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An Analysis of 26 Years of Beef Bull Performance Testing at Auburn University

CONTENTS

COVER PHOTO. The new Bull Test Station at Auburn University.

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An Analysis of 26 Years of Beef Bull Performance Testing at Auburn University

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PERFORMANCE TESTING of beef bulls that included consignments from university and cooperative herds in Alabama dates back to 1951. This Alabama Agricultural Experiment Station program was designed to enable breeders to identify bulls that, when tested under uniform conditions, gained faster and therefore more efficiently.

The concept of performance testing is not new. In early controlled studies Sheets *(14),* Winters and McMahon *(17),* Black and Knapp *(1),* and Knapp *et al. (6)* reported differences in various performance traits among beef bulls and described methods of utilizing these differences in a selection program.

Rapid gaining cattle make more efficient use of management, labor, capital, facilities, and equipment. Perhaps of more importance, they are more efficient in their utilization of feed as shown by Winters and McMahon *(17),* Knapp and Baker *(7),* and later by Koch *et al. (9).* Brown and Keaton *(2)* summarized 10 years of performance testing at Arkansas which included consignment bulls tested at three locations. This study provided individual feed efficiency in addition to rate of gain. Results showed a 0.05-pound increase in average daily gain (ADG) per year, which resulted in a yearly reduction of 0.09 pound of feed required to produce a pound of gain. Silcox *(16)* analyzed 3 years of test data collected at the new test station at Auburn where individual feed consumption was obtained. He concluded that ADG was the best predictor of feed efficiency, accounting for 68 percent of the differences in feed

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utilization. Adding other traits to the prediction equation, such as frame, muscling, and fat, increased accuracy very little.

Soon after Knapp and Nordskog *(8)* reported the first heritability estimates for growth and efficiency of gain, Patterson *et al. (10),* Shelton *et al. (15),* Chambers *et al. (3),* and Patterson *et al. (12)* presented results to show the relationship of test performance in bulls to performance of their progeny. Earlier, Patterson and McGuire *(11)* used path analysis (standardized partial regression coefficients) to show the relationship between performance traits, namely conformation score (CS), weight per day of age (WDA), and ADG with selling price.

The purpose of this publication is to show trends in performance throughout the test history and the influence that different factors have on test ADG.

MATERIALS AND METHODS

Data used in this study were from test records of bulls from 1951 through 1976 inclusive, a period of 26 years. Bulls were consigned by Alabama breeders and by the Alabama Agricultural Experiment Station of Auburn University.

There were 2,445 bulls that completed the tests, of which data from 2,369 were included for the analysis given in table 1. The remaining 76 bulls were from a second test conducted in 1968 at a different time of year. Since average performance differed greatly from other tests, these data were not included.

There were some minor differences in test dates, but in general bulls were delivered to the test station in early September and after a 3-week, warm-up period the official test was begun. The first five

TABLE 1. NUMBER OF BULLS ON TEST AND WEIGHT PER DAY OF AGE (WDA) REQUIREMENTS FOR ENTRY BY YEAR GROUPS

Group	Years	Bulls on test	WDA requirements
		No.	*Lb.*
A	1951-56	312	none
B	1957-59	200	1.5-1.75
C	1960-65	495	2.0
D	1966-69	475[1]	2.1
E	1970-72	440	2.2
F	1973-76	447	2.3 or 2.5[2]

[1]A second test with 76 bulls was conducted in 1968-69. These data were not included since the test was conducted during the spring and summer months with older cattle that performed differently.

[2]Minimum WDA requirements were 2.3 pounds for the British breeds and 2.5 pounds for the large breeds.

tests were 154 days in length, while all others were for 140 days. The tests were usually completed in February with a test sale in early March.

During the first 5 years, bulls were grouped in pens with covered feeding areas and dirt loafing lots. As a result of muddy conditions, the remainder of the tests were conducted in pastures containing covered self-feeders.

