Relationship Between Cow Type Classification Score and Cow Productivity

John Frey, R. R. Frahm and D. F. Stephens

Story in Brief

The purpose of this study was to determine the relationship 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 the performance record of a cow's first calf.

Classification and productivity 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 performance was measured on their calves produced from 1965 to 1969. Cow productivity was measured by calf performance to weaning.

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. 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. Fatter cows tended to receive higher type classification scores but weaned lighter, lower scoring calves. Total type classification score was of little value in predicting future production 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 pro-

In cooperation with Ft. Reno Livestock Research Station, Agricultural Research Service, Animal Science Research Division, USDA.

ducing ability for heifers prior to calving. Weaning weight of the cow's first calf was a more reliable predictor of future producing ability than any of the measurements taken on the cow.

Introduction

Beef cattle breeders have traditionally put some selection pressure on the visual subjective evaluation of an individual's usefulness for a certain purpose. One of the objectives of their breeding programs has been to produce animals of a certain type. The present concept of desirable beef type is generally characterized by abundance of muscling, freedom from excess fat, and adequate size and scale. In practice, type is subjectively determined by visual appraisal of body size and 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.

In addition to type, breeders select breeding stock on the basis of performance in economically important traits. Evidence has strongly indicated that performance should be the first consideration; however, selection pressure for type still continues. In breeding programs designed to improve the level of productivity, it is important to determine the relative attention to give actual performance records and visual appraisal of the animal being evaluated. The proper utilization of these two kinds of information in selecting breeding stock requires an accurate determination of the relationship between type and productivity.

Materials and Methods

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. These cattle are part of the four Angus lines involved in a beef cattle selection experiment which has been described by Frahm and Whiteman (1968) and Frahm (1970).

The measure of type used in this investigation was the official breed association type classification score given the cows in the spring and fall of 1964 and 1965. Five official classifiers scored the cattle during the first three classifications and six official classifiers scored the cattle in the fall of 1965. The average of the scores given a cow by all classifiers on the same date was used as the type score for that cow since it should be the most accurate estimate of a cow's true type. 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 categorized into four age groups: 1, 2, 3 and 4 years and older, based on their age at first classification. Cows in age group 1 were approximately 18 to 20 months of age when first classified.

The score card used to determine type classification score is presented in Table 1. 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. The cows were also evaluated for condition or fatness by the official classifiers using 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 the winter, in the spring after calving and in the fall after weaning and cow weight at the time of classification was determined as a linear estimate based on the two closest actual weights.

Cow productivity was measured by calf performance to weaning. The method of least squares was used to obtain additive correction factors for adjusting 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 served to adjust the calf performance records for these known non-genetic sources of variation and thereby placed the calf performance records, and consequently the cow productivity measures, on a more comparable basis. A cow's productivity record consisted of the adjusted birth weights (BW), weaning weights (WW) and weaning conformation scores (WS) of her offspring. In addition, the most probable producing ability (MPPA) of each cow was determined for birth weight

Table 1. Score Card for Cow Type Classification.

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

(MPBW), weaning weight (MPWW), and weaning score (MPWS) according to the formula:

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

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.

The repeatability of a trait is the correlation between different performance records of an individual, and it indicates the extent that observed differences between performance records of individual will be repeated in the future. The repeatability estimates used in this study were 0.25, 0.40, and 0.30 for birth weight, weaning weight, and weaning score, respectively.

The cow productivity measures considered in this study were the cow's first performance record as a 2-year-old, the average of all available performance records, and the most probable producing ability measures. A cow's first and average performance records will be denoted by a prefix "1" and "A", respectively. Thus, "1BW" and "ABW" indicates the birth weight of a cow's first calf and the average birth weight of all calves, respectively. Of the productivity measures considered, MPPA is expected to provide the most accurate estimate of an individual's relative genetic potential for productivity. Some of the cows in this study were obtained after they had produced one or more calves. Consequently, data were not available on the first performance record for cows in age groups 3 and 4. There were 119 and 220 cows with first and average performance records, respectively. The number of performance records per cow ranged from one to six, the average being 3.38.

