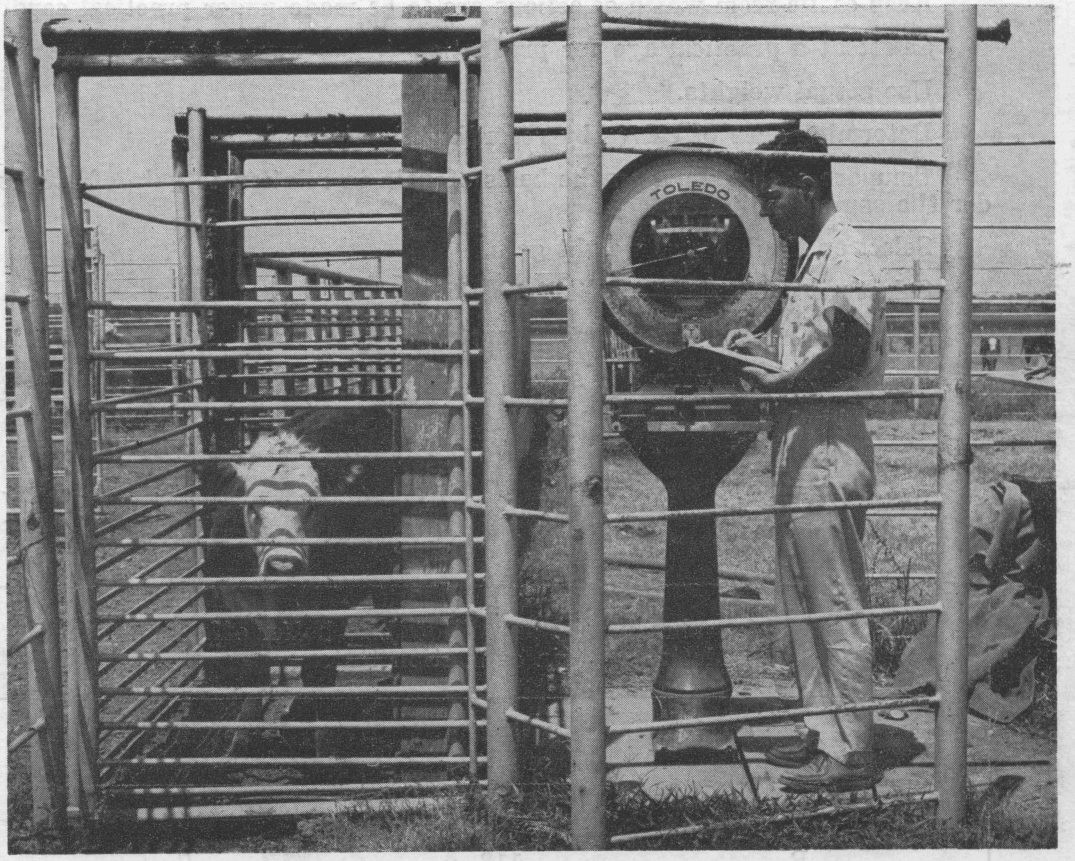
Bulletin 815 August 1955

Beef Cattle Performance

II. Selection Based on Gaining Ability



Scales tell the rate of weight gain.

in cooperation with the
UNITED STATES DEPARTMENT OF AGRICULTURE

TEXAS AGRICULTURAL EXPERIMENT STATION

R. D. LEWIS, DIRECTOR, COLLEGE STATION, TEXAS

DIGEST

While cattle will always have a prominent place in Texas agriculture, the beef production industry must rely on technological advances to keep pace with other agricultural fields. Results of a continuing study at Substation No. 23, at McGregor, Texas, of the ability of young cattle to grow and gain weight form one of the most important advances made in recent years.

Gaining ability as a basis for selection is of major importance for efficient beef cattle production. Selection for characteristics that are not of economic importance reduces progress in selecting for the important ones. Gaining ability is a trait high in heritability and selecting for it permits progress to be made in herd improvement.