For the first six tests there were no entry requirements other than bulls be purebred, be born on or after October 1 and before March 1 of the following year, and the farm or ranch be located in Alabama. Thereafter, WDA requirements were established, table 1. The test announcement recommended that bulls be weaned and placed on feed similar to the test ration prior to delivery date. Health requirements were that bulls be dewormed, free of warts, show a negative test to tuberculosis and brucellosis, and in later years vaccinated for blackleg, malignant edema, hemorrhagic septicemia, infectious bovine rhinotracheitis, and bovine virus diarrhea.

Upon delivery to the station, bulls were weighed, given a CS, and examined by a veterinarian for defects and for general health. Bulls failing to meet all requirements were returned to their owners. All bulls finishing the tests, with the exceptions previously noted, were included for analyses.

Bulls were weighed on two consecutive days at the beginning and end of the test. These weights were averaged and used as the initial weights (IW) and final weights (FW). Care was taken in all years to avoid shrunk IW and excess fill at FW so that actual test gains were estimated. Weights were taken at 28-day intervals for reporting purposes.

The average ration fed is shown in table 2. Ingredients were purchased, prepared, mixed, and full fed as a blended mixture.

TABLE 2. AVERAGE COMPOSITION OF RATIONS FED DURING THE PERFORMANCE TESTS[1]

Feed	Percent of ration[2]
Cottonseed hulls or grass hay	30.0
Alfalfa meal	5.0
Cracked corn	43.5
Cane molasses	10.0
Cottonseed or soybean meal	10.0
Salt	1.0
Dicalcium phosphate	.5

[1]Average analysis of feed samples were: 88 percent dry matter, 12 percent protein, 14 percent fiber, 2.5 percent fat, 3.5 percent ash, and 57 percent nitrogen-free extract.
[2]Percentages varied slightly depending upon availability and price.

Analysis of Data

The data were analyzed by least-squares procedures *(5)*. Tests of significance among individual least-squares means were made using Fishers protected LSD *(4)*. Separate analyses were made for IW, IWDA, ADG, FW, FWDA, and CS, appendix table 1.

For the last 9 test years where Beef Cattle Improvement Association (BCIA) records were used and each bull recorded as having been creeped (C) or non-creeped (NC), the same traits were analyzed with the exception of CS, appendix table 3.

Regression analyses were made to determine the effect of IWDA on ADG. Because of the significant difference among breeds for IWDA, appendix table 1, these analyses were made on a pooled, within-breed basis, appendix table 2.

RESULTS AND DISCUSSION

Numbers and Distribution

Because of small numbers, certain breeds were combined for purposes of analyses, table 3. Red Angus (RA), which had a total of 34 and most of which were on test in the latter years, were combined with Angus (A). Likewise, Charbray (CB) were combined with Charolais (C) since all CB were at least 7/8 Charolais. Beefmasters (B) with only 7 total were combined with Santa Gertrudis (SG) since both breeds contain Brahman blood. Polled Shorthorn (PS) with 34 and Shorthorn (S) with 31 were combined. Hereford (H) and Polled Hereford (PH) were analyzed as separate breeds because of the large numbers in each breed and distribution was fairly uniform over the test years.

In the early years there were few of the large breeds on test. From 1951 through 1969 they made up less than 8 percent of all bulls on test, compared to 22 percent for the remaining years, table 3. On the other hand, 55 of 65, or 85 percent, of PS and S were on test in the

TABLE 3. NUMBER OF BULLS ON TEST BY BREED AND BY YEAR GROUP

Breed groups	Number of bulls by year group						
	A	B	C	D	E	F	Total
Angus and Red Angus	78	45	182	250	201	243	999
Charolais and Charbray	4	5	21	36	81	67	214
Hereford	113	74	160	80	43	33	503
Polled Hereford	61	58	112	92	94	76	493
Santa Gertrudis and Beefmaster	9	10	13	15	20	28	95
Shorthorn and Polled Shorthorn	47	8	7	2	1	0	65
Total	312	200	495	475	440	447	2,369

first 8 years. All other breeds as grouped were more evenly distributed. This difference in distribution among breeds had an effect on performance in early compared to latter test years.