Results and Discussion

Correlation Analyses of Classification Scores and Cow Productivity Measures

The least squares additive correction factors used to adjust birth weight, 205-day weaning weight, and weaning score for the effects of year, sex and age of dam are presented in Table 2. Calf performance records were adjusted to a bull calf out of a mature cow (5 years and older) basis. The means and standard deviations for the classification variables and for cow weight (WT) at classification time are presented in Table 3. The means and standard deviations for the productivity measures are presented in Table 4. The correlation coefficients between

Table 2. Additive Correction Factors For Birth Weight, Weaning Weight and Weaning Score.

Source	Birth Weight, lbs.	Weaning Weight, lbs.	Weaning Score
Year			
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[1]			
1	0.00	0.00	0.00
2	3.99	35.86	— .14
Dam Age (yrs.)			
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

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

Table 3. Means and Standard Deviations for First and Average Classification Variables and Cow Weight at Classification Time.

Variable[1]	Number of cows	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 (lbs.)	220	875.6	147.6	932.5	140.3

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

Tble 4. Means and Standard Deviations for the Cow Productivity Measures.[1]

Variable	Number of cows	Mean	St. dev.
1BW	119	71.2	7.2
1WW	119	456.7	35.3
1WS	119	12.5	0.7
ABW	220	71.0	5.8
AWW	220	452.9	30.0
AWS	220	12.4	0.6
MPBW	220	69.1	2.9
MPWW	220	441.0	21.1
MPWS	220	12.3	0.3

[1] All weights are in pounds.

classification scores and the productivity measures are presented in Table 5.

The realtionship between first classification scores and the productivity measures were of particular interest because the typical breeder probably would only have his cow herd classified once. The cows in this study were classified from one to four times, the average number of classifications being 2.65. Therefore, it was of interest to evaluate the relationship between average classification scores and the productivity measures to determine if they were more highly associated with the productivity measures than were the first classification scores.

As can be seen in Table 5, 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 is expected to be 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. In view of this close agreement, the correlations of the first and average classification scores with the productivity measures will be discussed together.

Since total score consisted of a weighted average of the clasisfication subgroupings, the high (0.73 to 0.97) positive relationships generally obtained by correlating a component part with the total score were anticipated. Correlation coefficients between classification variables and measures of birth weight and weaning score ranged from —.08 to 0.07 and —.11 to 0.10, respectively. Most of these correlations were close to zero, suggesting there was virtually no relationship between classification scores and measures of birth weight or weaning score. There appears to be a slight negative relationship between measures of weaning weight and classification scores. These correlations ranged from —.18 to 0.04, and only one of the coefficients was greater than zero. Four of the 30 correlations involving a measure of weaning weight were significantly ($P<.05$) less than zero.

Cow weight had highly significant ($P<.01$) positive correlations with appearance, general appearance, beef character, and total score in both the first and average classification analyses. These data indicate a slight positive relationship between cow weight and measures of birth weight and weaning weight, with correlations ranging from 0.05 to 0.19 and 0.01 to 0.19 for the two measures, respectively. There appears to be a slight negative association between cow weight and measures of weaning score, with correlations ranging from —.19 to —.04.

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 coefficients were determined within each age group for spring and fall classifications

Table 5. Correlations Between First and Average Classification and Weight Variables and Cow Productivity Measures.

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

[1] Significantly different from zero at the 0.01 probability level.
[2] Significantly different from zero at the 0.65 probability level.

separately and pooled over years. These analyses were conducted on data from 103 cows that were classified all four times (twice within each season). The cows were categorized according to age at first classification, there being 46, 41 and 16 2-, 3-, and 4-year-old cows, respectively.

The correlation coefficients between total score and the cow productivity variables are presented in Table 6. Correlations between both spring and fall scores and most probable birth weight were essentially zero for all age groups. The data indicated virtually no association between spring score and most probable weaning weight for the age group 2; however, there was a significant ($P<.05$) negative association for the fall classification score and MPWW. This pronounced change in spring and fall correlations for age group 2 was possibly the result of the younger cows having a greater change in condition due to lactation and, consequently, classification score from spring to fall.

