PROCEEDINGS

BEEF IMPROVEMENT FEDERATION

RESEARCH SYMPOSIUM & ANNUAL MEETING

MAY 16-18, 1977

HOLIDAY INN

BOZEMAN, MONTANA

PROCEEDINGS OF BEEF IMPROVEMENT FEDERATION
RESEARCH SYMPOSIUM AND ANNUAL MEETING

Compiled and Edited by Robert C. de Baca
with assistance from Mrs. Joane Cole

Table of Contents

Beef Improvement Federation
Symposium and Annual Meeting
May 16-17-18, 1977
Holiday Inn
Bozeman, Montana

May 16 - Monday

9:00 a.m. to 9:00 p.m.	Registration
10:00 a.m. to 3:45 p.m.	Committee Meetings, Dixon Hubbard in charge.
9:45 a.m. to 10:00 a.m.	Coffee Break
10:00 a.m.	National Sire Evaluation - STATE ROOM
1:00 p.m.	Farm & Ranch Testing - MONTANA ROOM Carcass Evaluation - UNIVERSITY ROOM Merchandizing - STATE ROOM Central Testing - AGATE ROOM RAMADA Record Utilization - MEADOW LARK ROOM RAMADA Reproduction - BITTERROOT ROOM RAMADA
3:45 p.m. to 4:00 p.m.	Coffee Break
4:00 p.m.	Caucus for Election of Directors Breed Associations, C. K. Allen, presiding - STATE ROOM Easter States BCIA's, James Bennett, presiding - MONTANA ROOM Central and Western states BCIA's, J. David Nichols, Presiding - UNIVERSITY ROOM

May 17 - Tuesday

6:30 a.m.	Breakfast Meeting: Board of Directors (retiring and new directors)

SYMPOSIUM

CORRELATED RESPONSE TO SELECTION FOR GROWTH
Dwight Stephens, Moderator

STATE ROOM

8:30 a.m. to 9:10 a.m.	Dr. Don Kress, Montana State University - CORRELATED RESPONSES - WHAT ARE THEY AND HOW ARE THEY MEASURED.
9:10 a.m. to 9:50 a.m.	Dr. R. M. Koch, University of Nebraska, MARC DIRECT AND CORRELATED RESPONSES TO SELECTION FOR WEANING WEIGHT, YEARLING WEIGHT AND MUSCLING IN CATTLE.
9:50 a.m. to 10:10 a.m.	Coffee Break
10:10 a.m. to 10:50 a.m.	Dr. Ralph Bogart, Oregon State University DIRECT SELECTION FOR TRAITS OR SELECTION FOR INDICATOR TRAITS.
10:50 a.m. to 11:30 a.m.	Dr. Ray Woodward, US Range Station, Miles City - PERFORMANCE TESTING AND THE US RANGE STATION.
12:00 noon	Awards Luncheon - POOLSIDE Ken Ellis, presiding Pioneer recognitions - Dr. Robert Blackwell Seedstock breeder recognitions - Jim Bennett Commercial breeders recognitions - Lloyd Schmitt
1:30 p.m.	Committee Meetings - Dixon Hubbard in charge
3:00 p.m.	Coffee Break
3:10 p.m.	General Session, committee reports STATE ROOM
6:00 p.m.	Social hour - POOLSIDE
7:30 p.m.	Awards Banquet - STATE ROOM Master of Ceremonies - J. David Nichols National BIF Awards - C. K. Allen Beef Cattle Improvement Association of the Year Breed Association of the Year Commercial Producer of the Year Seedstock Breeder of the Year Continuing Service Awards President's Address - Martin Jorgensen Ecology of the Half Moon - Bob Ross

May 18 - Wednesday

6:30 a.m.	Breakfast Meeting: Board of Directors (retiring and new directors)

CONTINUATION OF SYMPOSIUM

REPRODUCTIVE TRAITS THAT ARE EASILY MEASURED AND IMPORTANT
Wm. Durfey, Moderator

8:30 a.m. to 9:10 a.m.	Dr. R. H. Foote, Cornell University - TESTICULAR MEASUREMENTS AND THEIR IMPORTANCE
9:10 a.m. to 9:50 a.m.	Dr. Peter Chenoweth, Colorado State University - SERVICING, CAPACITY AND LIBIDO TESTS FOR BULLS AND THEIR RELATIONSHIP TO BREEDING PERFORMANCE
9:50 a.m. to 10:10 a.m.	Coffee Break
10:10 a.m. to 10:50 a.m.	Dr. Jim Brinks, Colorado State University - GENETIC ASPECTS OF AGE AND WEIGHT AT PUBERTY
	Lunch - POOLSIDE

CORRELATED RESPONSES TO SELECTION

D. D. Kress

Animal and Range Sciences Department
Montana State University, Bozeman

Any time we talk about correlated responses to selection we must do it in relation to the direct response to selection because correlated responses are a result of direct response to selection. When we say "direct response" we mean the change, or response, in the trait that has been selected for directly. Correlated responses are the changes, or responses, in other traits that have not been selected. For example, if you are selecting for yearling weight, then direct response is the change in yearling weight per year and correlated responses are the changes in other traits such as birth weight, weaning weight, gain and mature weight per year.

