THE RELATIONSHIPS OF WEANING PRODUCTION FACTORS IN RANGE BEEF CATTLE

by

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INTRODUCTION

Livestock producers and research workers have been doing work in recent years to establish a more accurate appraisal of the producing ability of beef cows. The doing ability of beef cattle that are outwardly similar in conformation may show great variability. This variability in performance is the basis of selecting breeding animals to carry production to greater efficiency.

On the basis of work done, there is a general acceptance of performance and progeny testing as guides for improving the doing ability of beef cattle. This type of selection program may be called performance testing, gainability tests, or weight for age comparisons. The overall objective of production testing is to obtain information that can be used in the improvement of performance and thus reduce the cost of producing beef. The producing ability of beef cattle may be measured in several ways or by a combination of factors related to performance.

The characteristics considered to be of economic importance in this current study are weaning weight, weight for age, conformation, and condition scores adjusted to an uniform level to eliminate as much variability as possible due to temporary environmental effects. To increase the

efficiency of selection on the basis of outward appearance, the environmental variations must be reduced. A study of these factors gives a good indication of a cows mothering ability. The information is used in culling out the low producers in a herd while retaining those animals that have desirable characterisitics and the ability to transmit these traits to their offspring. The commercial beef cattle producers are interested in this type of selection program, which basically is to use facts instead of fancies in the finding of sires and dams that pass along to their progeny the capacity for gaining more weight in a shorter time on the least feed and of a desired grade.

Many outward expressions of traits of economic importance may vary in an individual animal due to the influence of certain environmental factors. Although it is difficult to measure all of the effects of environment, correction factors may be applied to weaning weights to standardize all records to a relative comparative basis as much as possible. The most important sources of variation are taken into consideration in the use of these correction factors. These sources include age of dam, sex, and age of calf.

Many beef cattle producers and research workers feel that the producing ability of cows and sires must be known early in their life if the records are to be of value in a

selection program based on performance. This study was undertaken to determine the relationships of weaning production factors in range beef cattle. An attempt also is made to evaluate some of the factors causing weight variations in calves at 270 days of age on Arizona ranges. The weaning age of 270 days was selected as this is a common weaning age for beef calves running on Southern Arizona desert grasslands.

Recently it has been shown that gains in body weight are highly heritable. Body weight, therefore, should be included in any selection index. Relationships between body weights and visual appraisal have not been definitely established. This is an attempt to provide additional information regarding this relationship.

REVIEW OF LITERATURE

Influence of Condition on Conformation Score

There have been very few studies reported in the literature concerning relationship between conformation scores by judges as influenced by condition. A few authors present information relating the effect of condition of animals as influencing the judges opinion on conformation score.

Green (1957) states that calves at weaning were given a condition score by the judges along with a score of conformation. Observations made during previous scorings of cattle have indicated that the degree of fatness may have an influence on the score given an animal for conformation. This publication further states that it has been indicated at numerous times that fat animals may receive scores higher than they probably would if they were in a less fat condition. Practically all of the animals in the Maryland study were given a condition score of "1" by all judges on each date scored. In this particular study, it was pointed out that conformation scores were probably affected little by differences in the degree of fatness between animals or by changes in the degree of fatness from one scoring period to another.

Gifford et al. (1951) reported highly significant differences in seasonal scoring levels of different judges in scoring beef type cows. A suggested explanation of these differences was the changes in the condition of the cows at the summer and winter scoring dates. However, the variance associated with these seasonal differences in scores accounted for less than 10 percent of the total variation in conformation scores.

Rollins and Wagnon (1956) reported a within years correlation of .42 between weaning grade and weaning weight. Brown et al. (1956) indicated a consistent positive relationship between weight and score. The accuracy of associating weight with condition at this point is, however, questionable.

Variation in Judges Scores

Published data are also limited on the correlations of conformation scores among judges scoring calves at weaning.

Brown et al. (1956) studied the relationships between conformation scores of judges and live animal measurements in which data from four experiment stations, consisting of records on 383 calves and 342 older beef cattle, were used. The average correlations between scores and weight, chest depth, body width, and fulness of round were positive but of limited predictive value. Multiple

correlations between all measurements and conformation scores varied from .38 to .76, thus accounting for 14 to 58 percent of the variance in scores.

The Hereford herd at the Arkansas Agricultural Experiment Station was used in an extensive study of classification scores by Gifford et al. (1951). The purpose of the study was to obtain data on (1) the agreement between judges, (2) the repeatability of judges in scoring, and (3) the cause of variation in conformation scores. The study covered a period from 1940 through 1949 in which 187 animals were scored and some of the animals were scored as many as 18 times.

Within season correlations indicate that the four judges scoring the cattle more than two times were in general agreement on the points of conformation scored. The judges agreed more closely for those items on which they must consider the entire animal. They were best able to recognize differences in overall ratings, followed by general appearance, breed type, body, hind quarters and fore quarters. A study by Knapp et al. (1939) of the accuracy of scoring certain characters in beef cattle resulted in findings that agree with the above results.

The repeatability of a judge was measured by the correlation between the scores which he gave the same animal but on different classification dates. These

correlations were found to be between 0.40 and 0.50. The results indicated that there was more agreement between the judges on a given classification date than they were able to agree with their previous scores. Stage of lactation, stage of pregnancy, and age of cow were factors tending to lower the repeatability of scores on different dates of classification. All judges seemed to be affected in about the same manner and none of the judges appeared to be able to evaluate properly the effect of these temporary conditions.

The interaction of cows with season and seasonal differences in scoring level were sources of variation. Cow differences accounted for 50 percent of the total variation in conformation scores.

Dahmen and Bogart (1952) concluded that weaning score did not have a significant effect on either rate or economy of gain during a test with 74 beef calves individually fed. It was also observed that the appearance of these calves was not reliable as an indication of their efficiency or capacity for growth. These authors found that there was greater variation among those scoring than total score variation among the calves scored. Thus, scoring technique is subject to considerable error and of doubtful value when the animals being scored are quite similar.

Averages of the scores of three judges indicated that the different judges were not in too great a degree

of agreement concerning the relative merit of different animals.

Scores of three different judges, as reported by Green (1957) of the Maryland Agricultural Experiment Station, indicated that they did not agree closely concerning the relative merit of different parts of the body of calves scored. Two scorers tended to give calves a "too high" a score while the third judge was in line with the estimated score. In comparing the actual with the estimated scores, it was found that 15 to 20 percent of the calves were given scores which deviated a reasonable amount from the estimated scores. An example of some points of disagreement among judges, one judge indicated that, in his opinion, the calves in general type and head and neck averaged the same while another judge considered head and neck more desirable than general type. One judge indicated that the calves averaged between a score of "2" and "3" in all parts of the body considered while another scorer judged the animals to be below "3" in all but two categories. There were other disagreements among the judges such as uniformity of the conformation of the calves scored.

