EVALUATION OF COW TYPE CLASSIFICATION SCORE AND ITS RELATIONSHIP TO COW PRODUCTIVITY

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CHAPTER I

INTRODUCTION

In the past, beef cattle breeders have generally put some selection pressure on the visual subjective evaluation of an individual's usefulness for a certain purpose. The breeders were selecting for a certain type. Type is an ideal or standard combining all the characteristics which contribute to an animal's worth for a specific purpose. The present concept of desirable beef type is generally characterized by abundance of muscling, freedom from excess fat, and adequate size and scale. Type is determined by body form, size, and shape, or conformation. Breed association type classification programs constitute an attempt to standardize type selection guidelines of cattle for breeding purposes by comparing an individual's type to the breed type ideal. For many years the relation of "form to function" has served as a basic principle in selection for type.

In addition to type, breeders select replacements on the basis of performance for economically important traits. Evidence has strongly indicated that performance should be the first consideration; however, selection pressure for type still continues. A general recommendation concerning the relative attention to give each of these factors has not been formulated. The determination of such a recommendation requires the accurate estimation of the relationship between type and productivity.

The objectives of this study were:

1. To determine the magnitude of the association between cow type classification score and measures of cow productivity.

2. To determine the accuracy of type classification score for predicting cow productivity, both alone and together with cow weight, cow condition score, and performance information on the cow's first calf.

CHAPTER II

REVIEW OF LITERATURE

Investigations on the relationship of body type or conformation to production in beef breeding females are rather limited. Those reported can be categorized as investigations of physical measurements or investigations concerned with subjective evaluations using conformation or type scores. Only those studies which were concerned with the relationship of conformation or type classifications to productivity will be reviewed in connection with the present study.

Koch and Clark (1955) reported correlations between subjective measurements of dam's conformation score and progeny performance in 4234 dam-offspring pairs. Year and age of dam effects were removed from the calf traits by grouping and analyzing the data within year of cow and calf birth. Correlations of 0.07, 0.01, -.01, and 0.08 were reported between dam weaning conformation score and average calf birth weight, actual weaning weight, weaning gain, and weaning score, respectively, and dam yearling conformation score was correlated 0.04, 0.12, 0.01, and 0.10 with the calf traits, while dam yearling weight had correlations of 0.21, 0.12, 0.09, and 0.13 with the calf traits, respectively. The authors reported heritability estimates of 0.16 and 0.15 for weaning score, based on regression of offspring on dam and regression of offspring on sire, respectively.

Brown *et al.* (1960) reported on a 15-year study of selection for type and body conformation as indicated by classification scores in a small herd of Angus cattle. The classification system ranged from a numerical score of 30 (poor) through 100 (excellent). Slow but permanent and cumulative progress was reported in improvement of type (about one grade change) and decline in variability of type. The data were examined with classification scores expressed as first score taken when the animals were less than one year of age, current score, average lifetime score, and most probable score. Improvement was noted in all four methods of expressing type; however, most probable score yielded the most conservative estimate of progress and was least affected by temporary environment. Repeatability estimates of classification scores were found to be 0.36 for contemporary and 0.42 for non-contemporary cows. The authors reported heritability estimates for classification scores of 0.33 by regression of offspring on mid-parent and 0.54 from intraclass correlation among paternal half sibs. Using the heritability estimate of 0.33 the expected improvement in classification score per generation was calculated as 3.3 units.

Marlowe (1962) reported one of the more extensive studies concerning the relationship of mature conformation grade of dam to performance of offspring. These data included 621 Angus cows with 1660 calves from 10 herds and 634 Hereford cows with 1500 calves from 12 herds. Separate analyses were conducted for each breed and the analyses were done on a within sire, herd, management practice, season, and year basis. Calf gains were adjusted for differences in sex, season of birth, and age of dam. Cow weights and grades were adjusted to that of a mature cow (over six years) in average flesh condition that was nursing a calf. The correlation coefficients of adjusted mature grade of dam and weaning grade of calf were 0.09 and 0.12 and the regression coefficients 0.10 and 0.15 for Angus and Hereford, respectively. The author reported a nonsignificant relationship between adjusted mature grade of dam and calf average daily gain to weaning when weight of dam was held constant. It was concluded that mature grade of dam has little influence on calf average daily gain to weaning or weaning grade. In this same study, correlation coefficients of 0.23 for Angus and 0.20 for Herefords were reported for the relationship of adjusted mature dam weight and calf preweaning average daily gain. Regression coefficients for this relationship were 0.061 pound for Angus calves and 0.052 pound for Hereford calves per hundred pound change in cow body weight. Flesh condition was reported to be a major source of variation in both weight and grade for the cows in this study. In the Angus cows flesh condition accounted for 22.5 percent of the variation in both weight and grade. In the Hereford cows flesh condition accounted for 15.3 and 19.9 percent of the variation, respectively, in weight and grade.

Tanner et al. (1968) in an analysis of a subset of the data from the present study reported on repeatability of total classification scores and the association between scores and certain measures of production in 76 cows and 115 carcass cattle. Pooled within season correlations for total scores between a classifier's score with the other three classifiers' scores were 0.76, 0.68, and 0.79 for 2-, 3-, and 4-year-old cows, respectively. Pooled repeatability estimates for total score for classifiers with themselves between seasons were 0.47, 0.58, and 0.77 for the 3 age groups, respectively. Correlations of spring scores with calf weaning weights and conformation grades were not significantly different from zero for 2- and 3-year-old cows but were positive, 0.59 and 0.39, respectively, for 4-year-old cows. Correlations of fall scores with calf weaning weights and grades were near zero for 3- and 4-year-old cows but were negative, -.30 and -.19, respectively, for 2-year-old cows. In the analysis concerning carcass cattle, correlations of 0.28 and 0.20 were reported between total score and hot carcass weight and fat thickness per hundred weight, respectively, indicating that the heavier, fatter cattle were scored higher. Total score was correlated -.04, -.29, and -.12 with rib eye area per hundred weight, percent retail cuts, and percent trimmed round, respectively, which again indicated the fatter animals were scored higher. The correlation of beef character with the above carcass traits, respectively, was 0.24, 0.20, -.26, -.26, and -.12.

Willham (1970) reported heritability estimates of Angus type classification scores on data from 158,388 animals. Intra-herd group heritabilities of 0.58 for conformation, 0.60 for size, 0.64 for head and breed character, 0.49 for feet and legs, 0.27 for shoulders and foreribs, 0.47 for rib and back, 0.51 for loin, 0.43 for rump, 0.57 for rear quarter, and 0.62 for total score were reported. The inter-herd group heritabilities were 0.30, 0.43, 0.45, 0.36, 0.15, 0.22, 0.23, 0.24, 0.39, and 0.35, respectively.

No other extensive reports on beef cow type or the relationship of beef cow type and productivity were found in the literature; however, several studies have been conducted where general observations on the matter have been made. Hultz (1927) reported that rangy Hereford cattle grew faster and produced carcasses with a higher dressing percentage than low set calves, with no significant difference in efficiency of gains. Observations on large, intermediate, and compress (small) type Hereford heifers were made by Stonaker et al. (1952), and it was reported that rate of gain and size were positively associated, but efficiency of gain was not associated with size when adjusted for differences in degrees of fatness. Woodward and Black (1942) reported that calves from large type cows were heavier and made more profit in the feedlot than calves from small type cows; however, there was no significant difference in birth weight or preweaning average daily gain of calves from the two types. Knox (1954) reported a marked advantage in lifetime productivity for large type cows which averaged 2170 pounds of calf produced as compared to 1442 pounds of calf produced by compact type cows. Several workers, Gregory et al. (1950), Knox (1957), Clark et al. (1958), Brinks et al. (1962), Neville (1962), Smith and Fitzhugh (1968), Godley et al. (1970), and Singh et al. (1970), have reported that heavier cows tend to produce heavier calves at weaning, although the relationship is rather low. Godley et al. (1970) reported that size score as a measure of skeletal size of the cow did not have a significant effect on calf preweaning growth.