Correlated responses always occur when you practice selection. Selection experiments that have been conducted for any length of time have observed correlated responses. Correlated responses are not necessarily bad -- in fact, many are beneficial and breeders should plan their breeding programs to take advantage of beneficial correlated responses.

The purpose of this paper is to explain correlated responses and to illustrate the amount of correlated response to be expected in other growth traits if selection is practiced for one particular growth trait such as yearling weight.

The amount of correlated response in a trait depends on the size of the genetic correlation of that trait with the trait that has been selected for directly. The genetic correlation may range from + 1 to - 1, depending on which two traits are involved. Table 1 summarizes genetic correlations among growth traits of beef cattle. For example, the genetic correlation of birth weight with weaning weight is .58. As an illustration, figure 1 shows the kinds of correlated responses to be expected for various sizes of genetic correlations (r_g). In order to generalize the figure the responses (both direct and correlated) have been expressed in standard measure (standard deviation units). The correlated responses are given in relation to the direct response. The direct response is represented by the continuous line and the correlated responses are represented by broken lines. When the genetic correlation is positive and large (for example, r_g=.7) the correlated response is in the same direction as the direct response and large. When the genetic correlation is zero there will be no correlated response. When the genetic correlation is negative and large (for example, r_g=-.7) the correlated response will be in the opposite direction of the direct response and large.

When a breeder is planning a selection program, not only does he need to know the amount of direct response that is likely but he also needs to know the kinds of correlated responses that are likely. Figures 2, 3, 4 and 5 show the direct and correlated responses that are expected if a breeder selects for weaning weight, postweaning gain (total gain during 160 days), yearling weight or mature weight, respectively. It was assumed that the selection intensity was 1.5 (i.e., that 50% of females and 4% of males were selected). This level of selection intensity is difficult to achieve, so the figures represent maximum or near maximum responses. Table 1 gives the genetic correlations and table 2 gives the heritabilities and additive genetic standard deviations that were used to calculate the expected direct and correlated responses in the figures. The generation interval was assumed to be 5 years.

Figure 2 illustrates the magnitude of direct and correlated responses when selection is practiced for greater weaning weight. The picture is generally favorable except that some breeders may not like the increases in birth weight and mature weight. The direct response in weaning weight over 10 years of selection is expected to be 42 lb. The expected correlated response for yearling weight is 58 lb and for mature weight is 56 lb. The reason that the correlated resonses for yearling and mature weight are larger than the direct response for weaning weight is because weaning weight is less variable (table 2). The expected correlated response for gain during 160 days postweaning is 24 lb and for birth weight is 5 lb.

Likewise, direct and correlated responses when selection is for postweaning gain (figure 3), yearling weight (figure 4) or mature weight (figure 5) are illustrated. The breeder can compare these figures with one another and then decide which one most nearly agrees with the goals of his selection program. For example, the response in weaning weight is maximized by selecting for either weaning weight (figure 2) or yearling weight (figure 4). If a breeder wishes to maximize response in postweaning gain and minimize response in mature weight, then he should select for postweaning gain (figure 3). Selecting for yearling weight (figure 4) would maximize response in weaning weight and yearling weight and nearly maximize response in postweaning gain -- which explains why many breeders are selecting for yearling weight. If a breeder's goal is to increase mature weight, then he should select for mature weight (figure 5) -- but he must recognize that he is minimizing the response in weaning weight and gain and nearly minimizing the response in yearling weight. Table 3 gives the values that were used to construct figures 2 through 5.

Summary

1. Correlated responses in other traits always occur when selection is practiced for a particular trait.
2. The amount of correlated response depends on the genetic correlation with the trait that has been selected for directly.
3. Breeders should consider correlated responses as well as direct response when planning selection programs.