Roubicek et al. (1951) in making progeny studies in Wyoming analyzed measurement and performance data of 46 Hereford and 35 Shorthorn offspring of two Hereford and two Shorthorn bulls. They obtained negative correlations of

conformation and quality scores with efficiency which may indicate the inability of the judge to select "good doers" on the basis of phenotype. The general trend appeared toward less efficient animals if judges' opinions are the sole basis for selection. The judges in placing feeder grades on the heifer progeny were unable to appreciably indicate the actual efficiency of those heifers. A low correlation of .15 of initial feeder conformation score to percent of round was found and conformation correlation to percent of loin was a -.07. There was consistently poor agreement between the judges' evaluations of the grade and the actual rate and efficiency of gain. However, a significant correlation of 0.49 was found for the final conformation score with the percent of loin and rump in working with the Shorthorn steer progeny and a correlation of 0.42 of the same factors in the Hereford steer progeny.

In general, the results seemed to indicate that the more upstanding calves at weaning time grew the least in height during the feeding period, yet made faster and more efficient gains. Also, the narrow and shallow chested heifers of both breeds scored down by the judges at weaning were the more efficient ones in the feedlot.

Contrary to the above negative correlations of conformation and quality scores with efficiency, Black and Knapp (1936) earlier found a positive correlation of 0.56 for these factors.

Heritability of Grade and Type in Beef Cattle

Conformation, type, or grade in beef cattle breeding operations cannot be ignored in view of its economic characteristics associated by many cattlemen to quality and early maturity. The changes that have taken place since the time of Robert Bakewell in quality, size, and shape of beef cattle indicate that these characteristics are heritable. Body conformation or type of beef cattle is still a factor of economic importance. Galgan et al. (1952) state that eye appeal is still important in a discriminating market which wants an animal to produce the type of carcass demanded by the consumer. It is generally agreed that depth and width of body of a beef animal will produce a carcass with a high percentage of yield of preferred cuts.

A study was made by Knapp and Nordskog (1946) of the heritability of live animal scores along with other characteristics in beef cattle. Records were available on 177 calves from 23 sires to estimate the relative effect of heredity on conformation score at weaning and other factors. The heritability of weaning score was found to be 53 percent by using the paternal half-sib correlation from analysis of variance. The regression of the weaning score on the sire was negative ($b = -0.07$).

Tyler and Hyatt (1948) reported a study in dairy cattle breeding in which the objectives were to determine

the heritability of type and the correlation between type and production. Animals used in making a heritability estimate of type included 3,738 classified paternal sisters and 1,601 cows of classified dams. A heritability of 0.30 was estimated, thus offspring inherit about one-third of the observed superiority of the parents' type. Herd improvement in the type of dairy cattle can be made by the selection of animals that are above the herd average in type for parents of the next generation.

Correlation coefficients of 0.16 to 0.19 were found between classification rating and production of butterfat in which data on 5,177 cows were available. Within herds there was an average increase of 13 pounds of butterfat for each increase of one grade of type.

According to Riggs and Maddox (1956) slaughter and carcass grade are determined by conformation, finish, and quality of cattle. Cattle of the most desirable beef conformation can be fattened sufficiently to make them grade prime or choice which in turn yield carcasses which grade prime or choice. Cattle of undesirable beef conformation cannot be made to produce prime or choice carcasses no matter how fat they become.

A study by Knapp and Black (1941) of factors influencing rate of gain during the suckling period seemed to indicate that when selection of replacements was made during the suckling period, the calves selected were those

that made the greatest gain. These calves were from cows which gave the most milk but scored the poorest for beef conformation. This method of selection may indicate that future offspring will be high milk producers but also would result in poorer beef qualities in the herd.

Knapp and Clark (1951), in working with 613 record of performance steers from 83 Hereford sires in Montana, concluded that there is little value in selecting feeders for rapid gain if sole dependence is placed on visual method of selection. However, they obtained a heritability estimate for conformation score of 31 percent. Similar conclusions had been made earlier by these two authors (1950) in which a heritability estimate was obtained by the half-sib correlation method for weaning score to be 28 percent. They also concluded that growth measures were more highly influenced by heredity than were measures of quality and conformation.

Bogart and Elings (1953) indicated that the market price of our beef cattle is based largely on grade and that quality is every bit as important as pounds of meat. Consequently, selection must be made on the basis of grade as well as gaining efficiency. They pointed out further that conformation and quality along with rate and efficiency of gain are important inherited characteristics.

Preliminary results by Koger and Knox (1952) showed selection for compactness in Hereford cattle to be highly

effective, indicating a relatively high heritability of body proportions. A heritability estimate for grade of 24 and 23 percent was obtained in working with records from 1,257 calves and their dams. The former estimate is based on paternal half-sib correlation while the latter is based on an offspring dam regression. These estimates are substantially lower than for the corresponding overall score which they found with Angus cattle and slightly lower than the estimate by Knapp and Clark (1950) of 28 percent already mentioned.

In this same study, weaning scores were obtained from 715 Angus calves and their dams running on semi-desert range. The heritability estimates for scores were also based on an offspring dam regression coefficient and paternal half-sib correlation. The heritability estimates obtained respectively of the two methods mentioned were as follows; overall weaning score, 50 and 30 percent; lowness score, 46 and 13 percent; thickness score, 15 and 10 percent; and smoothness score, 15 and 18 percent.

One interesting feature of these data was the variation in estimates for different years. Whether the association with feed conditions was coincidental is not known but it raises again the question of relative adaptability under different conditions.

In earlier work, Koger and Knox (1947) concluded that differences in maternal influences were expressed more

freely in weaning weights than in grade, since all cows seemed to give sufficient milk for the calf to reach the grade allowed by its conformation.

Rollins and Wagnon (1956) presented heritability estimates of weaning grade in two experimental Hereford herds in California to be an average of 36 percent. Their data included weaning grades of 577 calves collected from 1937 through 1947 in two herds referred to as A and B. Over a two generation span, progress in improving grade in Herd A was 20 percent greater than expected while progress in Herd B was 12 percent less than expected. Management of the two herds varied in that Herd A was maintained at a slightly higher level of nutrition than Herd B. This may suggest that heritability of weaning grade may be higher under the more adequate nutritive conditions as the weaning grade progress was greater as well as the fact that the heritability estimates within generations were consistantly higher in Herd A. The heritability estimate of weaning grade over a period of two generations in Herd A was 42 percent and in Herd B 29 percent. These estimates of heritability compare favorably with those reported by Knapp and Clark (1950) and Koger and Knox (1952) which have already been discussed.