Tests for selection for gaining ability with large numbers of animals are being made at the McGregor station. Results to date indicate that heritability of gaining ability is 50 to 55 percent, a relatively high value which indicates that selection can be effective in increasing the gaining ability of beef cattle.

The following recommendations are made to the breeder and producer:

Keep cattle from which selections are to be made under practical conditions for production.

Select at a practical age for production (usual market age).

Use actual weights.

Determine ages of calves by recording the date of birth.

Compare each animal on the basis of gain in relation to gain of others at the same time and under the same conditions.

Select on the basis of weight gain.

Select on the basis of the individual's record.

Select both sexes — sires more carefully.

Keep selection simple and sound.

When buying, get tested, high-gaining sires.

Gain ratios of Brahman sires and all of their heifer offspring from Hereford cows which were in the 1954-55 McGregor gain evaluation test.

Sire	Gain ratio of sire	No. of offspring from each sire	Average gain ratio of each sire's offspring
A	123	5	120
B	113	7	112
C	106	6	106
D	105	8	94
E	105	6	87
F	101	4	77

This example from the most recent McGregor gain test was chosen because for the first time several tested sires were represented and each had several heifers entered as a progeny test. Note that the ranking of the progeny groups in gaining ability is the same as the ranking of their respective sire's gaining ability record. On the average, high gaining sires produce high gaining offspring. This is just an example, but it illustrates the findings of statistical analyses.

Beef Cattle Performance

II. Selection Based on Gaining Ability

T. C. CARTWRIGHT, BRUCE L. WARWICK and H. O. HILL*

THE RESULTS OF TESTS ON THE GROWING ABILITY of young cattle form the basis for one of the most important advances in beef cattle production in recent years. An inherently healthy, vigorous, climatically adapted animal that is highly fertile is necessary for the ranchman. At the same time, a high quality product is necessary for the packer and consumer.

This bulletin is the second of a series reporting the results of investigations with beef cattle at Substation No. 23 at McGregor, Texas. The first of the series, Bulletin 790, was based on *"Evaluation Tests for Gaining Ability."* Others will include: selection in the McGregor station herd based on performance; carcass evaluations of Hereford and first-cross Hereford x Brahman steers; weight for age at weaning; regularity of breeding; use of heat tolerance tests; and hybrid vigor.

Permanent improvement in beef cattle results through selecting superior animals and stabilizing their inheritance through breeding. Management and feeding should not be overlooked, but more productive cattle should be bred. Growing ability is the key to fast, economical beef production. The theoretical basis was given in the first bulletin of this series (Warwick *et al.*, 1955), Bulletin 790. Bulletin 815 presents the actual beef-producing performance records of the offspring of selected high-gaining parents. Specific recommendations to the breeder include:

What to select for and why.

What not to select for and why.

How to get records on animals for use in selection.

The amount of success that can be expected.

ESTABLISHING A BASIS FOR SELECTION

Determining which animals are to remain in the breeding herd and which ones are to be sold is the key to herd improvement. Differences among individual animals are caused by differences in the way they are fed or treated (their environment) and differences in the individual's inheritance or genetic makeup. Actually both sets of differences affect all characteristics, but the more important fact to consider in a breeding program is that individual animal differences in some characters (characteristics) are produced to a greater extent by inherited differences than is the case with other characters. If differences in a character are due largely to inherited differences, the character is said to be highly heritable and proper selection can be expected to improve the herd average for this character. However, if differences among animals are due almost entirely to environmental differences, selection will not improve the herd average for this character. The amount of improvement that can be achieved by selection depends also on how large the differences are among individuals and how accurate the selection is in picking the top animals.