TABLE 1. GENETIC CORRELATIONS AMONG GROWTH TRAITS OF BEEF CATTLE

First trait	Second trait Wn. wt.	Gain	Yr. wt.	Mat. wt.
Birth weight	.58	.56	.64	.64
Weaning weight		.58	.79	.55
Postweaning gain			.86	.34
Yearling weight				.64

TABLE 2. HERITABILITIES (h^2) AND ADDITIVE GENETIC STANDARD DEVIATIONS (σg) FOR GROWTH TRAITS OF BEEF CATTLE

Trait	h^2	σg (lb)
Birth weight	.45	5.4
Weaning weight	.30	25
Postweaning gain (daily)	.50	.163
Yearling weight	.50	45
Mature weight	.55	62

TABLE 3. DIRECT AND CORRELATED RESPONSES[a] TO SELECTION FOR VARIOUS GROWTH TRAITS OF BEEF CATTLE

Selected trait	Direct or correlated response (lb) B. wt.	Wn. wt.	Gain	Yr. wt.	Mat. wt.
Birth wt.	10.8[b]	30	30	58	80
Weaning wt.	5.2	42[b]	24	58	56
Gain[c]	6.4	30	56[b]	82	46
Yearling wt.	7.4	42	48	96[b]	84
Mature wt.	7.6	30	20	64	138[b]

[a]Response per 10 years of selection (assumed to be 2 generations).
[b]Direct responses are on diagonal and other responses are correlated responses.
[c]Gain during 160-day postweaning period.

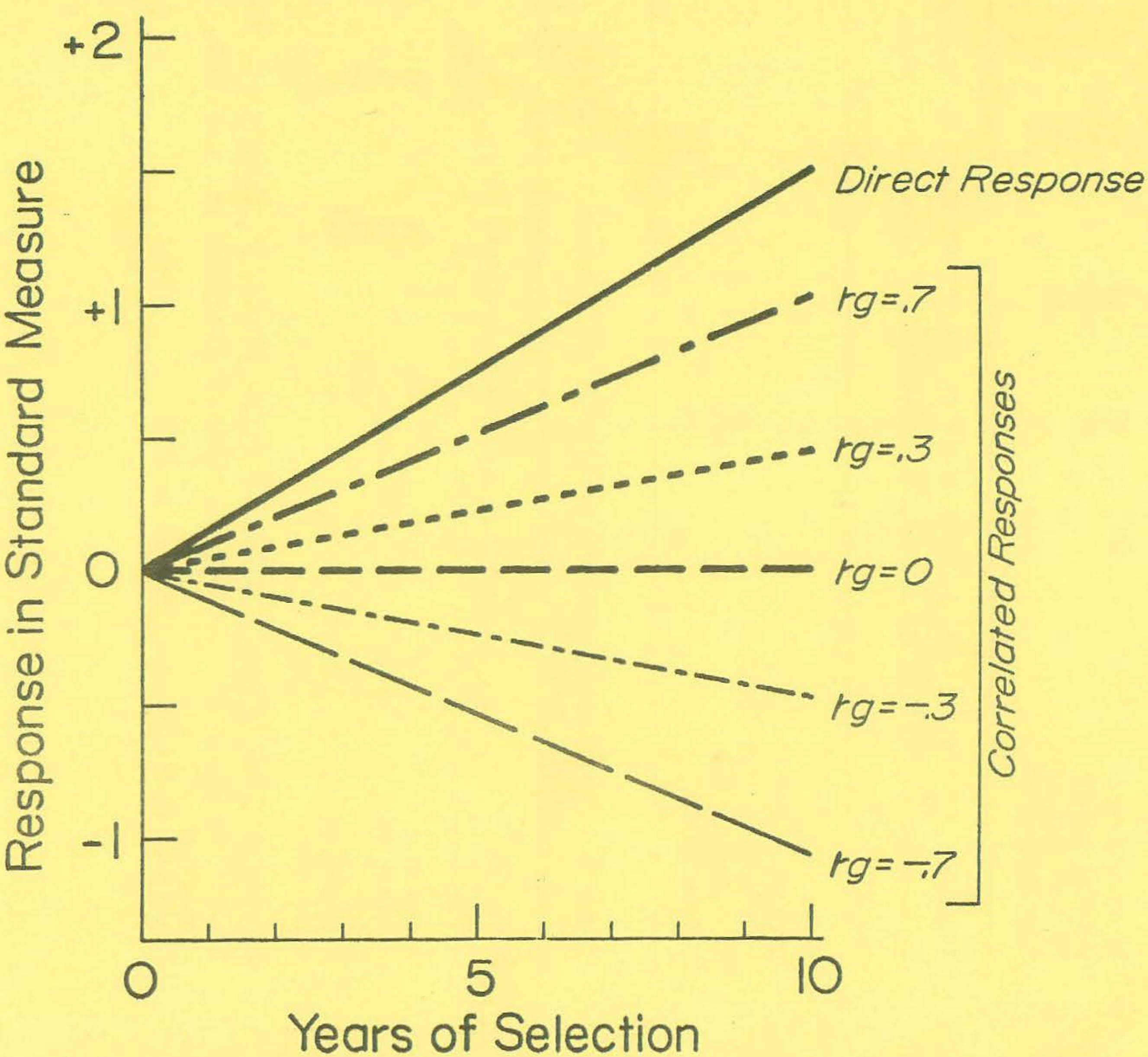

Figure 1. Illustration of direct and correlated response to selection for various levels of genetic correlation(r_g). Responses were expressed in standard measure (standard deviation units). It was assumed that selection intensity was 1.5 and that all heritabilities were .5.