The relationship of type and conformation to productivity has been examined in several studies in dairy cattle. These studies involving dairy cattle take on added significance when it is considered that milk production plays an important role in calf preweaning performance. Knapp and Black (1941) reported that selection of beef calves for the greatest preweaning gain resulted in selection of calves from cows with the highest milk production but with the poorest beef type characteristics in a study involving 58 dam-offspring pairs of Shorthorn cattle. A correlation coefficient of 0.52 was reported between calf daily gain and quantity of milk consumed. The relationship between milk production of the beef cow and preweaning calf growth has been studied by Drewry et al. (1959), Gifford (1953), Neville (1962), Brumby et al. (1963), Furr and Nelson (1964), Christian et al. (1965), Gleddie and Berg (1968), and Wilson et al. (1969). These workers have reported correlations ranging from 0.41 to 0.84 between cow milk production and calf preweaning average daily gain.

Gowen (1920) was the first to show that even a limited production record was more accurate than conformation in predicting future production. He studied the records of 1674 Jersey cows and their type scores by 140 different judges. It was reported that a seven-day milk production record was 2.5 times as accurate as conformation in estimating a cow's yearly production. Total type score of the cow had a 0.194 correlation coefficient with milk production. In a later study with Jersey cattle, Gowen (1921) computed correlation coefficients between cow type, as scored by 19 judges, and yearly milk production. The average correlation coefficient was 0.25; however, these data were from many herds in many states, and the herd differences present probably tended to inflate the correlation reported. In this study a seven-day milk yield record was twice as accurate as conformation in estimating yearly milk production.

Copeland (1938) investigated the relationship between conformation scores, as determined by a herd classification, and Jersey production records. No statistical analysis was reported; however, it was concluded that classification for conformation alone was of little value in estimating producing ability.

Engeler (cited by Lush, 1945) reported a correlation between type score and milk production of 0.04 in an investigation involving 55 Brown Swiss cows. In a later study of 138 cows in one herd, he reported a correlation of 0.32 between type score and milk yield. It was concluded that type and milk production are to a high degree independent and that the two characteristics are not sufficiently related to use either alone as a basis for selection when attempting to improve both traits.

Tyler and Hyatt (1948) reported correlations between official type classification ratings and butterfat production on data from 5117 Ayrshire cows from 304 herds. All analyses were done on an intra-herd basis and both first fat record and type and nearest record to classification and type had a 0.16 correlation coefficient, while the average of all records and type had a 0.19 correlation coefficient. It was concluded these correlations were too low to be of practical significance. The heritability of type rating was estimated to be 0.28 by doubling the intra-sire regression of daughter on dam.

Johnson and Lush (1942) reported on the correlations between type and production in a study involving 229 Holstein-Freisan cows. The measure of type was the official breed association classification score. First type rating after 10 months of age and first production had a 0.19 correlation coefficient, while two type ratings and two production records and three type ratings and three production records were correlated 0.38 and 0.18, respectively. Repeatability of type score was 0.34 when ratings made at 10 months or less were eliminated. Type ratings made at 10 months or less were less repeatable than those made at older ages. It was concluded that two or more type ratings of an individual cow were a far more accurate guide to her true type than was one official rating. This conclusion was also supported by Hyatt and Tyler (1948) when they reported the repeatability of official type score to be 0.55 in a study involving 80 Ayrshire cows.

Touchberry (1951) reported a zero genetic correlation between type and milk and fat production in a study of 187 Holstein dam-daughter pairs, whereas the phenotypic correlations were 0.18 and 0.25, respectively.

Harvey and Lush (1952) reported on data involving 2786 daughter-dam pairs from 226 herds in the Jersey breed. Heritability of official type rating was estimated to be 0.14 by intra-herd regression of daughter on dam. The genetic correlation between type and production was 0.18, indicating that selection for type should bring about some genetic improvement in production. It was concluded, however, that selection for type alone would require about 6 to 10 generations to obtain the improvement in production that could be obtained by one generation of selection based on production.

A -.52 genetic correlation between type and butterfat production was reported by Freeman and Dunbar (1955) in an intra-herd analysis of records on 729 Ayrshire daughter-dam pairs. An intra-herd phenotypic correlation of 0.08 between type and fat production was reported from records on 1273 cows. The authors concluded that in selecting for butterfat production alone nothing could be gained by giving positive emphasis to type score.

Tabler and Touchberry (1955) reported intra-sire phenotypic and genetic correlations between type and milk and fat production in records of 2810 Jersey cows from 414 herds. Phenotypic correlations were 0.08

and 0.11 for type and milk yield and fat yield, respectively. The genetic correlations reported were 0.07 and 0.08 for type and the two production traits, respectively. It was reported that selection for type along with milk and fat yield resulted in a 15 percent decrease in expected genetic gain of milk and fat yield.

Johnson and Fourt (1960) investigated the phenotypic and genetic relationship between type and butterfat production in 3161 Brown Swiss daughter-dam pairs. The phenotypic and genetic correlations between type classification score and fat production were 0.26 and 0.24, respectively. The heritability of final type score was 0.35 based on intra-sire regression of offspring on dam. The positive genetic correlation between type and production indicated that selection for type would also increase production; however, it was reported that selection on type alone would require four generations to obtain the genetic improvement in production that could be expected in one generation of selection on butterfat production alone.

Wilcox et al. (1962) reported on data from a single herd of 233 Holstein cows with 671 lactation records and 2272 classification scores. The phenotypic, genetic, and environmental correlations, respectively, between over-all type score and milk yield were 0.14, 0.08, and 0.14, while these values for over-all type score and fat yield were 0.11, 0.21, and 0.08. Repeatability of type score without regard to sire was 0.39 and the heritability was reported as 0.12.

This review indicates that body type or conformation score is a moderately to highly repeatable and heritable trait in beef cattle. However, the literature indicates there is a low relationship between body type or conformation scores and measures of cow productivity.

CHAPTER III

MATERIALS AND METHODS

Source of Data

The data used in this study were the official type classification scores of 220 purebred Angus cows classified in 1964 and 1965 and the preweaning performance records of 990 Angus calves raised from 1964 to 1969 at the Fort Reno Livestock Research Station, El Reno, Oklahoma. These cattle were part of a long-term beef cattle selection study initiated in 1964 involving four Angus lines. The foundation females in this study were progeny of over 30 different sires and were obtained by sampling several herds in several states. The cattle were considered to be a representative sample of the Angus breed, and with such a broad genetic base it was hoped that the results obtained from the study would be as applicable to the breed as a whole as is experimentally feasible.

Breeding and Management

Heifers were bred to calve for the first time at two years of age. The cow herd was assigned to sires by using a stratified randomization scheme that insured equal dispersion of cow age-groups within sires and avoided matings between half sibs or more closely related individuals in order to keep inbreeding at a low level. The cow herd was separated into breeding groups for a 90-day breeding season from May 1 to July 31. Four sires were used per line per year and each sire was used for two years. All cows were pregnancy checked in the fall and cows diagnosed open were usually culled.

Management of cow herd was similar to most commercial operations in central Oklahoma. The cows were pastured on native range and, when available, were placed on wheat pasture during the late fall and winter months. If necessary supplemental alfalfa hay and cottonseed meal were also fed during the winter months. Every effort was made to insure uniform environmental conditions for all cows and calves. Most of the calves were born in February, March, and April and were maintained with their dams on native pasture without creep feed until they were weaned in late September at an average age of 205 days. Following weaning the heifers were wintered on native range and wheat pasture, to gain approximately 0.75 to 1.0 pound per day.

