feed from 5 p.m. to 8 a.m. A supply of salt and mineral block was available at all times. Analysis of the feed mixture gave 72.77 per cent total digestible nutrients.

Initial individual weights, grades, body measurements and photographs were taken at the beginning of the experiment. At twenty-eight day intervals thereafter the steers were weighed and body measurements taken. Slaughter weights were taken at 8 a.m. the morning the steers were slaughtered, after being withheld from feed for twenty-four hours. Two faculty members of the Colorado A and M Animal Husbandry Department graded the steers at slaughter time and forty-eight hours later graded the steer carcasses.

Steers were slaughtered at a relatively constant degree of finish which was a grade of good or better. Grading may not be considered an effective means of entirely describing type differences. In evaluating differences in steer types by the scoring method, it was found that the comprest type steers graded higher as feeder calves and again as slaughter steers than did the conventional type steers. Variations in initial grade and slaughter grade were greater in the conventional type steers than in the comprest type steers.

Body measurements most useful in objectively describing type differences are wither height, body length, depth of chest and heart girth. More revealing were ratios of weight to wither height, heart girth to wither height and less significant was the ratio of circumference of hind quarter or round (as measured from patella to patella) to wither height.

Correlation of variations in measurements of types with efficiency were not significant. Neither were they correlated with dressing per cent. The most significant correlation was between ratio of weight to wither height and slaughter grade but then only for total population, within types and within sires of the same type, not between types. The ratio heart girth to wither height was significantly correlated with slaughter grade for total population and within types only.

Efficiency and age were not correlated in this study either between types or within types. The same was true of the correlation between weight and efficiency. Therefore, the lighter comprest type steers were as efficient as the heavier conventional type steers and age had no effect on efficiency of feed utilization.

Slaughter grades of comprest type steers were slightly higher than those of conventional type. The carcass grades remained the same as slaughter grades for comprest type steers and dropped slightly for conventional type steers. In all sire groups represented in the conventional type dressing per cent was higher than for the comprest type steers.

Within the limitations of this study, such as small numbers in the comprest type, small numbers in some sire groups, and only one bull represented in the comprest type, it may be concluded from this initial investigation that overall conclusive evidence of the superiority of either comprest or conventional type in feedlot performance does not exist.

A P P E N D I X

Table 1.--SLAUGHTER GRADES AND DRESSING PER CENT OF STEERS BY TYPE AND BY SIRE.

Sire A. Compreſt type steers

Steer number	Slaughter grade (X)	Dressing per cent (Y)
1041	4.33	56.65
1018	4.66	56.44
1025	4.33	58.28
1021	4.66	57.14
1016	4.66	57.04
N = 5	$\Sigma X = 22.64$	$\Sigma Y = 285.55$

Sire A. Conventional type steers

Steer number	Slaughter grade (X)	Dressing per cent (Y)
1037	4.66	60.26
1040	4.33	58.15
1013	4.33	60.59
N = 3	$\Sigma X = 13.32$	$\Sigma Y = 179.00$

Sire B. Conventional type steers

Steer number	Slaughter grade (X)	Dressing per cent (Y)
1006	4.00	59.34
1010	4.33	58.49
986	4.33	60.31
1020	4.00	58.99
996	4.33	58.52
1043	4.00	58.59
N = 6	$\Sigma X = 24.99$	$\Sigma Y = 354.24$

Table 1.--SLAUGHTER GRADES AND DRESSING PER CENT OF STEERS BY TYPE AND BY SIRE--Continued

Sire C. Conventional type steers

Steer number	Slaughter grade (X)	Dressing per cent (Y)
978	4.00	58.71
982	4.33	60.39
992	4.66	59.80
N = 3	$\Sigma X = 12.99$	$\Sigma Y = 178.90$

Sire D. Conventional type steers

Steer number	Slaughter grade (X)	Dressing per cent (Y)
988	4.66	60.68
984	4.00	60.41
990	4.66	60.52
1012	4.33	59.59
1001	4.33	60.33
1026	4.00	58.82
1002	4.33	58.20
1005	4.33	57.45
1015	4.33	60.49
1029	4.66	57.70
N = 10	$\Sigma X = 43.63$	$\Sigma Y = 594.19$

Totals conventional type steers

N = 22 $\Sigma X = 94.93$ $\Sigma Y = 1306.33$

Table 2.--EXAMPLE OF CALCULATION OF VARIANCE AND COVARIANCE ANALYSIS OF DRESSING PER CENT (Y) ON SLAUGHTER GRADE (X). DATA FROM TABLE 1.