This is important because of the effect of considering too many characters in selection. Most progress can be made in improving a certain character by considering only that one character. The amount of progress to be expected in improving a single character decreases as the total number of characters considered in selection increases. If noticeable improvement is to be made, the number of characters must be limited. This point seems to be little understood. It has been said that selection for looks or conformation might not help but that it does no harm. It does do harm, as

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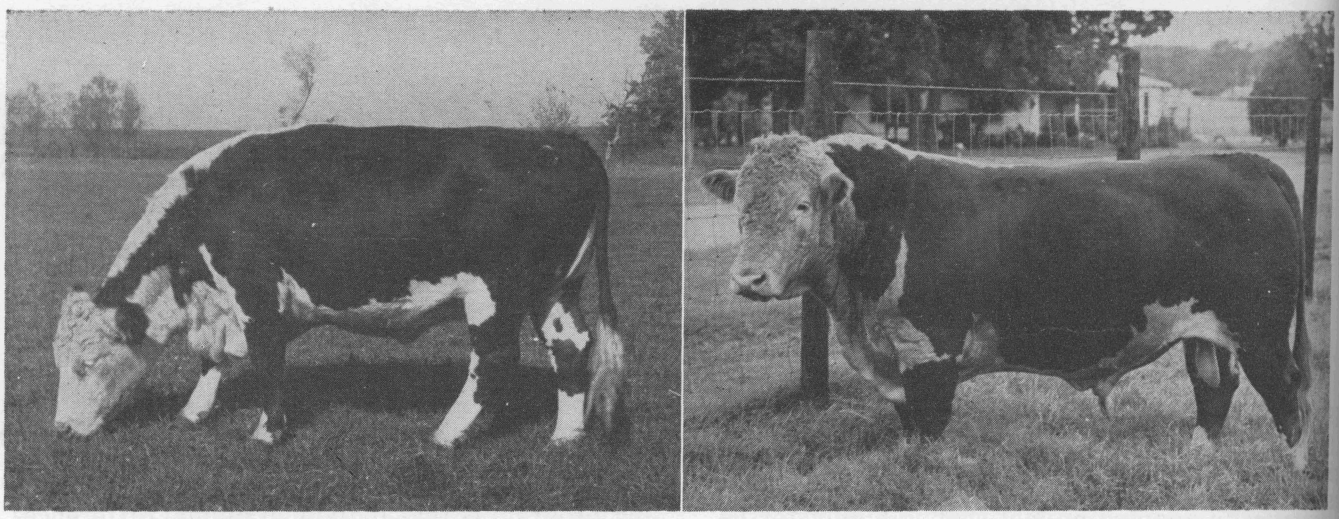

Figure 1. Left—This 7-year-old Hereford cow produced five calves in 5 years. Of the four that have been tested, all were high gainers and averaged 24 percent above their gain test average. She has been proved by the performance of her offspring. Right—Mr. BF 909, a 3-year-old son of the cow at the left, was 40 percent above average in gain. It is more practical to rate an animal's ability by its own performance while it is still young and growing. Such high gainers make excellent herd replacements.

pointed out above, because it greatly reduces the amount of progress possible for more useful production characters.

Determining what characters to consider is important. Only points that have economic value should be considered and those with the most value should be emphasized. The advantages of selecting for characters high in heritability, exhibiting large differences among individuals and having high economic value are evident.

Tests from five experiment stations show that differences in ability to gain weight are caused largely by differences in inheritance, that is, the character is high in heritability. The work at McGregor reported in Bulletin 790 indicates that heritability of differences in gaining ability is about 50 to 55 percent. This is considered very high, as compared with most quantitative or measurement-type characters, and allows comparatively rapid improvement under intense selection.

Differences among individuals are large enough to make selection worthwhile. In the 1953-54 McGregor gain evaluation test, the high-gaining Hereford bull gained 3.1 pounds per day over the 140-day period, while the low-gaining bull on the same feed gained 1.0 pound per day. Such differences form the basis for selection.

Gaining ability has high economic value. For beef cattle of about the same age and degree of finish, weight at market time is the most important character. The ability of young beef cattle to grow or gain weight is the character that warrants most attention in selection, first, because it is important economically, and, second, because it is highly heritable and there are large differences among animals of the same breed. The economic value of gain can be measured readily in dollars.