Weights and Measures - Calves

The calves were weighed and identified within 24 hours after birth. Weaning weights were adjusted to a 205-day basis by multiplying 205 times average daily gain from birth to weaning, and adding birth weight. This weight was then adjusted for age of dam by multiplying by 1.15, 1.10, 1.05, and 1.00 for calves from 2-year-old, 3-year-old, 4-year-old, and 5-year or older dams, respectively, as suggested in Beef Improvement Federation's Guidelines for Uniform Beef Improvement Programs (1970). These 205-day age of dam corrected weights were used to calculate weaning weight ratios within line and sex. An 18-month (550-day) adjusted weight was calculated for the heifers by adding 345 times the postweaning average daily gain to their 205-day age of dam corrected weights. The calves were subjectively evaluated for conformation by a committee of at least three persons at weaning. Conformation scores were assigned according to the grading standards recommended by the U. S. Department of Agriculture, with each grade being subdivided into thirds. The grades were averaged and coded to the nearest 0.1 grade point (1/30th of a grade). With this scale 13.0 represents average choice and 10.0 represents average good. These conformation scores will be referred to as weaning scores in the course of this study.

Weights and Measures - Cows

The measure of type used in this investigation was the official breed association type classification score given the cows in March and October of 1964 and March and November of 1965. Five official classifiers scored the cattle during the first three classifications, and six official classifiers scored the cattle in November of 1965. The arithmetic average of the scores given a cow by all classifiers on one date was taken as the type score for that cow. This average score should be the most accurate estimate of a cow's true type. Johnson and Lush (1942) and Hyatt and Tyler (1948) have reported that two or more type ratings are a more accurate guide to an individual's true type than is one rating. The cows either had calved or were about to calve when the spring classification was made, and the fall classification was made after weaning. The cows were divided into four age groups, 1, 2, 3, and 4 years and older, based on their age at their first classification. Cows in age group 1 were approximately 18-20 months of age when first classified.

The score card used to assign a type classification score to the cows is presented in Table I. A total score of 100 was possible with this score card. A score of 100 represents the breed ideal for type, and the total score given an individual represents the percentage approach to the breed type ideal.

TABLE I

SCORE CARD FOR COW TYPE CLASSIFICATION

Component	Maximum Score Possible		
General Appearance (GAPP)			50
Appearance (APP)		30	
(Type)	(14)		
(Size)	(10)		
(Quality)	(6)		
Breed Qualities (BRQL)		20	
(Feet and legs)	(12)		
(Head and breed character)	(8)		
Beef Character (BFCR)			50
(Shoulder and chest)	(8)		
(Rib and back)	(10)		
(Loin)	(10)		
(Rump)	(10)		
(Rear quarters or round)	(12)		
Total Score (TSC)			100

The cows were also evaluated for condition or fatness by the official classifiers on a 1 to 5 scale with 1 representing a very thin cow, 3 a cow in average condition, and 5 a very fat cow.

The cows were weighed in January, April, and October of 1964 and in January, May, and September of 1965. The spring weights were taken after calving was completed, and the fall weights were taken shortly after weaning. The estimate of weight used in this study was a linear approximation of the weight at the time of classification based on the two closest actual weights.

Index of Productivity

The primary objective of this study was to determine the relationship between cow type score and cow productivity. The measures of cow productivity used were the offspring's preweaning performance records. Sire effects were regarded as random contributions to variation and were not considered in the analyses. This should be a valid assumption because cows were distributed at random among sires when allotted to breeding groups.

Preweaning performance traits considered included birth weight, 205-day weaning weight, weaning score, and weaning weight ratio. In addition, most probable producing ability (MPPA) for birth weight, weaning weight, and weaning score were calculated according to the formula suggested by Lush (1945):

$$MPPA = HA + \frac{nr}{1 + (n - 1)r} (IA - HA)$$

where HA is the herd average,

IA is the individual's average,

n is the number of records that the IA is based on, and

r is the repeatability of the trait.

In this analysis the repeatability estimate of birth weight used was 0.25. This was the weighted average for repeatability of birth weight reported by Petty and Cartwright (1966) based on an extensive literature survey. The repeatability estimates used for weaning weight and weaning score were 0.40 and 0.30, respectively, as suggested in Beef Improvement Federation's Guidelines for Uniform Beef Improvement Programs (1970). Kempthorne (1957) showed that the term $\frac{nr}{1 + (n - 1)r}$ is the best predictor of the genetic deviation when the phenotypic deviation of the individual's performance from the population mean performance is known. Therefore, of the productivity measures studied, the most accurate estimate of an individual's true producing ability was MPPA.

The accuracy of the MPPA's as a productivity index should have been increased due to the incorporation of data adjustments for non-genetic sources of variation. Both the IA and HA used in the formula were based on data adjusted for effects due to years, sex of calf, and age of dam.

Average daily gain (ADG) from birth to weaning and age adjusted weaning weight are very similar traits, differing only because of a scaling factor due to birth weight; consequently, ADG was not considered as a measure of productivity. This contention is supported by the average weighted phenotypic and genetic correlations, respectively, of 0.97 and 0.98 between gain from birth to weaning and weaning weight as reported by Petty and Cartwright (1966).

Statistical Analyses

In the first part of the statistical analyses the least squares method of fitting constants for data with disproportionate subclass numbers (Harvey, 1960) was used to estimate the effect of various independent variables on performance traits. The estimates of these effects were used to correct the data in order to put the performance records in different years, different sexes, and from different ages of dam on a comparable basis. The general mathematical model considered appropriate for these analyses was:

$$V_{ijkl} = \mu + Y_i + S_j + A_k + (YS)_{ij} + (YA)_{ik} + (SA)_{jk} + e_{ijkl}$$

where:

V_{ijkl} is the birth weight, 205-day weaning weight, or weaning score, of the lth calf, in the kth age of dam, of the jth sex, in the ith year.

μ is the overall mean, an effect common to all observations.

Y_i is the effect of the ith year,
$i = 4, 5, 6, 7, 8, 9$.

S_j is the effect of the jth sex of calf,
$j = 1, 2$.

A_k is the effect of the kth age of dam,
$k = 2, 3, 4, 5$.

$(YS)_{ij}$ is the effect of the interaction of the ith year with the jth sex,

$(YA)_{ik}$ is the effect of the interaction of the ith year, with the kth age of dam,

$(SA)_{jk}$ is the effect of the interaction of the jth sex with the kth age of dam, and

e_{ijkl} is the random error associated with each observation.

All factors in the model, except error, were assumed to be fixed. The random errors were assumed to be normally and independently distributed with zero means and homogeneous variances.

The system of equations solved in these analyses can be described in matrix notation as:

$$[X'X]\hat{\beta} = [X'Y]$$

where, X = observation matrix, X' = transpose of the observation matrix, Y = vector of observations, and $\hat{\beta}$ = vector of least squares constants. Since the full [X'X] matrix was singular it was necessary to impose a restriction in order to obtain a unique solution. The restriction imposed was that the sum of the least squares constants for each main effect and interaction was equal to zero. Thus, the number of least squares constants for each effect in the model was reduced to the number of degrees of freedom for each effect and the least squares constants obtained were expressed as deviations from a mean of zero. This restriction necessitates the deletion of the first classification for each effect when constructing the observation matrix. The procedure for constructing the observation matrix under this restriction is discussed in detail by Cundiff (1966) and Cunningham (1967).

Solving the system of equations for $\hat{\beta}$ yields estimates of the least squares constants (partial regression coefficients):

$$\hat{\beta} = [X'X]^{-1} [X'Y]$$

where $[X'X]^{-1}$ is the inverse of [X'X].