$$\Sigma x^2 = \Sigma X^2 - \frac{(\Sigma X)^2}{n}, \quad \Sigma xy = \Sigma XY - \frac{(\Sigma X)(\Sigma Y)}{n}, \quad \Sigma y^2 = \Sigma Y^2 - \frac{(\Sigma Y)^2}{n}$$

$$\Sigma x^2 = \Sigma\left[(4.66)^2 + (4.00)^2 + \dots + (4.66)^2 + (4.66)^2\right] - \frac{(117.57)^2}{27} = 1.51$$

$$\Sigma xy = \Sigma\left[(4.66)(60.68) + (4.00)(60.41) + \dots + (4.66)(57.14) + (4.66)(57.04)\right] - \frac{(117.57)(1591.88)}{27} = -1.06$$

$$\Sigma y^2 = \Sigma\left[(60.68)^2 + (60.41)^2 + \dots + (57.14)^2 + (57.04)^2\right] - \frac{(1591.88)^2}{27} = 46.06$$

$$\Sigma x_T^2 = \frac{\Sigma X_F^2}{n_F} + \frac{\Sigma X_G^2}{n_G} - \frac{(\Sigma X)^2}{n}, \quad \Sigma xy_T = \frac{\Sigma xy_F}{n_F} + \frac{\Sigma xy_G}{n_G} - \frac{\Sigma XY}{n}, \quad \Sigma y_T^2 = \frac{\Sigma Y_F^2}{n_F} + \frac{\Sigma Y_G^2}{n_G} - \frac{(\Sigma Y)^2}{n}$$

$$\Sigma x_T^2 = \left[\frac{(94.93)^2}{22} + \frac{(22.64)^2}{5}\right] - 511.95 = 0.18$$

$$\Sigma xy_T = \left[\frac{(94.93)(1306.33)}{22} + \frac{(22.64)(285.55)}{5}\right] - 6931.75 = -1.97$$

Table 2.--EXAMPLE OF CALCULATION OF VARIANCE AND COVARIANCE ANALYSIS OF DRESSING PER CENT (Y) ON SLAUGHTER GRADE (X). DATA FROM TABLE 1.--Continued

$$\Sigma y_T^2 = \left[\frac{(1306.33)^2}{22} + \frac{(285.55)^2}{5}\right] - 93,854.89 = 20.97$$

$$\Sigma x_{wT}^2 = \Sigma x^2 - \Sigma x_T^2, \quad \Sigma xy_{wT} = \Sigma xy - \Sigma xy_T, \quad \Sigma y_{wT}^2 = \Sigma y^2 - \Sigma y_T^2$$

$$\Sigma x_{wT}^2 = \Sigma x^2 - \Sigma x_T^2 = 1.51. -0.18 = 1.33$$

$$\Sigma xy_{wT} = \Sigma xy - \Sigma xy_T = -1.06 - (-1.97) = 0.91$$

$$\Sigma y_{wT}^2 = \Sigma y^2 - \Sigma y_T^2 = 46.06 - 20.97 = 2509$$

$$\Sigma x_S^2 = \left[\frac{(\Sigma X_A)^2}{n_A} + \frac{(\Sigma X_B)^2}{nB} + \dots + \frac{(\Sigma x_D)^2}{n_D}\right] - \frac{(\Sigma X)^2}{n} - \Sigma x_T^2$$

$$\Sigma xy_S = \left[\frac{(X_A)(Y_A)}{n_A} + \frac{(\Sigma X_B)(\Sigma Y_B)}{n_B} + \dots + \frac{(\Sigma X_D)(\Sigma Y_D)}{n_D}\right] - \frac{\Sigma xy}{n} - \Sigma x\, y_T$$

$$\Sigma y_S^2 = \left[\frac{(\Sigma Y_A)^2}{n_A} + \frac{(\Sigma Y_B)^2}{n_B} + \dots + \frac{(\Sigma Y_D)^2}{n_D} - \frac{(\Sigma Y)^2}{n}\right] - \Sigma y_T^2$$

Table 2.--EXAMPLE OF CALCULATION OF VARIANCE AND COVARIANCE ANALYSIS OF DRESSING PER CENT (Y) ON SLAUGHTER GRADE (X). DATA FROM TABLE 1.--Continued

$$\Sigma x^2_S = \left[\frac{(43.63)^2}{10} + \frac{(24.89)^2}{6} + \frac{(12.99)^2}{3} + \frac{(13.32)^2}{3} + \frac{(22.64)}{5}\right] - 511.95 - 0.18 = 0.21$$

$$\Sigma xy_S = \left[\frac{(43.63)(594.19)}{10} + \frac{(24.99)(354.24)}{6} + \frac{(12.99)(178.90)}{3} + \frac{(13.32)(179.00)}{3} + \frac{(22.64)(285.55)}{5}\right] - 6931.75 - (-1.97) = 0.44$$

$$\Sigma y^2_S = \left[\frac{(594.19)^2}{10} + \frac{(354.24)^2}{6} + \frac{(178.90)^2}{3} + \frac{(179.00)^2}{3} + \frac{(285.55)^2}{5}\right] - 93,854.89 - 20.97 = 1.15$$