RESULTS

Six annual gain evaluation tests have been completed, including 453 animals from cooperators and 825 raised at McGregor. The early tests were for 154 days. The present tests continue for 140 days after a 2-week adjustment period. All breeding animals have been fed a high roughage or growing ration. Part of the steers each year were fed a high concentrate ration. A typical ration consisted of about 65 percent Johnsongrass hay and Hegari fodder, 20 percent sorghum grain and 15 percent cottonseed meal. All ingredients were ground and mixed and self-fed without restricting the amount.

The emphasis in selection at McGregor has been on growth as indicated by gaining ability. However, when the herd was brought together in 1948, few animals with known or tested gaining ability were available. Calves from cows and bulls raised and tested at McGregor Farm are supplying information on the gain of the parent and the gain of its offspring. This gives an actual measure of the extent gaining ability of a parent is passed on to its offspring.

Animals fed in different years often gain differently. Also, animals of different sexes gain differently. For these reasons, it is necessary to evaluate an animal on its ability to gain in relation to the rate of gain of other animals which were fed the same way, at the same place, during the same period and were of the same breed and sex. This may be done by the use of a "gain ratio." A gain ratio shows how the animal compares with the average for the same breed and sex, and makes possible a comparison of 1 year's results with those from other years.

The gain ratio is computed for each animal by dividing its gain on test by the average gain on test of animals of the same year, breed, sex

and ration group and multiplying by 100. Examples:

Hereford bull No. 3089 gained 373 pounds in the 1953-54 test. All Hereford bulls gained an average of 343 pounds in this test. The gain ratio for No. 3089 is $\frac{373}{343} \times 100 = 112$.

Hereford bull No. 1047 gained 343 pounds.

His gain ratio is $\frac{343}{343} \times 100 = 100$

Thus, an average animal will have a gain ratio of 100 while any animal below average will have a gain ratio below 100, and one above average a gain ratio above 100.

To be most useful, the gaining abilities of both parents should be known. Table 1 gives the results from all tested offspring (whose sires and dams were also tested) through the 1953-54 test.

Table 1 illustrates several important things:

(1) Heritability appears to be about as first estimated. This is the test of the heritability estimates. The offspring were above average but not as far above as were their parents. They were not expected to be. The parents were 12.0 percent above average and the offspring were 6.8 percent above average. Stated differently, the offspring inherited 56.7 percent (6.8÷12=56.66) of the parents' superiority in gaining ability. In this case, heritability appears to be 56.7 percent, which is not greatly different from the estimate of 50 to 55 percent.

(2) Not every offspring is above average. It is not expected to be.

Each animal has its own individual complex environment, not all aspects of which are under experimental control. It is impossible to provide a perfectly uniform environment for all animals. This fact makes it possible for individuals to have by chance better or worse than average environments. This can account for some of the amount by which an individual's value is above or below average. The "average" offspring from selected high-gaining parents was a higher-gaining individual than the "average" offspring from all parents, which included those not selected for gain.

TABLE 1. GAIN RATIOS OF 10 PAIRS OF GAIN-TESTED PARENTS AND THEIR GAIN-TESTED OFFSPRING

Parent's gain ratio		Average of both parents' gain ratios	Offspring's gain ratio
Sire	Dam		
125	97	111.0	83
131	117	124.0	129
114	113	113.5	129
126	94	110.0	114
117	99	108.0	86
126	112	119.0	104
117	105	111.0	106
112	106	109.0	117
117	105	111.0	100
114	93	103.5	100
		112.0	106.8

Average gain ratio of all cattle tested	100.0
Amount that parents were above average	12.0
Amount that offspring were above average	6.8

(3) Some of the offspring have higher gain ratios than the higher parent. This allows selection to continue to improve. There is a limit somewhere but it is not in sight yet.

The data in Table 1 are valuable but are not based on enough animals to give final answers. The data summarized in Table 2 are based on animals with only one parent tested and include 206 parents and their 476 offspring. All of the calves were raised and tested at McGregor. The untested parents can be assumed to have been about average in gaining ability.

Figure 2. Heifers on test at Substation No. 23. Selection on individual gain records is effective with females as well as with bulls.