A negative relationship was indicated between classification score and MPWW for age group 3, with the fall correlation coefficient being significantly ($P<.01$) less than zero. There were a limited number of cows in age group 4, therefore, the correlations for age group 4 should be interpreted with extreme caution. The negative correlations obtained for age groups 2 and 3 were probably the result of the better producing younger cows being in poorer condition due to heavy lactation, therefore, receiving lower classification scores. 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 cows in age group 4 were likely in better condition and consequently would have received higher type classification scores.

The 0.16 correlation between spring score and most probable weaning score for age group 2 and the 0.14 and 0.18 correlations for age group

Table 6. Pooled Within Season Correlations Between Total Classification Scores and Productivity Measures for Cows of Different Ages.

Cow productivity measures	Cow age group at first classification (years)					
	2		3		4	
	Spring class.	Fall class.	Spring class.	Fall class.	Spring class.	Fall class.
MPBW	—.07	—.03	— .03	—.06	—.01	—.13
MPWW	—.02	—.24*	— .20	—.33**	—.15	—.03
MPWS	0.16	—.03	0.01	—.09	0.14	0.18

* Significantly different from zero at the 0.05 probability level.
** Significantly different from zero at the 0.01 probability level.

4 may indicate a slight positive relationship; however, the remaining correlations were close to zero. Both classification score and most probable weaning score were based on subjective evaluations; therefore, the correlation coefficients between these variables should be interpreted with caution.

Regression Analyses of Classification Scores and Productivity Measures on Average Cow Condition Score

The linear regression coefficients for average type classification and cow productivity measures on average cow condition score are presented in Table 7. The linear regression coefficient of a response variable (such as classification scores and cow productivity measures) on average condition score measures the amount of change in the response variable expected for each unit change in average condition score. For example, the regression coefficient of total score on condition score of 2.22 means that a one unit increase in condition score is expected to result in 2.22 units increase in total score.

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. 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 ranged from —6.61 to —.18. The regression coefficients for the weaning score measures on condition score range from —.14 to —.004, with two of the negative co-

Table 7. Linear Regression Coefficients of Cow Type Classification and Productivity Measures on Condition Score.

Reponse variable	Regression coefficient	Reponse variable	Regression coefficient
APP	0.15	1WS	—0.004
BFCR	1.57**	ABW	0.37
BRQL	0.52**	AWW	—6.61[1]
GAPP	0.68**	AWS	—0.14
TSC	2.22**	MPBW	0.37
WT	58.61**	MPWW	—4.45[1]
1BW	0.25	MPWS	—0.08*
1WW	—0.18		

* Significantly different from zero at the 0.05 probability level.
** Significantly different from zero at the 0.01 probability level.
[1] Significantly different from zero at the 0.10 probability level.

efficients 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 for Cow Productivity

One of the objectives of this study was to determine the accuracy of type classification score for predicting cow productivity. The producer is interested in information that has utility in estimating a heifer's future producing ability in order that the genetically superior heifers among those available are selected for replacements in the cow herd. In many cases, the only information available at the time replacement heifers are selected is weight and a subjective evaluation of conformation or type; therefore, prediction equations for MPWW were developed utilizing total classification score (TSC), condition score (COND) and 18-month adjusted weight (WT).

These prediction equations for MPWW were developed from data on 55 pregnant heifers that were classified at approximately 18 months of age (Table 8). The standard error of estimate is essentially the average deviation (or average miss) of the predicted MPWW value from the actual MPWW value. The coefficient of determination is a measure of the proportion of the variation in MPWW accounted for by the prediction equation. The smaller the standard error of estimate and the larger the coefficient of determination, the more accurate the prediction equation is in predicting MPWW.

The 55 heifers had an average MPWW of 439 pounds with a standand deviation of 20.4 pounds. Thus if the MPWW of every heifer was estimated to be this average amount, the heifer's actual MPWW would be missed by 20.4 pounds on the average. A relatively low linear relation-

Table 8. Prediction Equations for MPWW of Heifers Classified at 18 Months of age.