Age of Dam Influence on Weaning Weight

The cows used in this study ranged in age from three to nine years. Age of dam along with age and sex of

calf were used in adjusting the weaning weights to 270 days. These adjustments in weight were made in accordance with methods discussed by Pahnish (1958) in a more extensive study of performance factors of the two Arizona herds. His analysis of data revealed that the trend in age of dam influences was similar for both male and female calves.

A number of experiment stations are in general agreement as to the age of dam influence on the weaning weights in calves. To overcome the relative disadvantage of the weaning weight of the calves produced from young or old cows, a correction factor for age of dam should be used in putting the weaning weights of calves in a herd on a relative basis.

Dairy cattle have been shown to reach their peak of milk production during their 6th, 7th, and 8th year of age.

Various authors have reported on the influence of age of dam on the weaning weights of beef type calves. The general conclusion of their findings has been that cows between six and eight years of age produce more milk for their calves and that weaning weight is largely influenced by this greater milk availability.

Heavy weaners are indicative of the milking ability of the cow according to Bogart and Elings (1953). The daily gain up to weaning can be calculated by subtracting the birth weight from the weaning weight and dividing by the

age in days. This gain from birth to weaning is a reliable indication of the milk produced by the cow and to a lesser extent the growthiness of the calf.

Gregory et al. (1950) related heavier birth weights with heavier weaning weights. Cows making smallest gains during the nursing period tended to produce calves making largest gains from birth to weaning. This was probably due to increased milk flow among these cows studied.

Koch (1951) pointed out the extent to which the weaning weight of the calf is a permanent characteristic of its dam is an important part of the problem of selecting cows to improve their productivity. The younger the cow when her producing ability can be known accurately, the more efficient the selection can be. The weaning weight of the calf is a useful measure of a cow's yearly production, since this observation is taken at the end of the period over which she exerts maximum influence of the growth of the calf. Many range calves are sold at or shortly after weaning and their weight determines to a large extent the amount the owner receives. This author analyzed weaning weight data obtained from 745 calves produced by 180 purebred or high grade Herefords at the U. S. Range Livestock Experiment Station, Miles City, Montana. The differences between cows accounted for 52 percent of the variance in the calves corrected weaning weights. Therefore, the extent

to which the weaning weight of calves is a permanent characteristic of range Hereford cows, as determined from this study, is 0.52. The repeatability of 0.52 is based on differences between cows which made their records during a 10-year interval and may, therefore, be slightly high for comparing cows born in the same year.

In light of certain estimates and analysis of the effect of the dam age on lactation, Rollins and Guilbert (1954) concluded that the lactating ability of a cow makes a major contribution to the growth of the calf throughout the entire suckling period.

Riggs and Maddox (1956) stressed milk production as the biggest single factor influencing weaning weight of calves and that its heritability scarcely can be questioned.

Gifford (1953) concluded that the peak of milk yield is reached by Hereford cows at about seven to eight years of age. In other work by this author (1949) an insignificant correlation of milk production of beef cows with the suckling gains of the calves after the calves reached 120 days of age was found. He suggested caution in estimating too strongly the importance of milk yield after four months of age.

Sawyer et al. (1948) found a regression of 1.28 pounds per day of weight on age along with the fact that younger (two year old) cows weaned calves 75 pounds lighter than mature cows. The weaning weight of calves increased

with increasing age of dams through eight years but then declined. Other authors indicated that the weaning weight of a calf is greatly influenced by the age of its dam.

Knox et al. (1951) reported very little difference among weaning weights of Hereford calves weaned by cows between the age of six and eight years. This work was done on New Mexico ranges and showed that the seven-year-old cows produced the heaviest calves. Knox and Kroger (1945) showed earlier that the age of maximum weight and production of range cows was also six to eight years with a peak at seven years. Knapp et al. (1942) in a Montana Hereford study found that weaning weights reached a maximum from six-year-old cows. A gradual increase was noted from two to six years of age and a more rapid decrease from six to eleven years.

Lush and Shrode (1950) stated that milk production during a dairy cows lactation period increased with age at an ever-decreasing rate until maximum yield is reached at around six to eight years. Production then declines with advancing age. The regression of production on age is distinctly curvilinear.

Nelms and Bogart (1956) in Oregon trials reported early calves gained at higher rates than later calves and also that the influence of age of dam on suckling gains was insignificant. The calves from two- to three-year-old cows gained faster than had been anticipated which was

probably due to the fact that the younger cows had been selected for gaining ability while the older cows were not. This in itself may account for the difference in the performance of the calves.

Influence of Sex on Weaning Weight

Although adjusted weights are only a minor part of this current study, it may be appropriate to relate data pointing to the necessity for a sex adjustment factor. As previously mentioned, all weights of calves were adjusted to 270 days in this study as this is a common weaning age on Arizona ranges.

The weaning weights of the calves involved in the Boise herds experiment clearly indicate a difference between sexes.

Pahnish (1958) found the average weight of bull calves to be greater than that of the heifers in data presented with work on the two ranches in this study. He reported that the difference between weights of the two sexes changed from year to year on the Empire Ranch, ranging from 44 to 99 pounds over a six year period. The sex difference was consistently greater on the Empire than on the Arivaca Ranch from 1952 through 1954, the period of this current study. Although the Empire Ranch produced the heavier heifer calves in 1953, the Arivaca Ranch produced the heavier calves of both sexes in all other cases. In

general, he found Arizona range bull calves to be 28.8 pounds heavier than heifers at 205 days of age.

Knapp et al. (1941) found a highly significant influence of sex on the gains of 58 Shorthorn calves from birth to weaning at the U.S.D.A. Station at Beltsville, Maryland. The analysis of data showed differences between sexes were statistically significant, whereas differences between the progeny of different sires was not.

In work with Montana Range Herefords, Knapp et al. (1942) reported bull calves to be 22 pounds heavier than heifer calves and that seven percent of the variation in adjusted weaning weights to a constant age was accounted for by sex difference. Later, in analyzing 180 day weaning weight data from 745 Montana calves, Koch (1951) reported bull calves to be 44 pounds heavier than heifer calves of the same age and 31 pounds heavier than steer calves.

Rice et al. (1954) reported range Hereford bull calves under southwestern conditions to be 28.8 pounds heavier than heifer calves at 205 days of age.

Koger and Knox (1945) in a study of the effect of sex on weaning weight of range calves, calculated a regression coefficient of 1.21 pounds per day of weight on age of New Mexico steer and heifer calves. They used this regression coefficient in adjusting weaning weights of calves to 205 days at which time the heifer calves weaned 32 pounds lighter than did the male calves.

Sex effect was found by Burgess et al. (1954) to agree in direction but differ in degree from other studies as steers weighed only slightly more than heifers at the same age.