Since the restriction that the sum of the least squares constants for each effect equals zero was imposed, the missing least squares constant was obtained by subtracting the sum of least squares constants obtained from zero. For example:

$$Y_4 = -(Y_5 + Y_6 + Y_7 + Y_8 + Y_9)$$

is the estimate of the least squares constant for year 4.

Missing elements in the $[X'X]^{-1}$ matrix were obtained in the same manner:

$$C_{44} = -(C_{45} + C_{46} + C_{47} + C_{48} + C_{49}).$$

The standard errors of the least squares constants were obtained by:

$$S_{\hat{\beta}_i} = [C_{ii} \cdot \hat{\sigma}^2]^{\frac{1}{2}}$$

where C_{ii} is the corresponding diagonal element of the $[X'X]^{-1}$ matrix for the particular $\hat{\beta}$ being considered and $\hat{\sigma}^2$ is the error mean square obtained from the analysis of variance.

Appendix Table XI presents the number of observations that were included in each classification for the least squares analysis.

The primary objective of the least squares analysis was to obtain least squares constants for the main effects in the model for the performance traits. These least squares constants were used to formulate correction factors. Additive correction factors for years were obtained by changing the sign of the least squares constants for years. In order to make adjustments for age of dam to a 5-year-old cow basis, a quantity equal to minus the least squares constant for age 5 was added to the least squares constants for ages 2, 3, 4, and 5, respectively. This had the effect of making the 5-year-old age of dam constant equal zero and equally adjusted the other constants. Additive correction factors were then obtained by changing the sign of the adjusted least squares constant. Additive correction factors to adjust all records to a male basis were obtained in a similar manner. A multiplicative correction factor was not utilized because equality of variances among the sexes was not an important consideration in these analyses.

These correction factors are important because they have the effect of putting all performance records on as nearly an equal basis as is possible with the model and statistical analysis employed. The model and analysis employed serve to quantify known sources of variation for the performance traits. The correction factors account for these non-genetic sources of variation and put the records on a more comparable basis. Although not all the non-genetic variation in records can be removed by correction factors, appreciable fractions of certain important sources of variation can be. Those sources considered to have an important biological basis have been removed from the performance records used in this study and serve to standardize the records as much as possible.

The second objective of the analysis of the data was to determine the relationship between type classification scores and performance traits. To accomplish this objective the data were analyzed using linear correlation techniques as outlined by Snedecor and Cochran (1967).

The product moment correlation (r) is equal to the covariance of two random variables divided by the geometric mean of their variances. The computational procedure was:

$$r = \frac{\Sigma x_1 x_2}{[\Sigma x_1^2 \; \Sigma x_2^2]^{\frac{1}{2}}}$$

where,

X_1 and X_2 are two random variables,

$\Sigma x_1 x_2$ is the sum of cross products between variables X_1 and X_2, and

Σx_1^2 and Σx_2^2 are the sum of squares for variables X_1 and X_2, respectively.

The linear correlation coefficient (r) is an estimate of the population parameter, ρ(rho). Assuming the observations are a random sample from the joint bivariate normal distribution, a test for $\rho = 0$ was made by calculating

$$t = \frac{r(n - 2)^{\frac{1}{2}}}{(1 - r^2)^{\frac{1}{2}}}$$

and comparing this calculated t value with the tabulated t-distribution with (n - 2) degrees of freedom. This was accomplished by referring to the appropriate table in Snedecor and Cochran (1967).

The data were further analyzed by linear and multiple linear regression techniques (Snedecor and Cochran, 1967) to study the effectiveness of several variables when used in prediction equations for most probable weaning weight.

CHAPTER IV

RESULTS AND DISCUSSION

The analysis of variance for birth weights, 205-day weaning weights and weaning score is presented in appendix Table XII. The least squares constants and standard errors of the main effects for birth weight, weaning weight, and weaning score are presented in Table II. As expected, there was a wide range in the least squares constants for years for all the performance traits. Males were heavier at birth and weaning, but received lower weaning conformation scores than females. The age of dam effects followed a predictable pattern. Dams 2 and 3 years of age produced negative effects in all performance traits except birth weight, where only the effect of dam age 2 was negative. Dams 4 and 5 years or older produced positive effects in all performance traits.

The additive correction factors for birth weight, weaning weight, and weaning score obtained from the least squares analysis are presented in Table III. Standard errors for the correction factors are the same as the respective standard errors for the least squares constants as presented in Table II. Cow performance records corrected for year, sex of calf, and age of dam effects were used to analyze the relationship between cow type classification scores and cow productivity.

TABLE II

LEAST SQUARES CONSTANTS AND STANDARD ERRORS OF MAIN EFFECTS FOR PERFORMANCE TRAITS

Source	Birth Weight, lbs.	Weaning Weight, lbs.	Weaning Score
Mean	66.98 ± 2.96	413.46 ± 14.73	12.15 ± 0.29
Years			
64	-2.66 ± 0.72	-5.96 ± 3.54	0.30 ± 0.07
65	0.34 ± 0.62	2.69 ± 3.04	0.12 ± 0.06
66	1.79 ± 0.64	-.94 ± 3.21	-.15 ± 0.06
67	0.15 ± 0.73	11.59 ± 3.55	0.21 ± 0.07
68	4.21 ± 0.65	20.09 ± 3.21	-.16 ± 0.06
69	-3.83 ± 0.62	-27.47 ± 3.09	-.32 ± 0.06
Sex[a]			
1	1.99 ± 0.26	17.93 ± 1.31	-.07 ± 0.03
2	-1.99 ± 0.26	-17.93 ± 1.31	0.07 ± 0.03
Dam Age			
2	-4.38 ± 0.50	-33.31 ± 2.50	-.41 ± 0.05
3	0.07 ± 0.54	-9.94 ± 2.69	-.12 ± 0.05
4	1.38 ± 0.58	15.67 ± 2.87	0.18 ± 0.06
$\geq$ 5	2.93 ± 0.42	27.58 ± 2.07	0.35 ± 0.04

[a]Sex 1 = bulls, sex 2 = heifers

TABLE III

ADDITIVE CORRECTION FACTORS FOR BIRTH WEIGHT, WEANING WEIGHT, AND WEANING SCORE

Source	Birth Weight, lbs.	Weaning Weight, lbs.	Weaning Score
Years			
64	2.66	5.96	-.30
65	-.34	-2.69	-.12
66	-1.79	0.94	0.15
67	-.15	-11.59	-.21
68	-4.21	-20.09	0.16
69	3.83	27.47	0.32
Sex[a]			
1	0.00	0.00	0.00
2	3.99	35.86	-.14
Dam Age			
2	7.31	60.89	0.76
3	2.86	37.52	0.47
4	1.55	11.91	0.17
≥ 5	0.00	0.00	0.00

[a]Sex 1 = bulls, sex 2 = heifers

The Relationship of Cow Type Classification Scores and Cow Productivity

As previously discussed, the measures of cow type used in this study were the official breed association type classification scores. The measures analyzed included total score (TSC), and the component scores which included appearance (APP), breed qualities (BRQL), beef character (BFCR), and general appearance (GAPP). Cow productivity was measured by calf performance to weaning. A cow's performance record consisted of the least squares corrected birth weight (BW), weaning weight (WW), and weaning conformation score (WS) of its offspring. In addition, most probable producing ability for birth weight (MPBW), weaning weight (MPWW), and weaning score (MPWS), and the 205-day age of dam corrected weaning weight ratio, calculated within line and sex, were included in the performance record. The cow productivity measures considered were the cow's first performance record as a two-year-old, the second performance record as a three-year-old, and the average of all available performance records. Some of the cows in this study were purchased after they had produced one or more calves. Consequently, data were not available on the first performance record for cows in age group 3 nor for the first two performance records for cows in age group 4. There were 119, 144, and 220 cows with first, second, and average performance records, respectively. The number of performance records per cow ranged from one to six, the average being 3.38. A more detailed description of the data is given in the upper portion of appendix Table XIII where the distribution of cows according to number of performance records by cow age group is presented.