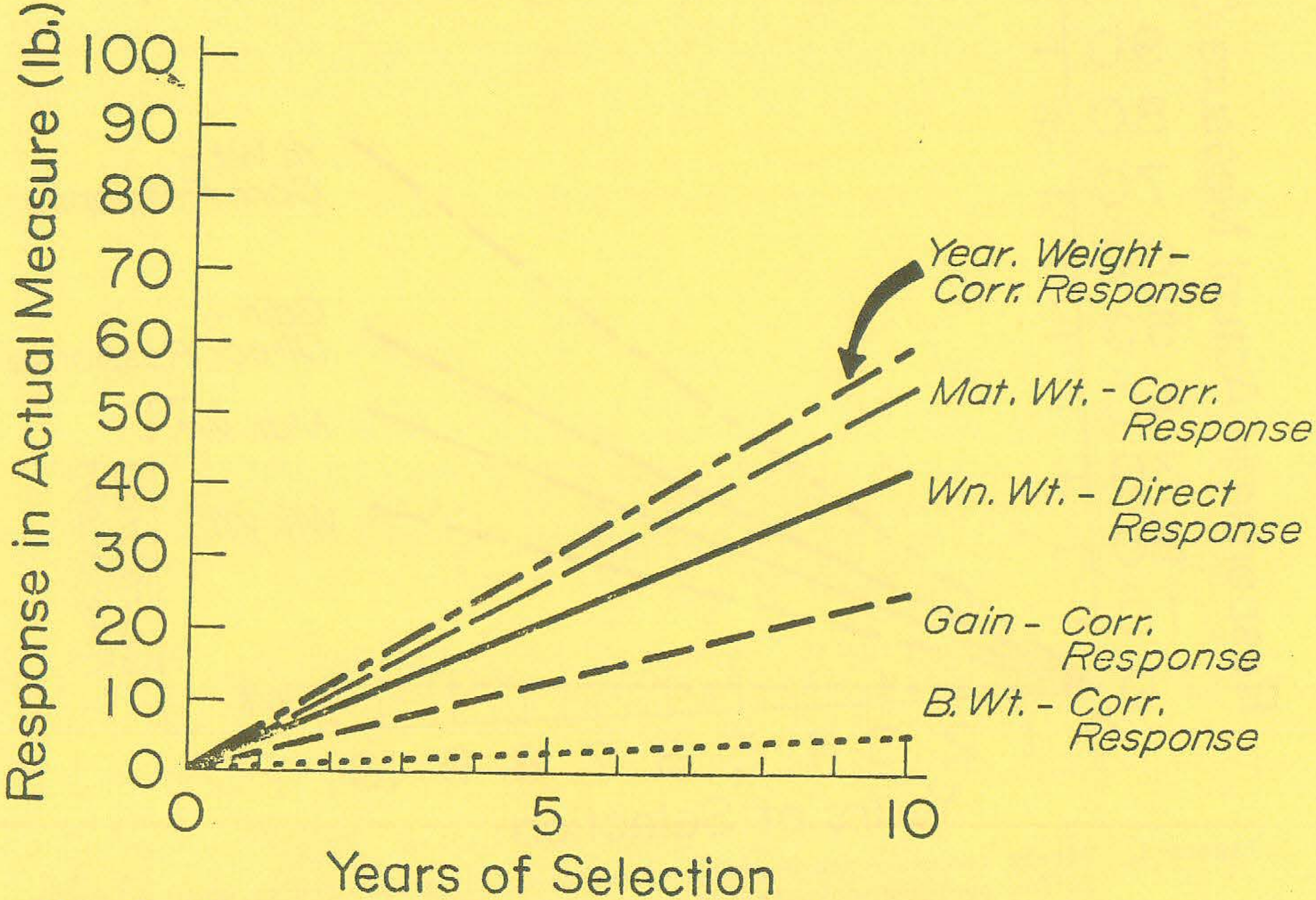

Figure 2. Direct response and correlated responses in growth traits when selection is for weaning weight. Continuous line represents direct response in weaning weight and broken lines represent correlated response in other growth traits.