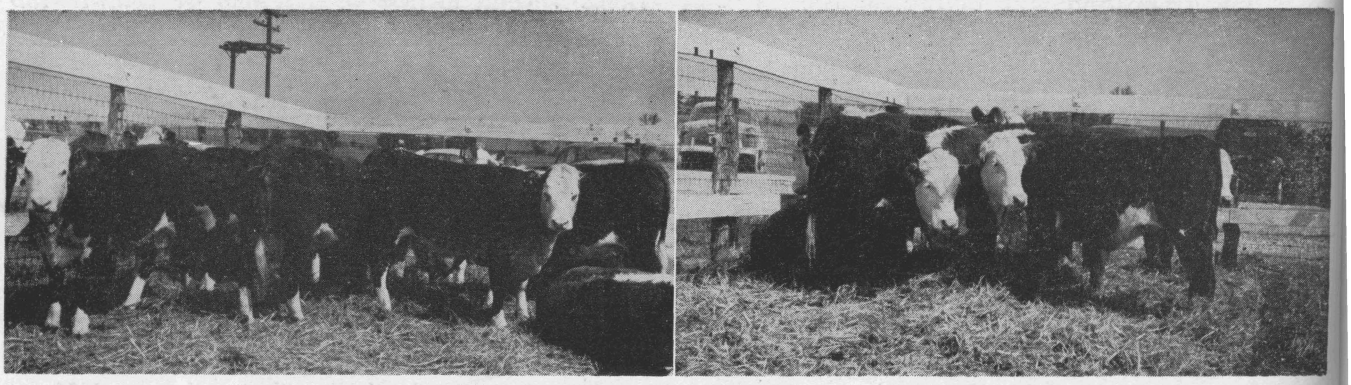

Figure 3. The Hereford steers and heifers on the left were sired by a selected high-gaining bull; the ones on the right were by a selected low-gaining bull. There was little difference in the appearance of these two groups but the scales told a real difference. Those from the high-gaining sire gained 14.4 percent more weight during the same period on the same ration.

These results include all available information from the herd through the 1953-54 test. No offspring were culled until after they were tested. The various heritability estimates agree well. Estimates from work in Texas reported previously and considered most valid are 52.9 percent from Balmorhea (Patterson *et al.*, 1955) and 53.8 percent from McGregor (Warwick *et al.*, 1955). If an animal is not tested, it is assumed to be average, regardless of its appearance. Parents not tested have had 444 offspring (including McGregor-raised calves) gain-tested at McGregor. These calves have an average gain ratio of 98, which is only slightly below the average of all calves tested.

RECOMMENDATIONS

Throughout Texas, beef cattle producers follow various systems of breeding and purchasing replacement cows and bulls. The significant points which fit all systems under which cattle are bred follow:

Select under practical production conditions. The breeder should keep in mind that he is breeding cattle to be used for beef production, directly or indirectly. Selection should be done under conditions similar to those under which the cattle or their offspring will be expected to produce. This would eliminate nurse cows. Creep feeding often is not desirable since this obscures the mother's milking ability which contributes to a calf's weight for age. Extra feeding and pampering should be avoided.

TABLE 2. AVERAGE GAIN RATIOS OF TESTED OFFSPRING AND THEIR ONE TESTED PARENT

Average gain ratio of 206 parents	104.9
Average gain ratio of 476 offspring	101.3
Amount parents were above average	4.9
Amount offspring were above average	1.3
Percent of parent's superiority in gaining ability which carried over to offspring $\frac{1.3}{4.9} \times 100 = 26.5$ percent	
Since only one parent was tested, heritability is twice the above value $2 \times 26.5 = 53.0$ percent	

Select at a practical age for production. Breeding animals should be selected at the age at which the producer sells his slaughter cattle. A mature animal should not be selected on the basis of size or looks. The decision to keep or cull should be made when the animal is 6 to 18 months of age—whenever the commercial cattle are normally marketed.

Obtain actual weights. Cattle are sold by the pound. The breeder should have scales or access to them to make accurate selections.