A cow's first performance record as a two-year-old will be denoted by a prefix "1" before the respective performance trait. For example, "1BW" indicates the birth weight of a cow's first calf. A cow's second and average performance records will be denoted by a prefix "2" and "A", respectively. Thus, "2BW" and "ABW" indicates the birth weight of a cow's second calf and the average weight of all calves, respectively.

Correlation coefficients of first classification scores and cow weight and average classification scores and cow weight with cow productivity measures were calculated in order to evaluate the interrelationships among these variables. Correlation analyses between first classification scores and productivity measures were of interest because the typical breeder probably would only have his cow herd classified once.

Correlation Coefficients between First Classification Scores and Productivity Measures

The means and standard deviations for the classification variables and for cow weight (WT) at classification time are presented in Table IV. The first classification scores are for the cow's first classification, irregardless of season of classification or cow age group. The means and standard deviations for the productivity measures are presented in Table V.

The correlation coefficients between the variables are presented in Table VI. Since total score consisted of a weighted average of the classification subgroupings, the high (0.73 to 0.95) positive relationships generally obtained by correlating a component part with the total score were anticipated.

TABLE IV

MEANS AND STANDARD DEVIATIONS FOR FIRST AND AVERAGE CLASSIFICATION VARIABLES AND COW WEIGHT[a] AT CLASSIFICATION TIME

Variable[b]	No.	First Classification		Average Classification	
		Mean	St. Dev.	Mean	St. Dev.
APP (30)	220	24.6	1.3	24.3	1.3
BRQL (20)	220	15.6	0.6	15.3	0.7
GAPP (50)	220	40.2	1.7	39.6	1.7
BFCR (50)	220	38.3	1.4	38.1	1.4
TSC (100)	220	78.5	2.9	77.7	3.0
WT	220	875.6	147.6	932.5	140.3

[a]Cow weight in pounds.

[b]The figure in parenthesis is the maximum score possible for the classification variables.

TABLE V

MEANS AND STANDARD DEVIATIONS FOR THE COW PRODUCTIVITY MEASURES[a]

Variable	No.	Mean	St. Dev.
1BW	119	71.2	7.2
1WW	119	456.7	35.2
1WS	119	12.5	0.7
2BW	144	72.3	8.2
2WW	144	462.9	36.1
2WS	144	12.5	0.8
ABW	220	71.0	5.8
AWW	220	452.9	30.0
AWS	220	12.4	0.6
1WWR	119	0.99	0.09
2WWR	144	1.02	0.08
AWWR	220	0.99	0.07
MPBW	220	69.1	2.9
MPWW	220	441.0	21.1
MPWS	220	12.3	0.3

[a]All weights are in pounds.

TABLE VI

CORRELATIONS BETWEEN FIRST AND AVERAGE CLASSIFICATION
AND WEIGHT VARIABLES AND COW PRODUCTIVITY MEASURES

	BRQL	GAPP	BFCR	TSC	WT	1BW	1WW	1WS	2BW	2WW	2WS	ABW	AWW	AWS	1WWR	2WWR	AWWR	MPBW	MPWW	MPWS
First Classification																				
APP	0.45[a]	0.94[a]	0.66[a]	0.87[a]	0.51[a]	-.05	-.02	-.08	0.06	0.04	0.04	0.04	-.04	-.05	0.02	0.02	-.03	0.06	0.00	0.00
BRQL		0.72[a]	0.62[a]	0.73[a]	0.12	0.02	0.00	0.04	0.01	-.11	0.07	0.02	-.10	0.09	0.04	-.13	-.09	-.05	-.16[b]	0.10
GAPP			0.75[a]	0.95[a]	0.44[a]	-.03	-.01	-.04	0.05	-.01	0.06	0.04	-.06	-.01	0.03	-.03	-.06	0.03	-.05	0.03
BFCR				0.93[a]	0.57[a]	-.08	0.00	0.01	-.08	-.19[b]	-.04	-.04	-.14[b]	-.07	0.03	-.16[b]	-.15[b]	-.04	-.14[b]	-.05
TSC					0.53[a]	-.05	-.01	-.03	-.01	-.10	0.02	0.00	-.10	-.04	0.04	-.10	-.11	0.00	-.10	-.01
WT						0.12	0.19[b]	-.04	0.17[b]	0.01	-.19[b]	0.09	0.01	-.19[a]	0.23[b]	0.08	0.03	0.18[a]	0.09	-.12
Average Classification																				
APP	0.47[a]	0.94[a]	0.74[a]	0.89[a]	0.60[a]	-.01	-.03	-.11	0.00	-.04	-.01	0.03	-.07	-.02	-.01	-.07	-.07	0.04	-.06	0.00
BRQL		0.74[a]	0.68[a]	0.74[a]	0.13[b]	0.07	0.04	0.01	-.03	-.14	0.04	-.01	-.11	0.08	0.07	-.14	-.09	-.07	-.18[a]	0.07
GAPP			0.68[a]	0.97[a]	0.51[a]	0.03	-.01	-.08	-.01	-.09	-.01	0.02	-.09	0.01	0.02	-.10	-.09	0.01	-.11	0.02
BRCR				0.95[a]	0.51[a]	-.03	-.02	-.01	-.10	-.19[b]	-.02	-.03	-.11	-.01	-.01	-.18[b]	-.13[b]	-.01	-.12	0.00
TSC					0.54[a]	0.01	-.01	-.06	-.05	-.13	-.01	-.01	-.10	0.00	0.02	-.14	-.11	-.01	-.11	0.01
WT						0.05	0.08	-.05	0.11	0.03	-.08	0.10	0.01	-.10	0.11	0.05	0.02	0.19[a]	0.10	-.04

[a]$P < .01$

[b]$P < .05$

Correlation coefficients between classification variables and birth weight ranged from -.08 to 0.06 with the correlations between total score and both average and most probable birth weight being 0.00. These correlations suggest there was virtually no relationship between classification scores and measures of birth weight.

There appears to be a slight negative relationship between measures of weaning weight and classification scores. These correlations range from -.19 to 0.04, and six of the 35 correlations involving a measure of weaning weight were significantly ($P < .05$) less than zero. Five of the six significant negative correlations concern the relationship of beef character to the weaning weight measures. Six of the seven correlations between total score and weaning weight measures were negative. Of the weaning weight measures studied, most probable weaning weight was the most accurate indicator of a cow's true producing ability in terms of weaning weight. Although only significant at the 0.15 probability level, the -.10 correlation between total score and most probable weaning weight suggests a slight negative relationship. Correlations ranging from -.08 to 0.10 indicate essentially no association between the classification variables and the weaning score measures.

Cow weight had highly significant ($P < .01$) positive correlations with appearance (0.51), general appearance (0.44), beef character (0.57), and total score (0.53), and a 0.12 ($P < .07$) correlation with breed qualities. These data indicate a slight positive relationship between cow weight and measures of birth weight and weaning weight, the correlations ranging from 0.09 to 0.18 and 0.01 to 0.23 for the two measures, respectively. There appears to be a negative association between cow weight and measures of weaning score, with correlations ranging from -.19 to -.04.