Other work reviewed showed males to be heaviest in weaning weight. Significant differences in rate of gain prior to weaning have been observed with male calves gaining at a more rapid rate (Black and Knapp, 1936, and Bloom, 1953). Koch and Clark (1955) also found that male calves were significantly heavier at weaning. Botkin and Whatley (1953), in working with 701 weaning weights of Oklahoma range Herefords, reported a mean difference between steer and heifer calves of 25 pounds at 210 days of age. The steer calves were the heavier. Contrary to the findings of many authors, Sawyer et al. (1948) in work with Oregon Herefords relating sex to weaning weight, found that steer calves were lighter at weaning but the difference was not statistically significant.

Guilbert and Gregory (1952) reported data on growth and development of purebred Hereford cattle maintained under favorable and fairly uniform conditions of environment in California. The average growth curve of approximately 75 bull and 100 heifer calves from 1 to 24 months of age was as follows: at one month of age the heifers were 97 percent as heavy as the bull calves; four months, 89 percent; eight months, 87 percent; and twelve months, 77 percent. This

indicates that heifers correspondingly are lighter than bulls as they both grow older.

Age of Calf Influence

In most commercial and purebred beef cattle cow and calf operations, it is impractical to wean calves individually as they reach a given age. The calves are commonly weaned at the same time and there may be a great deal of variation in ages. Several authors have reported linear weight-age relationships and methods have been devised for standardizing weaning weights to a constant age to reduce variation due to age.

In early work done with beef cattle in Southwest Texas, Lush et al. (1930) reported on the growth of cattle from birth to about 30 months of age. Weights were taken regularly eight times each year from 1921 through 1929. It was found that the average growth curve of Brahman, Hereford, and back-cross calves showed a straight line increase until about July 15. The growth rate from this date on to weaning time in October was somewhat less and the three different kinds of breeding showed almost parallel changes in weight.

Koger and Knox (1945) obtained an average intra-class regression of weight on age of 1.33 pounds per day. These findings were based on the analysis of 800 weaning weights that were classified by year, sex, and age of dam.

Analysis of weaning weights by Knapp et al. (1942) of 770 Montana Hereford calves showed that age at weaning

to be one of the significant factors influencing weaning weight. They found a positive correlation of 0.49 between weaning weight and weaning age.

Johnson and Dinkel (1951) analyzed data in which the monthly weights were taken from birth to weaning on 297 high grade and purebred Hereford calves. The average weaning weight at 185 days of age was 379.7 pounds. The object of their study was to obtain a growth curve from birth to weaning and to calculate correction factors for adjusting weaning weights of range calves to a standard age. The results showed a growth curve of the calves to be approximately a straight line up to 155 days of age and thereafter increased at a decreasing rate. The findings indicate that the growth curves at or near weaning age are constant enough to allow weaning and weighing calves on a given date and correcting weights to a standard age without much loss of information.

Botkin and Whatley (1953) obtained a regression coefficient of 1.46 pounds of weight on age. These results were found with Oklahoma range steers and heifers from 120 to 260 days of age.

Rollins and Guilbert (1954) in analyzing the unadjusted data found the average rate of growth from birth to four months of age to be 1.91 pounds per day with a standard deviation of 0.31 of a pound. The average 240 day weaning weight was 534 pounds with a standard deviation of 70 pounds.

Each calf weight was standardized to 120 and 240 days of age with its own successive monthly weights used for a linear interpolation.

Pahnish (1958), working with Arizona range cattle, classified unadjusted data by years and ranches within sexes and then assembled the data within each subclass in 20-day age arrays. In plotting the mean weights against corresponding mean ages, he obtained a distinct linear weight age relationship.

Heritability of Weaning Weights

Rice et al. (1957) defined heritability as that fraction of the observed phenotypic variance which results from differences in heredity--among the genes and gene combinations of the individual genotypes as a unit. This is the broad concept of heritability in which the hereditary variance is considered as the sum of the additively genetic, the dominance, and the epistatic variance.

It is this variability, associated with the additively genetic differences in the phenotype, that is closely associated with the potential improvement which can result in a population by selection.

Several research workers have pointed out varying degrees of estimates of heritability of weaning weights. These estimates have ranged from zero to 52 percent with the average heritability of weaning weights to be around 26 to 30 percent.

The fact that weaning weights are probably influenced by heredity, which suggests the transmission of biological traits from ancestors to descendants, has also been pointed out by several authors.

Gregory et al. (1950) in working with two Nebraska Hereford herds obtained heritability estimates for weaning weight of .26 and .52. These estimates were obtained from paternal half-sib correlations. They also found insignificant differences between sires for weaning weight or gain from birth to weaning of their get.

Montana studies by Knapp and Nordskog (1946) with Hereford cattle at the U.S. Range Livestock Experiment Station at Miles City only resulted in a .12 heritability of weaning weights. This estimate was also made by the paternal half-sib correlations. Heritability estimate of weaning weight obtained from sire:progeny regression was zero but when adjustments were made for differences in feeding for the sires each year, the heritability was found to be 30 percent for weaning weight.

A report by Dawson et al. (1954) of a Louisiana study was made dealing with comparable weights of 446 six-month-old calves obtained from 1945 through 1950. From sire offspring regressions and paternal half-sib correlations of immediate offspring, the heritability of six month weights was estimated as zero. The estimate of heritability was from 5 to 15 percent based on dam-offspring regressions.

Paternal half-sib correlations among daughters of the sires used and based on the weights of calves raised by the daughters gave a heritability estimate of 19 percent. These latter figures indicate the importance of maternal abilities in determining six month calf weights and suggest that they are heritable traits.

Dinkel and Musson (1956) found a higher heritability figure in work with Hereford cattle in South Dakota. They attributed about 36 percent of the differences in the weaning weights of calves to inheritance.

Botkin and Whatley (1953) made an estimate of repeatability for weaning weight of 0.43 and 0.49 in a study of 701 calves produced by 200 Oklahoma Range Hereford cows.

Knapp and Clark (1950) in their revised estimates of heritability of economic characteristics in beef cattle, obtained by the half-sib correlation method a weaning weight estimate of 28 percent. Lower fiducial limits of weaning weight heritability ($p = .01$) based on the half-sib correlation method was 7 percent.

Koger and Knox (1947) measured repeatability of weaning weight of calves from range Hereford cows. The average correlation between the weights of consecutive calves by the same cow was 0.09. Gregory et al. (1950) obtained values ranging from 0.37 to 0.50 for the correlation between various calves from the same cow.

A genetic analysis was made by Rollins and Wagnon (1956) of weaning weight in two experimental range herds of similar breeding. Only difference in management was that one herd and cows were supplemented during winter when the range was deficient, while the cows in the other herd were not supplemented.

The data were standardized for differential effects of pasture, year, sex, age of calf at weaning, and age of dam.