Determine ages of calves. Weight is important only in terms of age. It is not sound to estimate age according to the weight and then select calves on the basis of weight for age. Birth dates should be known. Figures should be compared for weight per day of age for calves that are not more than 3 or 4 months different in age up to weaning. After weaning, similar figures should be compared for calves whose ages are within 6 months of each other.

Compare animals on the basis of relative rather than actual gain. Cattle often make different gains in different years. Different sexes gain at different rates. Comparisons of actual pounds of gain should be avoided except for animals of the same sex which were fed together the same year. A gain ratio or some similar ranking method is useful. The important thing to consider is the animal's performance in relation to that of others in the same group, regardless of the number in the group. Relative or actual gains mean little for comparison purposes if the animals are not treated the same. Either feedlot or pasture gain is satisfactory since gain either place reflects inherent ability. Heavy grain feeding is neither necessary nor desirable.

Select on the basis of weight gain. This is the most important point. It does not matter whether weight per day of age or gain during a test period is used. Select the high gainers and cull the low gainers.

Select on the individual's gain record. Records can be obtained on breeding animals at early

ages. Long waiting and complicated progeny or offspring records are not necessary. An animal should be selected on the basis of its own gain. It is worthwhile to get progeny records to back up the individual's own record or to test an old sire that has no record of his own. However, it is not practical to wait for long complicated tests. It is simpler and just as effective to use the individual's own record.

Select both sexes. Gaining ability can be measured in bulls and heifers with equal accuracy. It is more important to select high-gaining bulls and the standards should be higher for bulls. However, for the 20 to 50 percent of the heifers that normally can be culled from a herd, the slow-growing, low-gaining ones should be discarded.

Keep selection simple and sound. The breeder should have accurate records. He should use them as the primary consideration in selection. Heritability is probably higher for gaining ability than any other character of economic importance and there are great differences among individuals.

Buy tested high-gaining bulls. Commercial producers look to the purebred breeders as a source of bulls. The purchaser should insist on some evidence that a bull is inherently a good gainer so that he will increase his chances of having faster-gaining calves which will be heavier at weaning or later market time. Feeders are beginning to look for this kind of breeding behind a calf and to pay a premium for it. The producer looking for a replacement bull should keep in mind the points listed previously. Some breeders are beginning to set up their own tests or to have some of their calves tested at PanTech Farms, Panhandle, Texas; Substation No. 9, Balmorhea, Texas; or Substation No. 23, McGregor, Texas. A permanent listing or registry from the McGregor test for all tested purebred calves is available as a supplement to Bulletin 790.