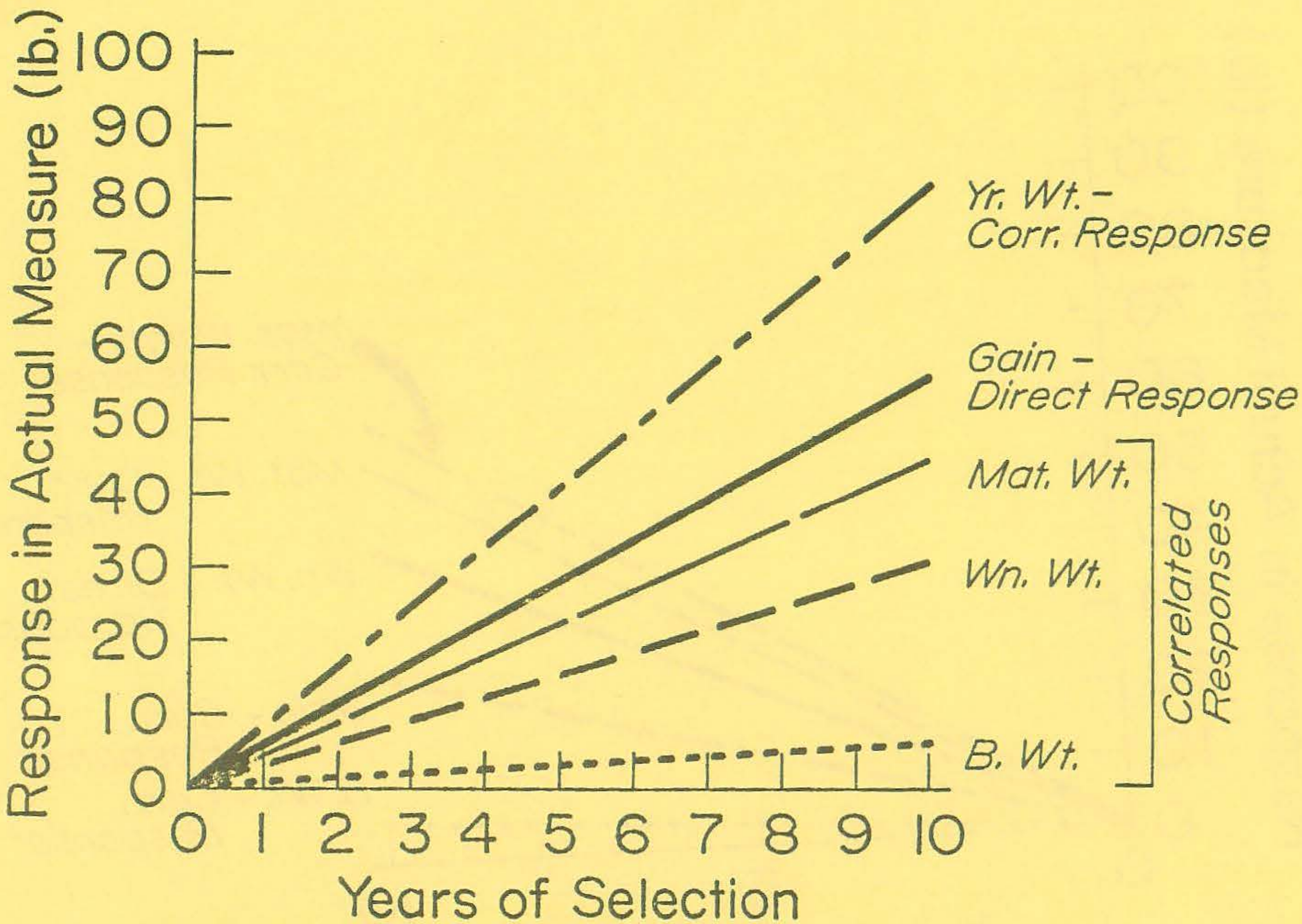

Figure 3. Direct response and correlated responses in growth traits when selection is for postweaning gain. Continuous line represents direct response in gain and broken lines represent correlated responses in other growth traits.