Breed Differences

There were highly significant differences among breeds, appendix table 1, for all traits analyzed. Since differences in IW are the function of pre-test gain and age, it was expected that the large breeds would have heavier IW than the English breeds. This was true, table 4, with the exception of PS and S where the average initial age for this breed group was 339 days compared to 305 days for all breeds combined.

C and CB bulls had a higher IWDA, FW, ADG, and FWDA than the other breeds. Further, B and SG were higher than the British breeds for any trait related to weight other than IW and FW, where S and PS, due to older age, were heavier for both traits.

Angus and Hereford bulls had higher CS than other breeds, while B and SG had the lowest. Even though some of these differences were significant, the overall average of CS was low Choice and for all practical purposes the differences were not important economically.

Year Effect and Trends

In an effort to improve accuracy of the test information, beginning in 1957 WDA restrictions were placed on bulls entering the test, table 1. These entry requirements were the basis for grouping test years and in turn for the analyses shown in appendix table 1. There were highly significant differences among year groups for all traits analyzed.

There was a gradual increase in IW of bulls on test through 1969, table 5, after which IW declined. This decline in latter years probably resulted from it being more difficult for older bulls to meet the WDA entrance requirements.

Average IWDA decreased and then showed a significant increase in the latter years of the test. Breeders were quick to learn that bulls with potential for rapid gain would gain even faster if they had been restricted or held back prior to entrance on test. This is commonly known as compensatory gain. As entrance requirements were increased, the opportunity to manipulate ADG decreased and therefore come closer to estimating true ability to gain.

TABLE 4. NUMBER OF BULLS, AVERAGE INITIAL AGE, AND LEAST SQUARES MEANS[1] FOR IW, IWDA, FW, ADG, FWDA, AND CS SHOWING THE EFFECTS OF BREEDS

Breed groups	No. of bulls	Initial age	IW	IWDA	FW	ADG	FWDA	CS[2]
	No.	*Days*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Units*
Angus and Red Angus	999	313.9	693.8^{b}	2.21^{c}	$1,032.8^{c}$	2.39^{c}	2.26^{c}	12.8^{a}
Charolais and Charbray	214	292.2	771.4^{a}	2.64^{a}	$1,187.9^{a}$	2.93^{a}	2.73^{a}	12.6^{ab}
Hereford	503	308.6	672.8^{c}	2.18^{c}	$1,008.0^{d}$	2.36^{c}	2.24^{c}	12.8^{a}
Polled Hereford	493	304.2	687.4^{bc}	2.26^{c}	$1,021.8^{cd}$	2.36^{c}	2.29^{c}	12.4^{bc}
Santa Gertrudis and Beefmaster	95	315.7	733.7^{a}	2.45^{b}	$1,092.5^{b}$	2.54^{b}	2.49^{b}	12.2^{c}
Shorthorn and Polled Shorthorn	65	339.1	739.2^{a}	2.19^{c}	$1,080.8^{b}$	2.39^{c}	2.19^{e}	12.4^{bc}
Average	2,369	304.9	698.3	2.29	1,046.4	2.46	2.35	12.7

[1]Means with different superscripts differ at $P < .01$.
[2]11 = high Good, 12 = low Choice, etc.

TABLE 5. NUMBER OF BULLS, AVERAGE INITIAL AGE, AND LEAST SQUARES MEANS[1] FOR IW, IWDA, FW, ADG, FWDA, AND CS SHOWING THE EFFECTS OF YEAR GROUPS