$\Sigma y^2_{WS} = \Sigma x^2_{WT} - \Sigma x^2_S$, $\Sigma xy_{SW} = \Sigma xy_{WT} - \Sigma xy_S$, $\Sigma y^2_{WS} = \Sigma y^2_{WT} - \Sigma y^2_S$

$$\Sigma x^2_{WS} = \Sigma x^2_{WT} - \Sigma x^2_S = 1.33 - 0.21 = 1.12$$

$$\Sigma xy_{WS} = \Sigma xy_{WT} - \Sigma xy_S = 0.91 - 0.44 = 0.47$$

$$\Sigma y^2_{WS} = \Sigma y^2_{WT} - \Sigma y^2_S = 25.09 - 1.15 = 23.94$$

EXPLANATION OF SYMBOLS

Σx^2, Σy^2, Σxy = Sums of deviations squared and crossproducts for total population.

Σx_T^2, Σxy_T, Σy_T^2 = Sums of deviations squared and crossproducts for between types.

Σx_{WT}^2, Σxy_{WT}, Σy_{WT}^2 = Sums of deviations squared and crossproducts for within types.

Σx_S^2, Σxy_S, Σy_S^2 = Sums of deviations squared and crossproducts for between sires within types.

Σx_{WS}^2, Σxy_{WS}, Σy_{WS}^2 = Sums of deviations squared and crossproducts within sires and types.

ΣX_A, ΣX_B ... ΣX_D = Sire groups A, B, ... D.

n = Number of steers.

N_A, N_B, ... N_D = Number of steers in sire groups A, B, ... D.

Σx_F^2, Σxy_F, Σy_F^2 = Sums of deviations squared and crossproducts for conventional type steers.

Σx_G^2, Σxy_G, Σy_G^2 = Sums of deviations squared and crossproducts for compress type steers.

Correlation

$$r = \sqrt{\frac{(\Sigma xy)^2}{(\ x^2)(\ y^2)}}$$

$$r \text{ totals} = \sqrt{\frac{(-1.06)^2}{(1.51)(46.06)}} = -.126$$

$$r \text{ within types} = \sqrt{\frac{(0.91)^2}{(1.33)(25.09)}} = -.158$$

$$r \text{ between sires within types} = \sqrt{\frac{(0.44)^2}{(0.21)(1.15)}} = .913$$

$$r \text{ within sires within types} = \sqrt{\frac{(0.47)^2}{(1.12)(23.94)}} = .090$$

r between types would be perfect because of only one degree of freedom.

Errors of estimate: $ss = \Sigma y^2 - \frac{(\Sigma xy)^2}{\Sigma x^2}$

ss totals = 46.06 -0.74 = 45.32

ss within types = 25.09 -0.63 = 24.46

ss between types = 45.32 - 24.46 = 20.86

ss within sires within types = 23.94 - 0.20 = 23.74

ss between sires within types = 24.46 - 23.74 = 0.72

$$ms = \frac{ss}{D/F \text{ Errors estimate}}$$

$$\text{ms between types} = \frac{20.86}{1} = 20.86$$

$$\text{ms within types} = \frac{24.46}{24} = 1.02$$

$$\text{ms between sires within types} = \frac{0.72}{3} = 0.24$$

$$\text{ms within sires within types} = \frac{23.74}{21} = 1.13$$

$$\text{F between types} = \frac{20.86}{1.02} = 20.47^{**}$$

$$\text{F between sires within types} = \frac{0.24}{1.13} = \text{less than}$$

unity.

** 20.47 is highly significant as designated in F table (Snedecor), therefore, it may be concluded that types differ significantly as to dressing per cent after variability due to slaughter grade has been removed. Between sires within types no significant difference existed.

Variance analysis

X = Slaughter grade

$$ms = \frac{\Sigma x^2}{D/F}$$

$$\text{ms between types} = \frac{0.18}{1} = 0.18$$

$$\text{ms within types} = \frac{1.33}{25} = 0.05$$

$F = \frac{0.18}{0.05} = 3.60$. Therefore slaughter grade differences between types are not significant.

ms between sires within types $= \frac{0.21}{3} = 0.07$

ms within sires within types $= \frac{1.12}{22} = 0.05$

$F = \frac{0.07}{0.05} = 1.40$. Therefore slaughter grade differences between sires within types are not significant.

Variance analysis

Y = Dressing per cent

$ms = \frac{\Sigma y^2}{D/F}$

ms between types $= \frac{20.97}{1} = 20.97^{**}$

ms within types $= \frac{25.09}{25} = 1.00$

$F = \frac{20.97}{1.00} = 20.97$. Therefore dressing per cent differences between types are highly significant.

ms between sires within types $= \frac{1.15}{3} = 0.38$

ms within sires within types $= \frac{23.94}{22} = 1.08$

$F = \frac{0.38}{1.08} =$ less than unity. Therefore no significant difference in dressing per cent between sires within type exists.

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