Heritability of weaning weight was estimated to be .30. The experimental evidence did not support a hypothesis that the nutritive level at which a herd is operated influences the heritability of weaning weight.

Evidence was presented that in a herd operated under optimum nutritive conditions, replacement heifers can be selected earlier and more effectively than in a herd operated under sub-optimum nutritive conditions. The relevant statistics are: repeatability of weaning weight was estimated to be .51 in the herd receiving supplement and .34 in the herd not receiving supplement, and regression of offspring's weaning weight on dam's weaning weight was estimated to be .42 and -.06, respectively.

Relationship Between Weight and Score

Conformation score and weaning weight are important inherited characteristics. This has been pointed out in the literature review on the heritability of each of these

factors. There is not a great deal of literature available by authors presenting a definite relationship of one to the other. However, Knapp and Nordskog (1946) in working with Montana steers found considerable variation in weights of steers from different sires and from the same sires. This variation was under management conditions where all steers were marketed at the same time. These writers observed that final weight and feedlot gain both had an effect on slaughter grade and carcass grade. The steers that weighed the most at the end of the feeding trial usually graded higher than a small steer of the same age. The following correlations, considered highly significant by the authors, were obtained: conformation score at weaning and weaning weight 0.68; slaughter steer grade and final feedlot weight 0.64; and carcass grade and final feed lot weight 0.54. These workers pointed out that a substantial part of the variance in scores and grades is accountable to weight.

The relation between weaning weight and weaning grade was studied by Rollins and Wagnon (1956) with data available on 577 calves produced in California. Steer calves averaged higher in grade than heifers. The authors indicated this sex difference in grade was largely due to difference in weight. A variation in weight and grade was observed between years due to the influence of the nutritive conditions of the ranges, yet improvement in weaning grade by selection did occur but was confounded with the effects

of the yearly fluctuations in weaning weight. On a within year basis, it was found that 18 percent of the variance in weaning grade was due to variation in weaning weight.

Somewhat similar results were found by Koger and Knox (1952) in studying the weaning grades of 715 calves and their dams of Angus breeding in northern Mexico. One interesting feature observed in their data was the variation in estimates of grade for different years. When forage was scant because of drought, regression of calf score on dam was low and in one year it was negative. During years when forage was average or above, regression varied from .18 to .22. These yearly variations indicate the effect of feed availability on weight of calves and cows and the changes in regression of grade scores relative to these conditions.

Conformation scores given to 383 calves at weaning and 342 older beef type cattle at the Arkansas, Tennessee, Maryland, and North Carolina Agricultural Experiment Stations were studied by Brown et al. (1956). The study was more on the relationships between conformation scores and live animal measurements of beef cattle but certain inferences were made as to weight and score relationship. The correlation coefficients observed seemed to indicate a tendency for the judges to favor cattle that are heavy, deep, wide in body, and full in the round. Eleven and one-half percent of the variance in type score of the older cows was accounted for by differences in weight. The

average correlation coefficient of weight with score estimated from data of all four stations was about 0.30. These authors stated that apparently most scorers consciously or unconsciously gave weight considerable importance in arriving at a conformation score. Furthermore, the rather consistent positive relationship between weight and score both grossly and independent of other measurements is at variance with the common held viewpoint that small cattle are favored in type evaluation.

MATERIALS AND METHODS

The current study is based on two herds of purebred Hereford cattle made available for research under a cooperative agreement with two Southern Arizona ranches, namely, Empire and Arivaca. Over a period of three years (1952-1954), weaning weights, conformation scores, and condition scores were collected on 164 bull calves and 161 heifer calves produced on desert grasslands of the two ranches. These ranches are located in an elevation area of about 4000 feet. These calves were the progeny of six registered Hereford sires, some of which were used for more than one year. A minimum of four sire groups were involved each year of this study.

The two ranches upon which this study is based were originally one ranch called The Chiricahua Ranches Company of Sonoita, Arizona. Frank S. Boice of Sonoita and Henry G. Boice of Arivaca, Arizona, became the owners and operators, respectively.

The general management methods applying to both ranches have been summarized by Pahnish (1958).

Management Procedure:

The breeding season for both herds covered the period from about April 10 to August 1 of each of the

three years of this study. The cow herd was later divided into two groups; (1) cows with heifer calves and (2) cows with bull calves. The cow herd was subject to the usual selection and culling processes. The culling was done mainly at the beginning of the breeding season. The weaning index, based equally on conformation score and weaning weight adjusted for age of calf and age of dam, was used as one of the additional factors in evaluating the dam.

Calving procedure:

The cow herd was checked daily during the calving season which began around the middle of January of each year. The birth date, sex of each calf and the dam of the calf was noted and recorded and the calf was numbered at this time. Approximately 70 percent of the calves were born within 50 days of the mean birth day. The calves were branded and tattooed at the end of the calving season.

Collecting weaning data:

The calves were weaned between November 29 and December 4 at which time they were identified with their dam and branded with a number for identification.

Weaning weights were taken and a committee of three judges scored the calves on the basis of conformation and condition. An average of three judges scores on conformation and the weights were used in evaluating the calves as possible herd replacements.

Range nutrition:

Forage for grazing on the two ranches included varying amounts and density of the following plants: black, side oats, hairy, blue and spruce top grama, Curley Mesquite, False Mesquite, and Sacaton. Moisture conditions and season of the year greatly influenced the availability of the more palatable and desirable plants. Some pasture supplement in the form of salt, trace minerals, dehydrated alfalfa and cottonseed meal was provided during the winter. A system of pasture rotation from year to year was used to reduce any major influence of pasture on the difference in performance of the herds.

Scoring procedure:

(1) Conformation: The score card used has a range in values from 1 to 15 (Fig. 1). A score of 15 indicated the animal was equal in conformation to an "attainable ideal" for the category of body type. It was assumed that feeder grade standards of perfection for body type was followed by all three scorers.

(2) Condition: The score card also has a range in values from 1 to 15 (Fig. 1). Condition score is simply an estimate of the degree of fatness of the animal. A score of 15 indicated that the animals carried a very satisfactory degree of fatness.

The three judges were men of several years experience in scoring in various performance testing programs

Beef-Cattle Scoring Form

Animal No. _____ Sex _____ Age _____ Date _____

Temperament _____ Color _____

Remarks _____

Grader _____

Conformation Score		Condition Score	
Prime (Fancy)	15 14 13	Excellent	15 14 13
Choice	12 11 10	Very Good	12 11 10
Good	9 8 7	Good	9 8 7
Medium	6 5 4	Fair	6 5 4
Common & Cull	3 2 1	Poor	3 2 1

Figure 1. Beef Cattle Scoring Form for Scoring Conformation and Condition.

and remained as the same three judges throughout the entire three year period of this study. One judge is a professor of animal science, another, a lifetime commercial and purebred rancher, and the third judge is a professor of veterinary science. These three men comprised the judging committee.