Year groups	No. of bulls	Initial age	IW	IWDA	FW	ADG	FWDA	CS
	No.	*Days*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Units*
1951-56 (A)	312	309.7	675.1^{c}	2.18^{d}	$1,046.4^{c}$	2.45^{c}	2.27^{d}	12.2^{c}
1957-59 (B)	200	350.1	735.2^{a}	2.10^{e}	$1,059.0^{bc}$	2.31^{d}	2.16^{e}	11.8^{d}
1960-65 (C)	495	327.0	742.4^{a}	2.27^{c}	$1,091.9^{a}$	2.50^{bc}	2.34^{c}	12.4^{bc}
1966-69 (D)	475	311.2	749.9^{a}	2.41^{b}	$1,098.5^{a}$	2.49^{bc}	2.44^{b}	12.7^{b}
1970-72 (E)	440	295.0	722.8^{ab}	2.45^{b}	$1,089.1^{ab}$	2.62^{a}	2.50^{b}	13.1^{a}
1973-76 (F)	447	268.2	691.9^{bc}	2.58^{a}	$1,060.9^{bc}$	2.64^{a}	2.60^{a}	13.2^{a}
Average (26 years)	2,369	304.9	698.3	2.29	1,046.4	2.46	2.35	12.7

[1]Means with different superscripts differ at $P < .01$.

Average FW generally followed the same trend as IW, reaching a peak in 1966-69 and then declining in the latter years.

The trend for ADG paralleled IWDA. First there was a decrease in ADG, then a significant increase in the latter years. It appeared that performance had reached a plateau by the mid-1970's and that continued progress would be hard to achieve as long as bulls were tested under the existing environmental conditions. This assumption was confirmed by Patterson *(13)*.

There was a significant increase in CS over the years. It was evident that further increase was unlikely in this trait.

Relationship Among IWDA, ADG, and FWDA.

Perhaps the most significant accomplishment brought about by increasing IWDA requirements was to make ADG and FWDA more nearly equal. During the first 15 years of the test (groups A, B, and C) IWDA and FWDA were always smaller than ADG. However, in groups D, E, and F, FWDA more nearly equaled ADG. FWDA is probably the best single indicator of a bull's true ability to gain. As ADG and FWDA become closer, performance test ADG is a more accurate estimate of ability to gain. The last 4 years of the test indicate that perhaps this has been accomplished when average IWDA, ADG, and FWDA were 2.58, 2.64, and 2.60 pounds, respectively.

To take a further look into the relationship between IWDA and ADG, regression analyses were performed on a within-breed basis for each of the year groups, appendix table 2. Since year groups were on the basis of similar IWDA requirements, it is understandable that variance due to regression was not significant for any of the year groups. Although the variance due to breed was significant at the .05 level in the E-year group and approached significance in the

TABLE 6. THE CHANGE IN ADG PER UNIT CHANGE IN IWDA

Year group	IWDA requirements	Actual IWDA	Actual ADG	Regression ADG on IWDA[1]	Standard error
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*
A	none	2.00	2.29	-.084[c]	.08
B	1.4-1.75	2.03	2.17	-.086[c]	.12
C	2.00	2.21	2.40	.077[b]	.08
D	2.10	2.31	2.47	.118[ab]	.10
E	2.20	2.45	2.63	.096[b]	.10
F	2.3-2.5[2]	2.54	2.61	.220[a]	.11

[1]Regressions with different superscripts differ at $P < .05$.
[2]Minimum WDA requirements were 2.3 pounds for British breeds and 2.5 pounds for large breeds.

A and F groups, there is no reason to suspect that breeds should be different.

The actual regression coefficients of ADG on IWDA are shown in table 6. The negative coefficients for A- and B-year groups are significantly lower than all others, which indicates that bulls with lower IWDA tend to gain faster on test as a result of compensatory gain. The coefficients for year groups C, D, and E are positive and are not different. They indicate that for each 1-pound increase in IWDA, ADG will increase approximately 0.1 pound. As requirements were further increased, the coefficient for group F was significantly higher than in previous years. Although it is not high, the regression coefficient of .22 is significantly different from zero and does continue the trend to a larger response and therefore makes ADG on test a more accurate indicator of lifetime ability to gain. One of the faults of all central test stations is that pre-test conditions are varied and often result in some compensatory gain. Even though requirements may be increased, there is no way to eliminate all differences.