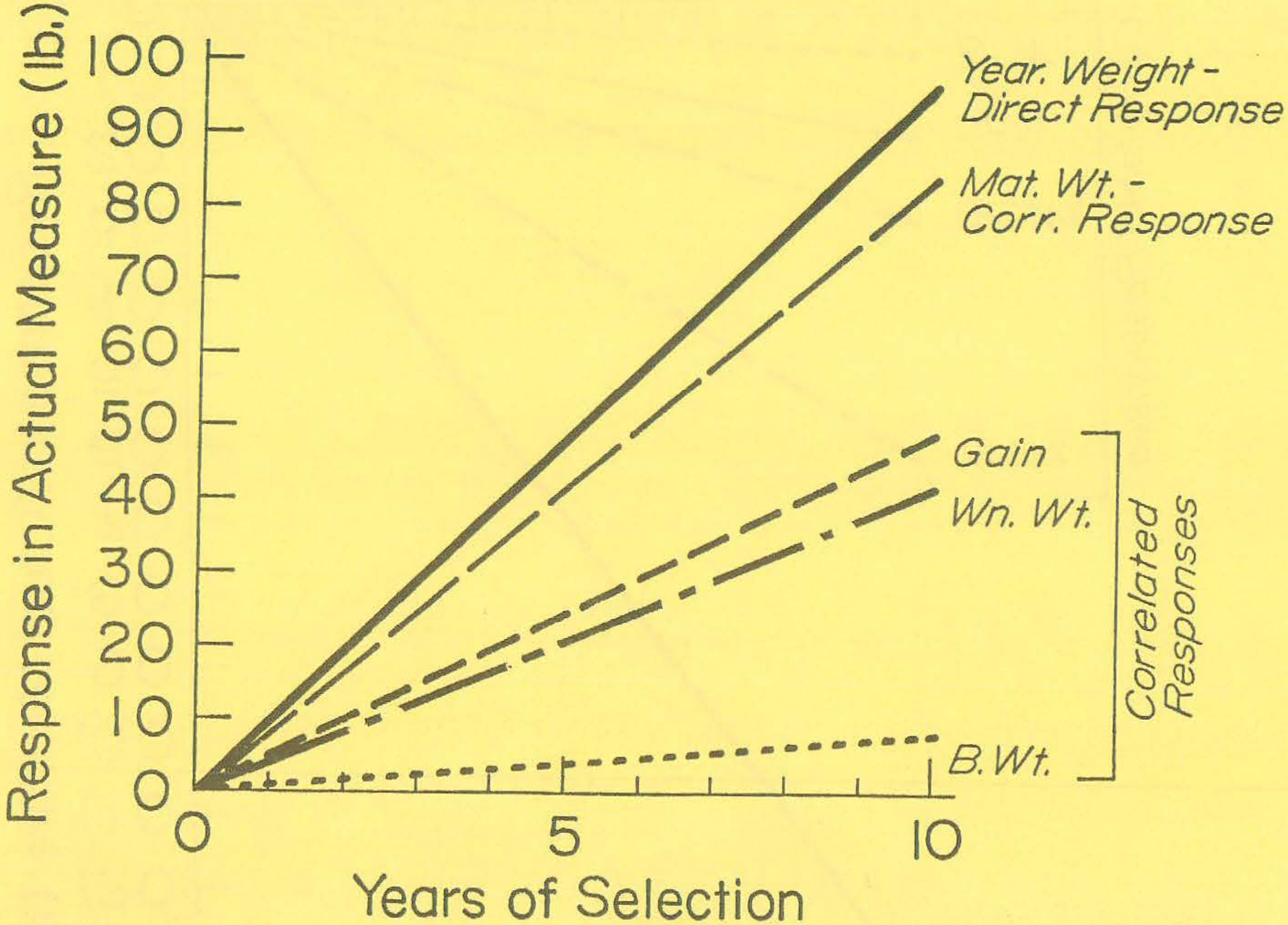

Figure 4. Direct response and correlated responses in growth traits when selection is for yearling weight. Continuous line represents direct response in yearling weight and broken lines represent correlated responses in other growth traits.