Statistical procedure:

The data for conformation, condition, and weights at weaning, collected over a period of three years, were coded and recorded on punched cards to permit computations on International Business Machines. A card was punched for each individual animal with the following information: identification of the calf, sire and dam, age of calf, weaning weight, conformation score, condition score, and various remarks that may be of value in further study.

The statistical analysis was the usual correlations and analysis of variance with a nested classification with disproportionate subclass numbers according to Snedecor (1956) and Anderson and Bancroft (1952). The values for the following were found: heritability estimates of conformation and condition of bull and heifer calves, correlation between conformation score and condition score, actual weight and adjusted weight, and between condition score and actual weight and adjusted weight. Also, correlations between judges were calculated.

RESULTS AND DISCUSSION

A large number of cattlemen attempt to project the future value of an animal in their herd by the degree of conformation desirability of the calf at weaning. In view of the literature presented, there is a great deal of conflict to this thinking as well as some agreement.

Roubicek *et al.* (1951) obtained negative correlations of conformation and quality scores with efficiency in a Wyoming study with Hereford and Shorthorn cattle. There appeared to be a general trend toward less efficient animals if judges' opinions are the sole basis for selection. Their results indicated that the more upstanding calves at weaning time and the narrow and shallow chested heifers of both breeds were the more efficient ones in the feedlot. Certainly, those calves that are narrow and shallow through the chest along with those quite upstanding calves are the kind receiving the lowest conformation scores by judges basing their judgment on showring standards. On the other hand, Brown *et al.* (1956) found positive multiple correlations between all body measurements and conformation score to vary from 0.38 to 0.76 and accounting for as much as 58 percent of the variance in scores.

It is common knowledge among cattle feeders that thin calves will generally make more rapid and efficient gains than fat calves of the same age and quality. Also, rate and efficiency of gain are highly indicative of net profit and are economic factors for which the feeder is aware. Looking at the economic aspect from the producers standpoint, his net profit will be greater for those calves grading and weighing more. Feeder buyers will usually pay a higher price for thin cattle of equal quality than for cattle carrying a high degree of bloom. This fact is reflected in our auctions and terminal markets throughout the country. The work by Roubicek et al. (1951) does not point out a comparison of the condition of the calves used in the feeding trials as to this degree of fleshing and the conformation scores received.

Both ranches under study follow the management practice of selling calves at weaning time and the ranch operators consider the matter of score as being of economic importance as the cattle are sold and purchased on a grade and weight basis. In view of the association as previously pointed out of type and quality by many feeders, it is economically sound for a rancher to continue to consider grade with weight at the present time.

Correlation Coefficients:

Correlation coefficients between conformation scores of calves at weaning and condition score, actual weight, and

adjusted weight are presented in tables 1 and 2. Also found in these tables are correlation coefficients between condition score and actual weights and adjusted weights.

Table 1. Conformation score, condition score, actual weight, and adjusted weight correlations of weaning heifer calves within herds and years.

	Condition Score	Actual Weight	Adjusted Weight
Conformation Score	.70	.37	.42
Condition Score	---	.60	.57

Table 2. Conformation score, condition score, actual weight, and adjusted weight correlations of weaning bull calves within herds and years.

	Condition Score	Actual Weight	Adjusted Weight
Conformation Score	.62	.20	.28
Condition Score	---	.52	.54

The correlation coefficients of scores and weights are positive in all cases in this study. This indicates that progress can be made in both weight and in scores by selecting for both characteristics or by selecting for either singly. This is often erroneously believed to not be the case by some cattlemen. Some purebred as well as commercial producers have shown some resistance to a

selection program based predominantly on performance records. These breeders have a tendency to think that such a program could develop big rough cattle that are not in keeping with the present market and consumer demands. The basis for this reluctance to large rough cattle is the demand of the consumer for smaller cuts of beef with enough marbling and finish to grade choice. The large rough type of cattle usually must be carried to a heavy weight to take on enough condition to grade choice. To satisfy both producer and consumer demands, an intermediate point between the two extremes may be considered. The highest positive association in the above mentioned tables of correlations is between conformation score and condition score with a correlation of 0.70 for heifer calves and 0.62 for bull calves. This positive correlation is in agreement with Knapp and Nordskog (1956) where they found a positive correlation between weaning score and weight to be 0.68. Other authors, Bogart and Elings (1953), found comparable positive relationship of score to weight.

The higher correlation of score to condition in the case of the heifer calves may be explained by the fact heifers tend to reach relative proportions of body makeup a bit earlier than male calves. An average of the condition scores given by the committee of judges were higher for heifer calves in the case of both herds (table 3). An

inference may also be made, since the heifers carried a higher degree of fatness than the bull calves as indicated by the condition scores, that the degree of condition could possibly be influencing the conformation scores given the animals by the judges. Very little work has been published on the influence of condition on conformation scores. Green (1957) observed that the degree of fatness may have an influence on the score given an animal for conformation. He also indicated that at numerous times fat animals received higher scores than they probably would if they were in a less fat condition.

The range of mean conformation scores during and among the three years in both herds was 10.7 to 11.4 for bull calves while this mean range was 11.2 to 11.7 for heifer calves (table 3). The average conformation score made by the judges for all years was 10.95 for bull calves and 11.4 for heifer calves. The heifer calves tended to vary less and score higher in conformation.

Conformation scores were probably affected little by the differences in degree of fatness of animals between the two herds. Also, weight differences of calves between the two herds appeared to have little effect on the differences of scores. It may be assumed that the judges had a tendency to score on a relative basis within each herd even though the scoring was done in successive days. It is

Table 3. Means of Actual Weights, Adjusted Weights, Conformation Scores, and Condition Scores.

		Means of Actual Weights (pounds)			
		1952	1953	1954	3 Year Average
Herd (1)	B	566	557	568	563
	H	503	497	461	487
Herd (2)	B	544	515	533	531
	H	467	489	453	470
		Mean Adjusted Weights			
		1952	1953	1954	3 Year Average
Herd (1)	B	554	553	550	552
	H	414	495	463	457
Herd (2)	B	509	544	522	525
	H	453	500	446	467
		Mean Conformation Scores			
		1952	1953	1954	3 Year Average
Herd (1)	B	11.2	10.7	11.3	11.0
	H	11.5	11.5	11.3	11.4
Herd (2)	B	10.8	10.7	11.4	10.9
	H	11.3	11.2	11.7	11.4
		Mean Condition Scores			
		1952	1953	1954	3 Year Average
Herd (1)	B	12.1	10.9	11.6	11.5
	H	11.9	11.5	11.7	11.7
Herd (2)	B	10.8	10.7	11.6	11.0
	H	11.7	12.1	11.7	11.8

suspected that differences due to sex-sire-year-ranch interaction were present (tables 4 and 5). However, this study does not present statistical data to substantiate this supposition.