The Effects of Creep Feeding

Starting in 1968, all bulls entering the test were required to be from herds enrolled in the Alabama Beef Cattle Improvement Association (BCIA). In recording data for BCIA, breeders coded each calf as creep fed (C) or non-creep fed (NC). These records were made available to the test station and were recorded for use in calculating an index. The last 9 years were analyzed to determine effects of C and NC on IW, IWDA, FW, ADG, and FWDA, appendix table 3. According to these analyses, creep feeding had no effect on any of the traits studied. On the basis of most research, one would expect calves that received creep to be larger at the start of test and gain slower on test. Some possible explanations are: (1) failure of breeders to report correctly the status of calves with respect to creep feeding; (2) creep feeding is defined by BCIA as "calves receiving extra feed in the form of creep for a period of at least 6 weeks," which could mean that many calves received some creep feed and were not reported on creep feed; (3) cows with calves grazing excellent winter small grain and/or clover pastures produce calves that are equal to or superior to creep fed calves and yet these calves would not be reported as creep fed. The lack of consistency in the data can be observed in table 7 where IW, IWDA, FW, ADG, and FWDA are reported for C and NC by years. It is interesting that

TABLE 7. NUMBER OF BULLS AND LEAST SQUARES MEANS FOR IW, IWDA, FW, ADG, AND FWDA SHOWING THE EFFECT OF C AND NC

Year	Bulls on test		Traits									
			IW		IWDA		FW		ADG		FWDA	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
	No.	*No.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
1968.....	35	45	685.1	771.0	2.46	2.43	1,086.3	1,141.6	2.87	2.65	2.60	2.51
1969.....	80	59	734.6	713.9	2.67	2.61	1,082.9	1,049.8	2.49	2.40	2.61	2.54
1970.....	77	58	719.4	691.9	2.51	2.40	1,071.8	1,072.3	2.52	2.72	2.51	2.50
1971.....	71	65	685.8	678.3	2.47	2.36	1,055.7	1,080.3	2.64	2.87	2.53	2.53
1972.....	86	83	759.4	691.5	2.47	2.50	1,109.5	1,062.8	2.50	2.65	2.48	2.55
1973.....	69	47	658.6	702.8	2.48	2.42	1,021.2	1,085.4	2.59	2.73	2.52	2.53
1974.....	70	67	710.2	693.4	2.56	2.55	1,083.3	1,061.0	2.66	2.62	2.60	2.57
1975.....	44	31	669.2	766.2	2.54	2.72	1,051.4	1,057.5	2.75	2.82	2.60	2.75
1976.....	62	57	733.6	683.2	2.58	2.56	1,093.0	1,053.6	2.57	2.64	2.58	2.59
Average ..	594	514	710.8	704.6	2.53	2.50	1,073.9	1,072.3	2.59	2.67	2.55	2.55

only in 1975 was there a large difference in FWDA between C and NC bulls. Also, overall ADG for the 9 years was higher (2.67 pounds) for NC bulls than for C (2.59 pounds) bulls, but both had a FWDA of 2.55 pounds.

SUMMARY

Twenty-six years of performance test data with a total of 2,369 records were analyzed. The following results were obtained:

1. The test gained in popularity as indicated by the larger number of bulls tested in the latter years.

2. In general, Charolais and Charbray bulls were heavier at every stage while on test and had a higher ADG than all other breeds.

3. Beefmaster and Santa Gertrudis bulls were intermediate in size and ADG compared to other breeds tested.

4. There were no consistent differences among the British breeds with respect to size and ability to gain.

5. Angus and Hereford bulls had higher conformation scores than other breeds.

6. Generally speaking, bulls were heavier at each stage of the test during the middle years compared to the early and latter years.

7. After minimum IWDA requirements were added, there was a significant increase in ADG and in FWDA as years passed.

8. The close association of IWDA, ADG, and FWDA in the latter years was attributed to elimination of most of the opportunity for compensatory gain.