Correlation Coefficients between Average Classification Scores and Productivity Measures

The means and standard deviations for the classification variables and cow weight, and for the productivity measures are presented in Tables IV and V, respectively. The average classification scores are the arithmetic average of all available classification scores on the cows. The cows were classified from one to four times, the average number of classifications being 2.65. A more detailed description of the data is given in the lower portion of appendix Table XIII where the distribution of cows according to number of times classified for type score by cow age group is presented.

The correlation coefficients between the variables are presented in the lower portion of Table VI. As expected, there were rather high (0.74 to 0.97) positive correlations between the various classification subgroupings and total score.

The correlations between the classification variables and the measures of birth weight and weaning score were close to zero, the coefficients for the relationships ranging from -.10 to 0.07, and -.11 to 0.08, respectively. None of these correlations were significantly different from zero.

The data indicate a slight negative association between the classification variables and measures of weaning weight. Four of the 35 correlations involving a measure of weaning weight were significantly less than zero. These correlations range from -.19 to 0.07, with only four of the 35 correlations being positive. Three of the four significant negative correlations were concerned with the relationship of beef character to the weaning weight measures. Six of the seven correlations between total score and weaning weight measures were negative. The most accurate estimate of the true relationship between classification score and weaning weight was the -.11 ($P < .13$) correlation between total score and most probable weaning weight.

Average cow weight had highly significant ($P < .01$) correlations with appearance (0.60), general appearance (0.51), beef character (0.51), and total score (0.54), and a significant ($P < .05$) correlation with breed qualities (0.13). These data indicate a slight positive association between cow weight and measures of birth weight and weaning weight, the correlations ranging from 0.05 to 0.19 and 0.01 to 0.11 for the two measures, respectively. There appears to be a slight negative relationship between cow weight and measures of weaning score with correlations ranging from -.10 to -.04, although none of the coefficients were significantly less than zero.

The results obtained from these analyses are in general agreement with those reported in the literature. Koch and Clark (1955) and Marlowe (1962) have reported low relationships between cow conformation grade and measures of calf growth to weaning and calf weaning conformation score. Numerous workers have reported rather low positive relationships between cow weight and calf growth to weaning.

There were no appreciable differences in the correlation coefficients of the various classification variables with a particular productivity measure in either the first or the average classification analyses. This was expected in view of the high interrelationships (correlations) of the classification measures. Therefore, subsequent analyses concerning the association of cow type classification score with cow productivity measures were determined by the relationship of total score to the productivity measures. The correlation coefficients between a particular classification variable and the series of measurements for each productivity trait have been very similar. This was anticipated due to the high correlations among the various measures for the productivity traits (appendix Table XIV). In view of this close agreement of correlations and considering that the MPPA measures are the most accurate estimates of real producing ability, subsequent analyses include only the MPPA measures as cow productivity variables.

Within Season Correlations Between Total Classification Scores of Cows of Different Ages and Productivity Measures

In order to evaluate possible differences in the relationship of type classification score and cow productivity due to differences in season of classification or age group at first classification, correlation analyses were conducted within age group within season within year and pooled over years. These analyses were conducted on data from 103 cows that were classified four times, twice within each season. The cows were divided according to age at first classification, there being 46, 41, and 16 cows in age groups 2, 3, and 4, respectively.

The correlation coefficients between total score and the cow productivity variables are presented in Table VII. Correlations between spring score and most probable birth weight were essentially zero for all age groups, however, all these correlations were negative. These data indicate virtually no association between spring score and most probable weaning weight for age group 2; however, there appears to be a slight negative association for age groups 3 and 4. One would expect the cows in age group 3 to be in the poorest condition in the spring, consequently, the -.20 correlation between spring scores and most probable weaning weight is probably a result of the higher producing cows in age group 3 being thinner and receiving lower classification scores. There were a limited number of cows in age group 4; therefore, the correlations reported in age group 4 should be interpreted with extreme caution. The 0.16 and 0.14 correlations between spring score and most probable weaning score for age groups 2 and 4, respectively, may indicate a slight positive relationship; however, the 0.01 correlation for age group 3 indicates no relationship between the variables. It should be remembered that both total score and most probable weaning score were based on subjective evaluations; therefore, the correlation coefficients between these variables should be interpreted with caution. None of the correlations between spring score and the productivity measures were significantly ($P < .05$) different from zero; therefore, these correlations are likely a chance deviation from zero.

Correlations between fall score and most probable birth weight were close to zero for age groups 2 and 3, but the 0.13 correlation for age group 4 may indicate a slight positive association. The correlations of fall score and most probable weaning weight were significantly less than zero for age groups 2 and 3, but close to zero for age group 4. The younger cows in age groups 2 and 3 utilized their body stores of energy and nutrient intake for lactation, growth, and maintenance; however, the older cows in age group 4 probably required very little energy for body growth. Therefore, the older cows in age group 4 were likely in better condition in the fall following lactation and consequently received higher classification scores. The significant negative correlations between total score and most probable weaning weight for age groups 2 and 3 were probably the result of the better producing younger cows being thinner in the fall after nursing a calf and consequently receiving lower classification scores. The 0.18 correlation between fall score and most probable weaning score for age group 4 indicates a slight positive association, but the correlations were negative and close to zero for age groups 2 and 3.

TABLE VII

POOLED WITHIN SEASON CORRELATIONS BETWEEN TOTAL CLASSIFICATION SCORES OF COWS OF DIFFERENT AGES AND PRODUCTIVITY MEASURES

	Spring Classification			Fall Classification		
Cow Age Group	2	3	4	2	3	4
Cow Productivity Measures						
MPBW	-.07	-.03	-.01	-.03	-.06	0.13
MPWW	-.02	-.20	-.15	-.24*	-.33**	-.03
MPWS	0.16	0.01	0.14	-.03	-.09	0.18

*P< .05
**P< .01

There was little difference between the spring and fall correlation coefficients for a particular productivity measure for age group 3. The differences between the spring and fall correlation coefficients for age group 4 should be viewed with caution because of the limited number of cows in age group 4. The differences between the spring and fall correlation coefficients for age group 2 for most probable weaning weight and most probable weaning score, however, were more pronounced. The better producing cows in age group 2 were likely to have the greatest change in condition, and consequently type score from spring to fall.

The cows that weaned the heavier, higher scoring calves were probably in the poorest condition in the fall, and therefore would have received lower type classification scores. Thus, the observed change in the correlation coefficients from spring to fall is probably the result of a more pronounced change in the spring and fall ranking of cows in age group 2 with respect to total score than for the cows in age groups 3 and 4.

The Relationahip of Average Cow Condition Score to Average Type Classification and Cow Productivity Measures

All cows were assigned a condition (fatness) score at the time of classification. The condition score had a non-normal distribution; therefore, its relationship to the other variables was studied by linear regression, with condition score being the independent variable. The average classification and condition scores were used for this analysis because they represent the most accurate single estimate of these variables.

The linear regression coefficients for average type classification and cow productivity measures on average cow condition score are presented in Table VIII. The highly significant (P< .01) regression coefficients for beef character, breed qualities, general appearance, and total score on condition score indicate the fatter cows received higher type classification scores. The highly significant (P< .01) regression coefficient for cow weight on condition score indicates the heavier cows were fatter at classification.

Marlowe (1962) found flesh condition to be a major source of variation in both cow weight and grade; when it was reported that flesh condition accounted for 22.5 percent of the variation for these two measures in Angus cows.