The range of means of condition score (table 3) for the three years in both herds varied more than conformation score for bull calves. This range was 10.7 to 12.1 for bull calves and in the same respect a condition score range of 11.5 to 12.1 for heifer calves, indicating the heifers were more similar in degree of fatness. The larger variation in condition scores of the bull calves may possibly be attributed to the nutrition variation of the three years.

It is noted that the lowest condition scores for bulls was obtained in 1953, a relatively dry year. The heifers seem to reach a mature size earlier and at a smaller size, consequently were not influenced as much as bulls that also tend to grow for a longer period to reach mature size. There is also the question of the more rapid rate of growth of bulls as compared to heifers. Sex is a genetically determined variable and each sex may respond differently to the same environment particularly during the suckling period.

The average mean weight for bull calves was greater than heifers in all years of the study for both actual and adjusted weight. This is in agreement with the findings of

Table 4. Variance Analysis and Heritability Estimates of Conformation, Condition, and Weaning Weight of Heifer Calves

Source of Variation	df	Mean Squares			
		Conformation	Condition	Weaning Weight	Expected Mean Squares
Between years	2	0.50	0.22	19,563	= Ve+11.90Vs+26.80Vh+53.53Vy
Between herds	3	0.00	1.33	6,082	= Ve+11.95Vs+26.80Vh
Between sires	10	2.90	1.00	3,562	= Ve+8.9Vs
Within sires within herds and years	145	1.47	0.64	3,918	= Ve

Conformation:

Variance Component	Calculated Variance	Percent
Error (Ve)	1.47	90.0
Sires (Vs)	0.16	10.0
Herds (Vh)	0.00	0.0
Years (Vy)	0.00	0.0
	1.63	100.0

$$\text{Heritability-Conformation} = \frac{4Vs}{Vs+Ve} = \frac{0.64}{1.63} = .39$$

Condition:

Variance Component	Calculated Variance	Percent
Error (Ve)	0.64	90.9
Sires (Vs)	0.04	5.7
Herds (Vh)	0.024	3.4
Years (Vy)	0.00	0.0
	0.704	100.0

$$\text{Heritability-Condition} = \frac{4Vs}{Vs+Ve} = \frac{0.16}{0.68} = .24$$

Table 5. Variance Analysis and Heritability Estimates of Conformation, Condition, and Weaning Weight of Bull Calves.

Source of Variation	df	Mean Squares			
		Conformation	Condition	Weaning Weight	Expected Mean Squares
Between years	2	5.56	11.00	4,513	= Ve+11.70Vs+27.51Vh+54.44Vy
Between herds	3	0.67	8.33	15,469	= Ve+11.39Vs+27.04Vh
Between sires	10	1.20	0.40	6,695	= Ve+9.49Vs
Within sires within herds and years	148	1.49	0.51	6,360	= Ve

Conformation:

Variance Component	Calculated Variance	Percent
Error (Ve)	1.49	93
Sires (Vs)	0.00	0
Herds (Vh)	0.00	0
Years (Vy)	0.10	7
	1.59	100

$$\text{Heritability-Conformation} = \frac{4Vs}{Vs+Ve} = 0.00$$

Condition:

Variance Component	Calculated Variance	Percent
Error (Ve)	0.51	51
Sires (Vs)	0.00	0
Herds (Vh)	0.29	29
Years (Vy)	0.20	20
	1.00	100

$$\text{Heritability-Condition} = \frac{4Vs}{Vs+Ve} = 0.00$$

several authors as noted in the review of literature. Among these, Pahnish (1958), working with the same herds included in this study, found that the average weight of male calves to be considerably greater than that of the females on both the Empire and Arivaca Ranches. He found a sex difference in weight to range from 44 to 99 pounds at 205 days of age. The mean adjusted weights of all three years of this study for heifer and bull calves were compared. A range in adjusted weight in favor of bull calves was found to be 44 to 140 pounds in considering weaning data from 1952 through 1953 at 270 days of age.

Botkin and Whatley (1953), in working with Oklahoma range Herefords, reported a mean difference between steer and heifer calves of 25 pounds at 210 days of age. Koger and Knox (1945) adjusted weaning weights of heifer calves to 205 days of age in which they found heifer calves to be 32 pounds lighter than bull calves of the same age.

Further analysis of the correlation coefficients in tables 1 and 2 indicate another sex difference in the relative association by the judges of conformation to both actual and adjusted weights. A correlation coefficient of conformation score to actual and adjusted weight was estimated to be 0.37 and 0.42, respectively, for heifer calves. This may indicate that size of calf at weaning tended to have little influence on the judges rating of

the animal on conformation, yet a bit more influence with heifers than in the case of bull calves. The same correlations on bull calves were 0.20 and 0.28, respectively. It is believed that at the 270 day mean weaning age, bull calves tend to reach the fast growing and awkward stage and possibly tend to stretch out more. In view of these suppositions, the judges may actually be influenced in scoring them down on conformation.

In the case of both heifers and bulls, a higher correlation was observed between conformation score and adjusted weight than between conformation score and actual weight. However, this difference was not significant.

One question may be raised in that the correlation coefficients of conformation score to weight, estimated to be .40 for heifers and .24 for bull calves, in this study may seem low in light of the high positive correlation of condition score to weight and of conformation score to condition. This lower association of conformation score to weight leads one to believe the scorers are looking at two things, weight and fatness in arriving at a condition score. Also, are allowing condition of the animal to influence their appraisal of the relative proportion of parts in establishing a conformation score.

It must be further noted that conformation and condition scores are given a narrow range in evaluating

animals. On the other hand, weight is an actual and factual appraisal. A few small animals below average in weight may receive a high conformation score because of desirable balance, shortness of body and legs. A few higher scores on animals of this type would reduce the association of conformation to weight. One of the judges in particular had a tendency to score some smaller, typier cattle higher than the other two judges.

Conformation-weight relationship in this study was found to have a lower correlation value than that found by Knapp and Nordskog (1956). These authors obtained a significant correlation of these characteristics at weaning to be 0.68. They also obtained a correlation value of 0.64 for slaughter steer grade to final feedlot weight and a carcass grade to feedlot weight relationship of 0.54. It was pointed out in their study that a substantial part of the variance in scores and grades is accountable to weight.

Rollins and Wagnon (1956) indicated a sex difference in grade was largely due to difference in weight, and that 18 percent of the variance in weaning grade on a within year basis was due to variation in weaning weight. Brown et al. (1956) stated that apparently most scorers consciously or unconsciously gave weight considerable importance im arriving at a conformation score. Furthermore, the rather consistent positive relationship between weight and score

both grossly and independent of other measurements is at variance with the common held viewpoint that small cattle are favored in type evaluation.