9. There appeared to be little effect on performance characteristics associated with the practice of creep feeding.

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APPENDIX

APPENDIX TABLE 1. ANALYSIS OF VARIANCE FOR IW, IWDA, FW, ADG, FWDA, AND CS

Source of variation	Degrees of freedom	F tests					
		IW	IWDA	FW	ADG	FWDA	CS
Total	2,368						
Group	5	9.04**	93.17**	3.10**	8.64**	81.95**	40.42**
Breed/group	29	7.10**	21.03**	13.16**	11.65**	27.59**	5.37**
Error	2,334						

* = P < .05.
** = P < .01.

APPENDIX TABLE 2. WITHIN-BREED REGRESSION ANALYSIS FOR ADG ON IWDA BY YEAR GROUPS

Source of variation	Degrees of freedom	F tests					
		A	B	C	D	E	F
Breed	5	1.90+	1.53	1.26	1.05	2.83*	1.74+
IWDA[1]	1	.00	1.47	0.17	0.69	0.06	0.88
IWDA/breed[2]	5	1.66	1.31	0.92	0.61	3.00*	1.15
Error[3]		(300)	(188)	(483)	(463)	(429)	(437)

[1]Variation due to pooled within regression of ADG on IWDA.
[2]Variation due to differences of within-breed regression of ADG on IWDA.
[3]Error degrees of freedom listed in parenthesis under each year group.
+ = P < .10.
* = P < .05.

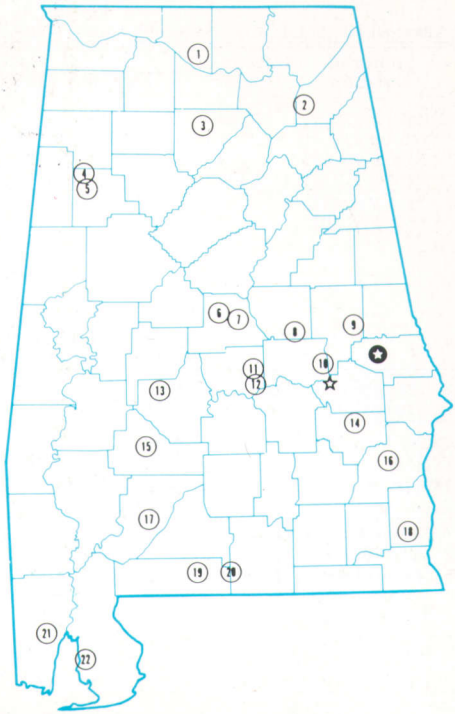
APPENDIX TABLE 3. ANALYSIS OF VARIANCE WITH RESPECT TO CREEP FOR IW, IWDA, FW, ADG, AND FWDA

Source of variation	Degrees of freedom	F tests				
		IW	IWDA	FW	ADG	FWDA
Total	1,107					
Year	8	2.68**	10.45**	1.94*	2.56**	3.58**
Creep	1	0.07	0.74	0.56	0.82	0.00
Year x creep	8	5.50**	2.75**	3.51**	1.21	1.42
Breed/year/creep	70	4.90**	7.89**	5.59**	3.93**	7.52**
Error	1,020					

* = P < .05.
** = P < .01.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

★ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Foundation Seed Stocks Farm, Thorsby.
7. Chilton Area Horticulture Substation, Clanton.
8. Forestry Unit, Coosa County.
9. Piedmont Substation, Camp Hill.
10. Plant Breeding Unit, Tallassee.
11. Forestry Unit, Autauga County.
12. Prattville Experiment Field, Prattville.
13. Black Belt Substation, Marion Junction.
14. The Turnipseed-Ikenberry Place, Union Springs.
15. Lower Coastal Plain Substation, Camden.
16. Forestry Unit, Barbour County.
17. Monroeville Experiment Field, Monroeville.
18. Wiregrass Substation, Headland.
19. Brewton Experiment Field, Brewton.
20. Solon Dixon Forestry Education Center, Covington and Escambia counties.
21. Ornamental Horticulture Field Station, Spring Hill.
22. Gulf Coast Substation, Fairhope.