Prediction equation ($\hat{Y}$ = MPWW in pounds)	Coefficient of Determination	Standard Error of Estimate (lbs.)
$\hat{Y}$ = average MPWW = 439.3	----	20.4
$\hat{Y}$ = 485.1 — 0.593 (TSC)	0.008	20.5
$\hat{Y}$ = 367.8 + 0.094 (WT)	0.060	19.9
$\hat{Y}$ = 443.1 — 1.092 (COND)	0.002	20.6
$\hat{Y}$ = 427.4 — 0.952 (TSC) + 0.127 (WT) — 1.106 (COND)	0.091	20.0

ship existed between MPWW and total score, 18-month weight, and condition score; therefore, the prediction equations which included these variables alone or in combination were 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. However, there was a 0.24 ($P<.01$) correlation coefficient between 18-month adjusted weight and MPWW, and although of limited value, it appeared to be the most accurate prediction of MPWW for heifers previous to calving.

Table 9 presents several prediction equations for MPWW and their coefficients of determination and standard errors of estimate determined from data on 51 cows classified in the fall after weaning their frist 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. This group of 51 cows had an average MPWW of 439 pounds with a standard deviation of 18.3 pounds. Therefore, a prediction based on the average alone would miss the actual MPWW by 18.3 pounds on the average. A relatively low linear relationship existed between MPWW and total score, cow weight, and condition score; consequently, prediction equations involving these variables alone were 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 (average miss) 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 a further indication of the general lack of merit of total score, cow weight, and condition score for predicting MPWW in these data.

Table 9. Prediction Equations for MPWW of Cows Classified in the Fall After Weaning Their First Calf.

Prediction equation ($\hat{Y}$ = MPWW in pounds)	Coefficient of Determination	Standard Error of Estimate (lbs.)
$\hat{Y}$ = average MPWW = 438.6	----	18.3
$\hat{Y}$ = 564.9 — 1.614 (TSC)	0.032	18.2
$\hat{Y}$ = 416.8 + 0.030 (WT)	0.010	18.4
$\hat{Y}$ = 480.1 — 15.647 (COND)	0.068	17.8
$\hat{Y}$ = 296.2 + 0.317 (Calf WW)	0.422	14.0
$\hat{Y}$ = 363.1 — 1.396 (TSC) + 0.064 (WT) — 1.026 (COND) + 0.312 (Calf WW)	0.471	13.9

Summary

The results of this study suggest there is limited opportunity to apply selection pressure for increased cow productivity prior to a cow weaning her first calf; however, selecting replacement females on the basis of their 18-month adjusted weight would be of some value. Although some initial screening is necessary, under most commercial conditions similar to those in this study where the objective is to increase the productivity of the cow herd, delaying the final selection of herd replacement until after the first calf is weaned would seem justified. The general lack of correlation between classification scores and measures of productivity suggests that both classification score and performance data must be employed as selection criteria if improvement in type scores and level of performance are both goals of the breeding program.

Literature Cited

Frahm, R. R. 1970. Beef cattle selection studies. Okla. Agri. Exp. Sta. Miscell. Pub. 84:104.

Frahm, R. R. and J. V. Whiteman. 1968. Selection procedures for beef cattle improvement. Okla. Agri. Exp. Sta. Miscell. Pub. 80:111

Milk Production of Range Cows

Robert Totusek, D. F. Stephens, J. R. Kropp, J. W. Holloway, Leon Knori, and J. V. Whiteman

Story in Brief

An experiment has been initiated to determine the influence of level of milk production of brood cows on productivity, supplemental feed requirements and efficiency of beef production. Three levels of milk production will be established with three kinds of females-Herefords, Hereford and Holstein crossbreds, and Holsteins. Three levels of supplement will be fed to determine the relationship between level of milk production and feed requirements. Growth curves of heifers during their first year on test and preliminary data on milk production and calf performance from a limited number of "pilot" females are presented.

In cooperation with the Agricultural Research Service, Animal Science Research Division, USDA.