TABLE VIII

LINEAR REGRESSION COEFFICIENTS FOR AVERAGE TYPE CLASSIFICATION AND COW PRODUCTIVITY MEASURES ON AVERAGE COW CONDITION SCORE

Variable	b	Variable	b
APP	0.153	2WW	-11.98*
BFCR	1.568**	2WS	-.227*
BRQL	0.517**	ABW	0.37
GAPP	0.678**	AWW	-6.61
TSC	2.220**	AWS	-.139*
WT	58.61**	1WWR	-.011
1BW	0.25	2WWR	-.016
1WW	-.18	AWWR	-.015
1WS	-.004	MPBW	0.37
2BW	0.02	MPWW	-4.45
		MPWS	-.081*

*P< .05
**P< .01

The regression coefficients for the birth weight measures on condition score were generally close to zero. The regression coefficients for the weaning weight measures on condition score range from -11.98 to -.011. The regression coefficients for the weaning score measures on condition score range from -.227 to -.004, with three of the negative coefficients being significantly ($P < .05$) less than zero. These regression coefficients indicate that the better milking cows which weaned heavier, higher scoring calves were thinner and received lower classification scores at classification time.

Prediction Equations

One of the objectives of this study was to determine the accuracy of type classification score for predicting cow productivity. Many beef cattle producers make their final heifer replacement selections at about 18 months of age. If the producer is on a spring calving program, as was the case in the present study, the heifers will be about 18 months of age in the early fall prior to producing their first calf as a 2-year-old. The producer is interested in information that has utility in estimating a heifer's future producing ability. In many cases, an individual's conformation and weight are the only bases for such an estimate. The measure of cow productivity used in these analyses was most probable weaning weight, and the type classification variable used was total score. In addition, condition score (COND) at classification and the heifer's 18-month adjusted weight (WT) were evaluated alone and together with total score as predictors of MPWW.

Table IX presents several prediction equations for MPWW and the coefficient of determination and standard error of estimate for each equation. These prediction equations were developed from data on 55 pregnant heifers that were classified at approximately 18 months of age. These equations provided evidence concerning the relative merit of total score, condition score, and 18-month adjusted weight for predicting MPWW.

TABLE IX

PREDICTION EQUATIONS, COEFFICIENTS OF DETERMINATION, AND STANDARD ERRORS OF ESTIMATE FOR MPWW FOR HEIFERS CLASSIFIED AFTER 18 MONTHS OF AGE AND PRIOR TO CALVING

Prediction Equation $\hat{Y}$ = MPWW in Pounds	Coefficients of Determination	Standard Error of Estimate (lbs)
$\hat{Y}$ = average MPWW = 439.3	------	20.4
$\hat{Y}$ = 485.1 - 0.593 (TSC)	0.0081	20.5
$\hat{Y}$ = 367.8 + 0.094 (WT)	0.0598	19.9
$\hat{Y}$ = 443.1 - 1.092 (COND)	0.0016	20.6
$\hat{Y}$ = 427.4 - 0.952 (TSC) + 0.127 (WT) - 1.106 (COND)	0.0911	20.0

The 55 heifers had an average MPWW of 439 pounds with a standard deviation of 20.4 pounds. A relatively low linear relationship existed between MPWW and total score, 18-month weight, and condition score; therefore, a prediction equation which included these variables alone or in combination was of little value. The standard error of estimate was not appreciably altered by using these prediction equations. These data suggest that knowledge of a cow's total score, adjusted weight, or condition score at 18 months of age and prior to calving is of little value in predicting MPWW. There was a 0.24 ($P < .07$) correlation coefficient between 18-month adjusted weight and MPWW, and although of limited value, 18-month adjusted weight appeared to be the most accurate estimator of MPWW for heifers previous to calving. On the other hand, total score and condition score had nonsignificant negative correlations of -.09 and -.04 with MPWW, respectively.

Table X presents several prediction equations and their coefficients of determination and standard errors of estimate for MPWW for data from 51 cows classified in the fall after weaning their first calf. The weaning weight of the cow's first calf (calf WW), and the cow's total score, weight, and condition score at classification were evaluated alone and together as predictors of MPWW.

TABLE X

PREDICTION EQUATIONS, COEFFICIENTS OF DETERMINATION, AND STANDARD ERRORS OF ESTIMATE FOR MPWW FOR COWS CLASSIFIED IN THE FALL AFTER WEANING THEIR FIRST CALF

Prediction Equation $\hat{Y}$ = MPWW in Pounds	Coefficients of Determination	Standard Error of Estimate (lbs)
$\hat{Y}$ = Average MPWW = 438.6	------	18.3
$\hat{Y}$ = 564.9 - 1.614 (TSC)	0.0324	18.2
$\hat{Y}$ = 416.8 + 0.030 (WT)	0.0100	18.4
$\hat{Y}$ = 480.1 - 15.647 (COND)	0.0676	17.8
$\hat{Y}$ = 296.2 + 0.317 (Calf WW)	0.4225	14.0
$\hat{Y}$ = 363.1 - 1.396 (TSC) + 0.064 (WT) - 1.026 (COND) + 0.312 (Calf WW)	0.4713	13.9

This group of 51 cows had an average MPWW of 439 pounds with a standard deviation of 18.3 pounds. A relatively low linear relationship existed between MPWW and total score, cow weight, and condition score; consequently, a prediction equation involving these variables alone was of little value and did not appreciably alter the standard error of estimate. There was a highly significant (P< .01) linear relationship between MPWW and calf WW, and the prediction equation involving calf WW reduced the standard error of estimate to 14.0 pounds. A prediction equation utilizing all four variables was no more accurate in predicting MPWW than the one utilizing calf WW alone. This is further indication of the general lack of value for total score, cow weight, and condition score for predicting MPWW in these data.

It should be mentioned that the 55 heifers classified at 18 months of age were a selected group. These heifers were selected as herd replacements on either their adjusted 205-day weaning weight or adjusted 18-month weight. Therefore, these 55 heifers do not represent the entire population of females available for selection. These 55 heifers were the only group of selected individuals in the study. The remaining cows were foundation females and were considered a representative sample of the Angus breed. One might expect to find less variation in total type classification score and MPWW within the selected group of 55 heifers than within the entire group of cows in this study. There was little difference, however, in the standard deviations for total classification score for the 55 heifers and for average total classification score for the entire group of 220 cows, these being 3.1 and 3.0, respectively. The standard deviations for MPWW were 20.4 pounds and 21.1 pounds for the 55 heifers and the entire group of 220 cows, respectively. Therefore, it appears the 55 heifers were a representative sample of the entire group of cows studied with respect to total classification score and MPWW.

The results of these prediction equation analyses suggest that there is limited means to apply selection pressure for increased cow productivity prior to a cow weaning her first calf; although selecting replacement females on the basis of their 18-month adjusted weight would be of some value. Thus, under most commercial conditions similar to those in the present study, where the objective is to increase the producing ability of the cow herd, it would seem desirable for a breeder to make his final herd replacement selections after a cow has weaned her first calf.

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to determine the magnitude of the association between cow type classification score and measures of cow productivity, and to determine the accuracy of type classification score for predicting cow productivity, both alone and together with cow weight, cow condition score, and information provided by a cow's first performance record.

Classification and performance records from 220 Angus cows raised under range conditions were studied. The cows were classified in 1964 and 1965 by official breed association classifiers and their performance records were made from 1964 to 1969. Cow productivity was measured by calf performance to weaning.

Least squares analyses were performed to obtain additive correction factors for birth weight, 205-day weaning weight, and weaning conformation score for the effects of years, sex of calf, and age of dam. These correction factors accounted for the non-genetic sources of variation due to these factors and put the performance records on a more comparable basis. The cow performance records corrected for year, sex of calf, and age of dam effects were used to analyze the relationship between cow type classification scores and cow productivity.

The correlation coefficients between first and average classification scores and measures of birth weight and weaning score were close to zero; however, the correlations with measures of weaning weight indicated a slight negative association. The correlation coefficients of the first classification scores and the average classification scores with a particular productivity measure were very similar. Therefore, even though average classification score may yield a more accurate estimate of a cow's true type than first classification score, it did not have a markedly different relationship with the productivity measures. Cow weight at the time of classification was positively correlated with the classification scores and with measures of birth weight and weaning weight, but was negatively correlated with the weaning score measures. All of the correlation coefficients between cow weight or the classification scores and measures of cow productivity were of low magnitude.