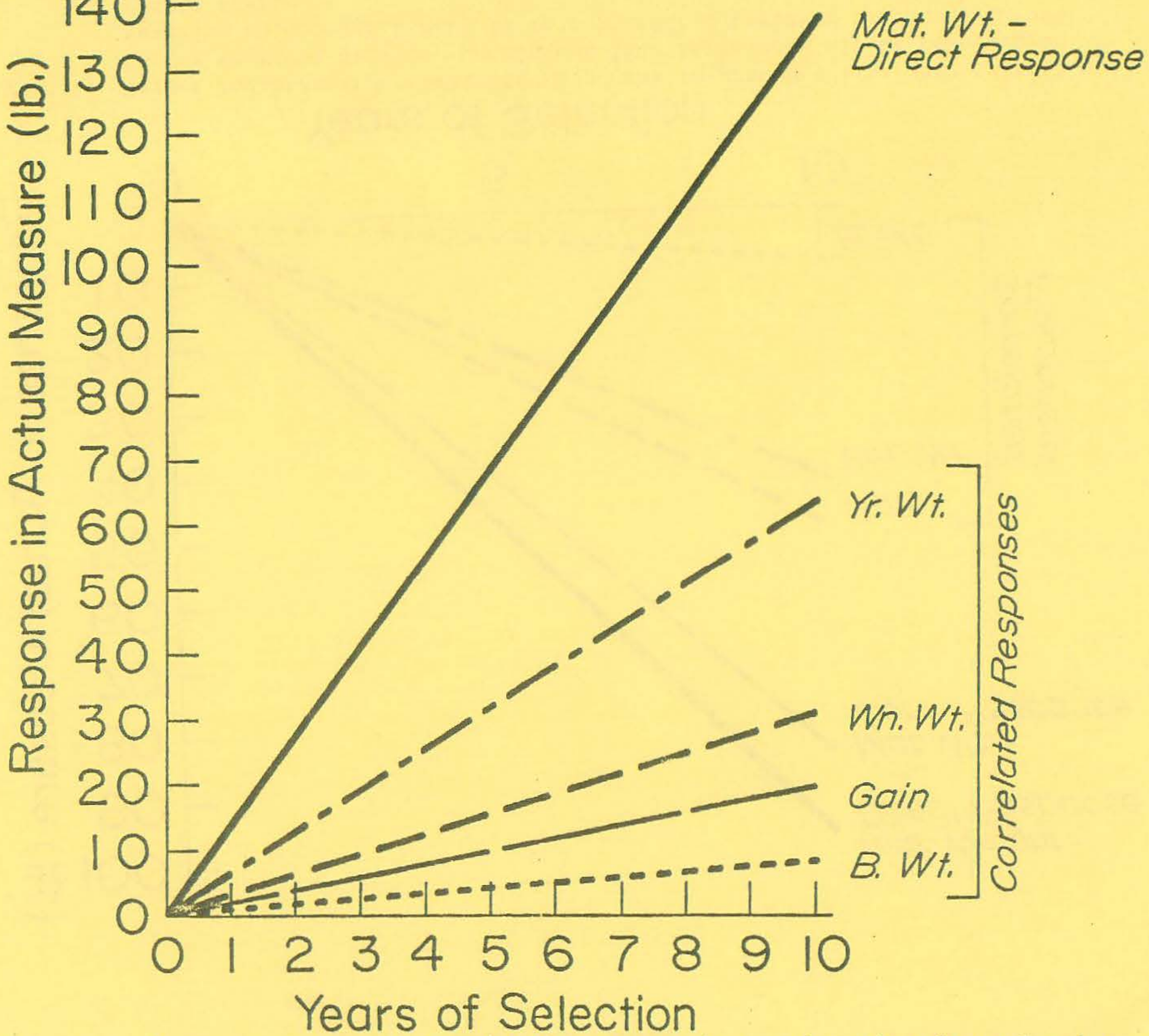

Figure 5. Direct response and correlated responses in growth traits when selection is for mature weight. Continuous line represents direct response in mature weight and broken lines represent correlated responses in other growth traits.

Direct and Correlated Response to Selection for Weaning Weight, Yearling Weight and Muscling Score in Cattle

Robert M. Koch[1]

As breeders you are aware of the importance of selection as a tool for genetic improvement. As breeders you are aware that selection for one trait often leads to change in traits not under selection. As breeders you are aware that results in your herd may differ considerably from results published by college professors. Forewarned is forearmed and I now feel free to share with you my estimates of selection response for a limited number of traits in cattle. Expected responses presented here are based on literature summaries and results from a long-term selection experiment initiated at Fort Robinson, Nebraska in 1960 and later transferred to the U.S. Meat Animal Research Center, where it is being continued. In the selection experiment, foundation cows were randomly divided into three lines. In one line the selection criteria was weaning weight standardized to 200 days. In another line the selected trait was yearling weight (452 days for bulls and 550 days for heifers). In the third line animals were selected on an index of yearling weight and muscling score. A measure of correlated response in carcass traits was planned by individually feeding samples of three heifers from each sire for about 250 days after weaning. Heifers were slaughtered and detailed carcass cut-out data were obtained from the right side of each carcass. Additional details and results of the experiment were described elsewhere (Koch et al. 1974 a,b) so only results pertinent to our discussion here will be repeated. Heritability of and genetic correlations among birth weight, weaning weight, yearling weight and muscling score are given in table 1. Estimates based on paternal half-sib variation and regression of offspring response to midparent cumulative selection differentials are presented separately along with the average values of reports from many experiment stations summarized by Petty and Cartwright (1966).

Direct response to selection for any one of the traits Y = (Heritability) (Selection differential). Heritability is the fraction of the differences among selected parents recovered as differences among their offspring in the next generation. Selection differential is the difference in performance of selected sires and dams compared with the average of the unselected group from which they came. Correlated response in trait Y to selection for trait X = $h_x h_y r_g \sigma_y$ for each standard deviation of selection of X; where h_x and h_y are the square roots of heritability for X and Y, and r_g is the genetic correlation between X and Y, and σ_y is the phenotypic standard deviation of Y. The values in table 1 were used to calculate expected direct

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Table 1. Heritabilities of (On Diagonal) and Genetic Correlations Among (Off Diagonal) Birth, Weaning and Yearling Weight and Muscling Score

Trait	Data Source[a]	Birth Weight	Weaning Weight	Yearling Weight	Muscling Score
Birth Weight	1	.55			
	2	.46			
	3	.44			
Weaning Weight	1	.48	.18		
	2	.82	.12		
	3	.58	.28		
Yearling Weight	1	.60	.71	.33	
	2	.66	1.11	.43	
	3	.64	.73	.44	
Muscling Score	1	.16	-.07	-.19	.27
	2	.13	.25	.16	.28