It is further indicated (table 6) that correlation coefficients among scorers show a higher degree of agreement and uniformity in the evaluation of condition than they did in scoring conformation. The lowest correlations among judges was in giving animals a conformation score (table 7). This indicates that there is disagreement among judges as to what constitutes the ideal type in weaning calves. This may be attributed to the difference in the experience, training, and background of each of the judges for this particular type of work. Table 8 also points out that two judges scored the calves in a manner resulting in a much lower condition--conformation association than the third judge. There is no question but what there exists a varying amount of disagreement among beef cattle producers and livestock judges everywhere in placing values on animals. This situation may be of value in animal improvement as selection programs fitting these different ideals are practiced. Time usually proves out the sounder programs and progress continues.

Heritability Estimates of Conformation and Condition

Heritability estimates of conformation and condition scores, within sexes, are shown in tables 3 and 4. These

Table 6. Correlation Coefficients Between Scorers for Condition by Herds and Sexes Within Years.

		Scorers		
		S-P	S-B	P-B
Herd 1	Bulls	.72	.66	.71
	Heifers	.73	.64	.60
Herd 2	Bulls	.66	.76	.68
	Heifers	.65	.60	.66

Table 7. Correlation Coefficients Between Scorers for Conformation by Herds and Sexes Within Years

		Scorers		
		S-P	S-B	P-B
Herd 1	Bulls	.41	.47	.55
	Heifers	.54	.42	.52
Herd 2	Bulls	.28	.55	.35
	Heifers	.51	.64	.63

Table 8. Correlation Coefficients Between Condition and Conformation for the Various Judges by Herds and Sexes Within Years.

		Scorers		
		S	P	B
Herd 1	Bulls	.34	.36	.57
	Heifers	.39	.50	.60
Herd 2	Bulls	.53	.22	.65
	Heifers	.62	.53	.73

calculations are accompanied by summaries of variance analysis, mean squares, and the expected mean squares, along with estimates of the percentage of the total variation accountable to each of the variables considered.

There is a marked difference in the heritability estimates for each of these factors between sexes. There also appears to be some difference in degree of influence on the sexes by the different variables considered. The estimated heritability of conformation for heifer calves was 39 percent. The comparable estimate for bull calves was zero. About 90 percent or more of the total variance in both the bulls and heifers was due to within sires, herds, and year effect. The balance of the variation of heifers was between sires within herds and years. Year differences accounted for the balance of the total variation for bulls.

Somewhat similar comparisons are found between the sexes for heritability estimates for condition. The estimate of heritability of condition was 24 percent for heifers and again zero for bulls. That fraction of the total variance of the different sources for heifers was as follows: error 90.9 percent, sires 5.7 percent and 3.4 percent due to herd effect. Fifty-one percent of the variance in condition score for bulls was due to error while herd and year effect accounted for 29 and 20 percent, respectively.

The heritability of conformation and condition appears to be reasonable for heifers. These conformation estimates of heritability compare favorably with the 36 percent average estimated by Rollins and Wagnon (1956). Other estimates obtained include Koger and Knox (1952), 50 and 30 percent; Knapp and Clark (1950), 28 percent.

The standard deviation for actual weaning weight was observed to be higher for bulls than would be expected due to the magnitude of numbers. This greater variation in weaning weights (tables 3 and 4) of bull calves within a sire group may be causing the lower heritability in bull scores. This may indicate a wider range of differences of scores among bull calves from individual sires than there are differences between bull calves from different sire groups. With this increased variation in weaning weights, would lead one to the supposition that a wider variation in scores would be expected. This, however, is not the case in this study with bull calves. The explanation for this may be one of two things; the judges are not using a wide enough range that is available on the scoring card (figure 1) in scoring the bull calves or the calves are very uniform. If the latter is the case, the variance is small and the heritability will be small if there is this high degree of homozygosity. There is reason to suspect that this degree of homozygosity of bulls and the judges

scoring of the animals accurately is not the case. This statement is made in view of the fact that the degree of variation is not the same for both sexes. The tremendous variance due to within sires leads one to suspect that in the case of the zero heritability of bulls, the judges are not scoring conformation without the influence of other factors.

SUMMARY

Weaning weights and scores of conformation and condition were obtained over a three year period on Hereford calves of both sexes at two ranches in Southern Arizona. The same three men scored the calves of both herds at weaning time for all three years. A total of 164 bull calves and 161 heifer calves were used in the study.

1. Heifer calves tended to vary less and score higher in conformation and, with the exception of one year in one of the two herds, scored higher in condition.

2. Progress in the performance of cattle can be made in both weight and in conformation by selecting for both characteristics or by selecting for either singly. The correlation coefficient of scores and weights are positive in all cases in this study.

3. A high positive correlation of 0.70 and 0.62 for heifer and bull calves, respectively, was found between conformation and condition scores. The heifers received a higher condition score as well as a higher conformation score. The fatness of animals appeared to influence the scorers in varying degrees as to the relative proportion of parts in placing a conformation score on the calves at weaning.

4. A correlation of over 0.50 was obtained between condition score and actual and adjusted weights. However, a conformation score to actual weight correlation was found to be 0.37 for heifers and 0.20 for bulls. Evaluations were made by judges in which a narrow range for conformation and condition scores were used while a wide range in actual weight was the case. Weights were actual measurements and scores were an average of the three judges evaluations of the animals. The lower association of conformation score to weight in the case of bull calves may infer that the judges are looking at weight and fatness in arriving at a condition score and in turn allowing condition to influence judgment of conformation. Bull calves seem to reach a fast growing and awkward stage and tend to stretch out more at 270 days of age than heifers and, consequently, the judges may be influenced in scoring them lower on conformation.

5. Weight differences of calves between the two herds appeared to have little effect on the differences in scores. The judges had a tendency to score the calves in each herd on a relative basis.

6. Correlation coefficients of scores among the different judges indicated a high degree of agreement in evaluating condition. Lower correlations among judges for conformation and the average correlation coefficients between condition and conformation for each judge by herds and sexes,

indicates disagreement among scorers concerning relative merit of animals.

7. The heritability of conformation and condition in heifers was estimated to be 39 and 24 percent, respectively. The heritability of these characteristics in bull calves was estimated to be zero. About 90 percent of the total variance in both sexes was due to within sires, herds, and year effect.

8. The degree of variation in weaning weights was not uniform for both sexes. The large variance due to within sires leads one to suspect that the judges are not scoring conformation without the influence of other factors, thus accounting for the low heritability of conformation and condition of the bull calves.

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