Within season correlation analyses between total classification scores of cows of different ages and productivity measures were conducted on 103 cows that were classified four times. None of the correlation coefficients between spring scores and most probable birth weight, weaning weight, and weaning score were significantly different from zero. Correlations between fall scores and most probable birth weight and weaning score were negative and close to zero for age groups 2 and 3, however, the correlations were positive for age group 4. The correlations between fall scores and most probable weaning weight were significantly less than zero for age groups 2 and 3, but close to zero for age group 4. The significant negative correlations for age groups 2 and 3 are probably the result of the better producing younger cows being thinner in the fall and consequently receiving lower classification scores.

Linear regression coefficients for average type classification and cow productivity measures on average cow condition score indicated that the fatter cows received higher type classification scores. The regression coefficients for the birth weight measures on condition score were close to zero; however, the negative coefficients for the weaning weight and weaning score measures indicated the cows which weaned heavier, higher scoring calves were thinner at classification time.

Prediction equations for most probable weaning weight were developed from data on 55 heifers that were classified at approximately 18 months of age. Prediction equations which included total classification score, 18-month adjusted weight, or condition score, alone or in combination, were of little value and did not appreciably alter the standard error of estimate. 18-month adjusted weight had a positive relationship with most probable weaning weight, but both total score and condition score had a negative relationship with most probable weaning weight.

Prediction equations for most probable weaning weight were also developed from data on 51 two-year-old cows classified in the fall after weaning their first calf. The weaning weight of the cow's first calf, and the cow's total classification score, weight, and condition score were evaluated alone and together as predictors of most probable weaning weight. The prediction equation involving calf weaning weight reduced the standard error of estimate from 18.3 to 14.0 pounds. A prediction equation utilizing all four variables was no more accurate than the equation utilizing calf weaning weight alone.

The conclusions drawn from the results obtained in this study can be summarized as follows:

1. The correlation coefficients between type classification scores and measures of cow productivity were of low magnitude. A slight negative association was indicated between type classification scores and cow productivity as measured by calf weaning weight.
2. The relationship between a cow's first classification score with measures of cow productivity and a cow's average classification score over several classifications with measures of cow productivity was not appreciably different.
3. Spring classification scores had virtually no association with cow productivity; however, fall classification scores were negatively correlated with cow productivity as measured by most probable weaning weight for cows 2 and 3 years of age at first classification.
4. Fatter cows received higher type classification scores but weaned lighter, lower scoring calves.
5. Total type classification score was of little value in predicting future producing ability as measured by most probable weaning weight. Although of limited value, a heifer's 18-month adjusted weight was the most accurate estimator of future producing ability for heifers prior to calving. Weaning weight of the cow's first calf was a valuable predictor of future producing ability.

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TABLE XI

NUMBER OF OBSERVATIONS IN EACH CLASSIFICATION FOR THE LEAST SQUARES ANALYSIS

	μ	Y_4	Y_5	Y_6	Y_7	Y_8	Y_9	S_1	S_2	A_2	A_3	A_4	A_5
μ	990	119	171	177	181	169	173	498	492	196	181	176	437
Y_4		119	-	-	-	-	-	57	62	55	24	13	28
Y_5			171	-	-	-	-	91	80	18	68	47	37
Y_6				177	-	-	-	82	95	29	14	63	71
Y_7					181	-	-	85	96	32	28	10	111
Y_8						169	-	91	78	28	17	23	101
Y_9							173	92	81	34	30	20	89
S_1								498	-	99	88	79	232
S_2									492	97	93	97	205
A_2										196	-	-	-
A_3											181	-	-
A_4												176	-
A_5													437

μ = overall mean; Y_4 = 1964, Y_5 = 1965, Y_6 = 1966, Y_7 = 1967, Y_8 = 1968, Y_9 = 1969; S_1 = bull, S_2 = heifer; A_2 = 2-year-old dam, A_3 = 3-year-old dam, A_4 = 4-year-old dam, A_5 = 5- to 9-year-old dam.

TABLE XII

ANALYSIS OF VARIANCE OF BIRTH WEIGHTS, 205-DAY WEANING WEIGHTS AND WEANING SCORE

Source of Variation	Degrees of Freedom	Mean Squares		
		Birth Weights	Weaning Weights	Weaning Score
Total	989			
Year	5	1854.44**	61310.41**	7.962**
Sex	1	4748.85**	371465.77**	3.586**
Age of Dam	3	2465.46**	183489.37**	28.178**
Year x Sex	5	108.27	4103.46*	0.541
Year x Age of Dam	15	80.04	2690.52	0.605
Sex x Age of Dam	3	59.75	963.37	0.137
Error	957	57.12	1417.69	0.564

*P< .05
**P< .01

TABLE XIII

A DISTRIBUTION OF COWS ACCORDING TO NUMBER OF PERFORMANCE RECORDS AND NUMBER OF TIMES CLASSIFIED FOR TYPE SCORE BY COW AGE GROUP

	Cow Age Group			
	1	2	3	4
No. Performance Records				
1	16	11	8	7
2	9	9	5	6
3	8	12	9	5
4	20	10	12	11
5	5	7	10	11
6	--	21	7	1
No. Times Classified for Type Score				
1	37	21	4	15
2	6	1	--	3
3	15	2	6	7
4	--	46	41	16

TABLE XIV

CORRELATION COEFFICIENTS BETWEEN THE
COW PRODUCTIVITY MEASURES

	1WW	1WS	2BW	2WW	2WS	ABW	AWW	AWS	1WWR	2WWR	AWWR	MPBW	MPWW	MPWS
1BW	0.46[a]	0.16	0.23[a]	-.06	-.15	0.71[a]	0.27[a]	0.07	0.46[a]	-.04	0.30[a]	0.62[a]	0.19[b]	0.06
1WW		0.34[a]	0.16	0.29[a]	0.02	0.39[a]	0.79[a]	0.32[a]	0.96[a]	0.35[a]	0.79[a]	0.37[a]	0.71[a]	0.31[a]
1WS			0.14	0.06	-.07	0.16	0.28[a]	0.61[a]	0.33[a]	0.10	0.27[a]	0.17[b]	0.24[a]	0.54[a]
2BW				0.53[a]	-.03	0.71[a]	0.39[a]	0.07	0.16[b]	0.51[a]	0.39[a]	0.70[a]	0.40[a]	0.07
2WW					0.33[a]	0.33[a]	0.72[a]	0.31[a]	0.28[a]	0.95[a]	0.70[a]	0.33[a]	0.73[a]	0.34[a]
2WS						-.01	0.29[a]	0.71[a]	0.04	0.28[a]	0.25[a]	0.01	0.29[a]	0.69[a]
ABW							0.53[a]	0.17[a]	0.39[a]	0.32[a]	0.52[a]	0.92[a]	0.49[a]	0.18[a]
AWW								0.54[a]	0.77[a]	0.71[a]	0.96[a]	0.53[a]	0.94[a]	0.54[a]
AWS									0.32[a]	0.28[a]	0.49[a]	0.12	0.43[a]	0.90[a]
1WWR										0.35[a]	0.81[a]	0.36[a]	0.69[a]	0.32[a]
2WWR											0.74[a]	0.32[a]	0.72[a]	0.31[a]
AWWR												0.50[a]	0.89[a]	0.51[a]
MPBW													0.58[a]	0.19[a]
MPWW														0.52[a]

[a]P< .01, [b]P< .05

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