ACKNOWLEDGMENTS

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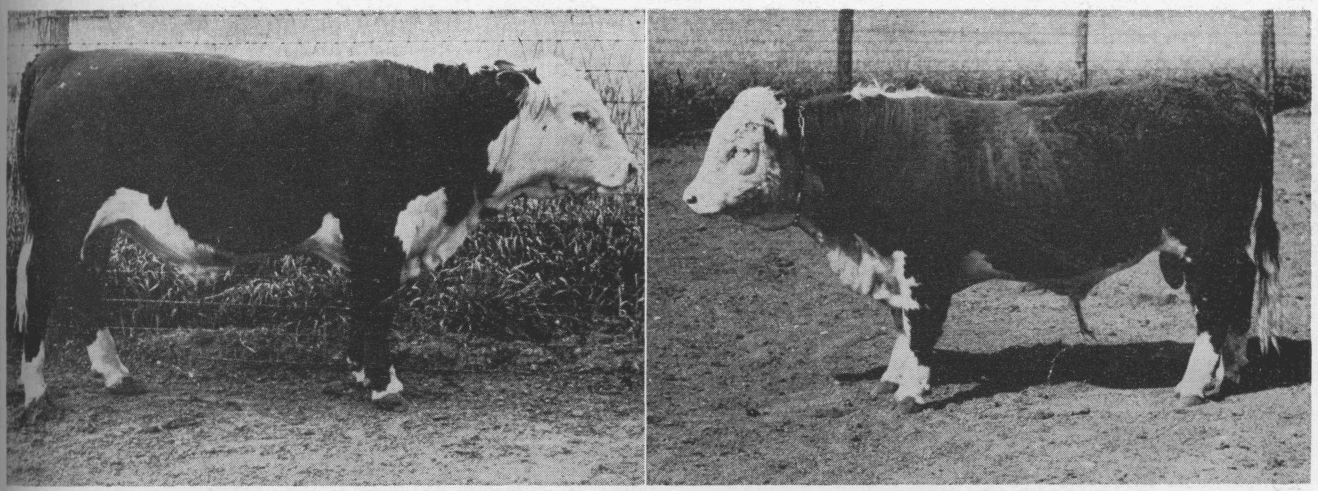
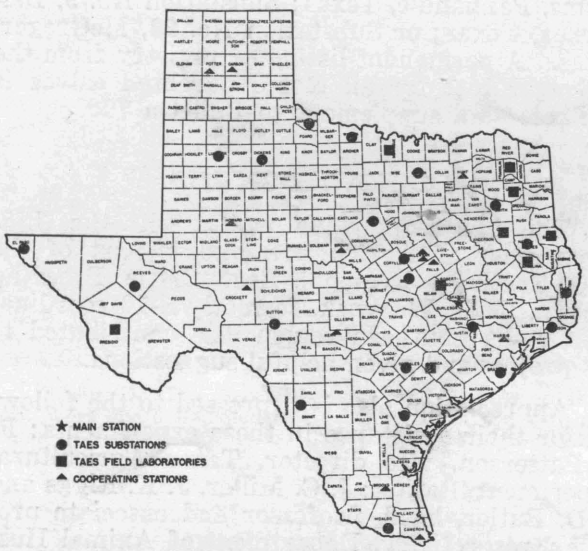


Figure 4. Which bull gained nearly twice as much as the other? These two registered Hereford bulls were fed in the 1954-55 gain evaluation test at McGregor. One made an average daily gain of 3.0 pounds for the 140-day feeding period. The other gained 1.6 pounds per day. There are large differences among cattle in their ability to gain weight. The heritability of these differences is high.



Location of field research units in Texas maintained by the Texas Agricultural Experiment Station and cooperating agencies

State-wide Research

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The Texas Agricultural Experiment Station is the public agricultural research agency of the State of Texas, and is one of nine parts of the Texas A&M College System

IN THE MAIN STATION, with headquarters at College Station, are 16 subject-matter departments, 2 service departments, 3 regulatory services and the administrative staff. Located out in the major agricultural areas of Texas are 21 substations and 9 field laboratories. In addition, there are 14 cooperating stations owned by other agencies, including the Texas Forest Service, the Game and Fish Commission of Texas, the U. S. Department of Agriculture, University of Texas, Texas Technological College and the King Ranch. Some experiments are conducted on farms and ranches and in rural homes.

RESEARCH BY THE TEXAS STATION is organized by programs and projects. A program of research represents a coordinated effort to solve the many problems relating to a common objective or situation. A research project represents the procedures for attacking a specific problem within a program.

THE TEXAS STATION is conducting about 350 active research projects, grouped in 25 programs which include all phases of agriculture in Texas. Among these are: conservation and improvement of soils; conservation and use of water in agriculture; grasses and legumes for pastures, ranges, hay, conservation and improvement of soils; grain crops; cotton and other fiber crops; vegetable crops; citrus and other subtropical fruits, fruits and nuts; oil seed crops—other than cotton; ornamental plants—including turf; brush and weeds; insects; plant diseases; beef cattle; dairy cattle; sheep and goats; swine; chickens and turkeys; animal diseases and parasites; fish and game on farms and ranches; farm and ranch engineering; farm and ranch business; marketing agricultural products; rural home economics; and rural agricultural economics. Two additional programs are maintenance and upkeep, and central services.

RESEARCH RESULTS are carried to Texas farm and ranch owners and homemakers by specialists and county agents of the Texas Agricultural Extension Service.