[a] 1 = Half-sib estimates from MARC selection experiment.
2 = Regression of offspring on midparent in MARC selection experiment.
3 = Average of many experiments summarized by Petty and Cartwright, 1966.

and correlated response to one standard deviation of selection for birth, weaning or yearling weight or muscle score. The results of these calculations are shown in table 2. A selection differential of one standard deviation was used because it standardizes the situation between traits and it approximates the amount of selection among midparents (sire and dam average) that was observed per generation in our experiment. A generation in beef cattle is about five years in most herds. Response shown in table 2 should only be considered as approximations to results you might expect in your herd. Note that selection for weight at any age leads to increased weight at every other age. Except for weaning weight, direct response to selection for traits exceeded the indirect or correlated response associated with a comparable amount of selection for another trait. The low response to selection for weaning weight and the high correlated response in weaning weight associated with selection for yearling weight suggests selection for yearling weight might be preferred to direct selection for weaning weight. However, I am not convinced that this would be a wise policy. I would prefer to select

Table 2. Direct and Correlated Response Expected from One Standard Deviation of Selection Among Midparents for Birth Weight, Weaning Weight, Yearling Weight or Muscling Score

		Expected Offspring Response			
Midparent Trait	Data Source[a]	Birth Weight	Weaning Weight	Yearling Weight	Muscling Score
Birth Weight SD = 8.3 lb	1	4.6	6.9	18.4	.15
	2	3.8	8.9	21.1	.12
	3	3.7	9.4	20.3	---
	AVG	4.0	8.4	19.9	.14
Weaning Weight SD = 46 lb	1	1.3	8.3	12.5	-.04
	2	1.6	5.5	18.2	.11
	3	1.7	12.9	18.4	---
	AVG	1.5	8.9	16.4	.04
Yearling Weight SD = 72 lb	1	2.1	8.0	23.8	-.14
	2	2.4	11.6	31.0	.14
	3	2.3	11.8	31.7	---
	AVG	2.3	10.5	28.8	.00
Muscling Score SD = 2.5 units	1	.5	-.7	-4.1	.68
	2	.4	2.1	4.0	.70
	AVG	.4	.7	.0	.69

[a] 1 = Half-sib estimates from MARC selection experiment.
2 = Regression of offspring on midparent in MARC selection experiment.
3 = Average of many experiments summarized by Petty and Cartwright, 1966.

bulls that had both superior weaning and yearling weights. In our selection herds at U.S. MARC the heaviest calves at weaning are in the weaning weight line while those in the yearling weight line are 10 to 15 lbs lighter. Whether this is due to a maternal affect of environmental nature rather than genetic in origin is still not clear. Muscling score reported here is somewhat unique to this experiment and is a visual estimate of thickness of muscling discounted for fatness.

Because carcass traits cannot be measured without slaughtering animals, improvement by selection must use progeny tests, sib tests or correlated response to traits measurable in the live animal. Tables 3 and 4 provide expected correlated response in several commonly reported carcass traits to a selection differential of one standard deviation in the

Table 3. Correlated Response in Carcass Traits to One Standard Deviation of Selection for Weaning, Yearling or Carcass Weight or Muscling Score (Age Constant Basis)

		Correlated Response			
Selected Trait	Data Source[a]	Carcass Weight lb.	Ribeye Area Sq. In.	Fat Thickness In.	Marbling or Grade 1/3 Degree
Weaning Weight SD = 46 lb	1	12.0	.05	.06	.0
	2	7.8	.08	.01	-.2
	4	14.6	.09	.03	.0
Yearling Weight SD = 72 lb	1	28.9	.00	.10	-.9
	2	13.9	.02	.01	-.2
	4	23.4	.02	.02	.2
Carcass Weight SD = 44 lb	5	28.7	.29	.03	.2
Muscling Score SD = 2.5 units	2	13.6	.29	.05	-.4

[a] 1 = Half-sib estimates from MARC selection experiment.
2 = Regression of offspring on midparent in MARC selection experiment.
4 = Miles City data (Shelby *et al*. 1963).
5 = Fort Robinson heterosis experiment (Cundiff *et al*., 1969, 1971).

selected trait. In estimated correlated response using results from Miles City (Shelby *et al*., 1963), the Fort Robinson heterosis experiment (Cundiff *et al*., 1969, 1971) or South Dakota (Dinkel and Busch, 1973) their heritability and genetic correlation estimates were used in conjunction with the phenotypic standard deviations observed in the selection experiment data to make expectations somewhat more comparable. In table 3 response is given for animals on a time constant feeding period and as analyzed,estimate the increase or decrease expected when animals in a given experiment were slaughtered at a common age. Selection for weaning weight or yearling (about 430-450 days in these data) weight resulted in significant gains in carcass weight. As carcasses increased in weight, ribeye area and fat thickness increased, but marbling or quality grade decreased in most instances.

We are interested in change of relative composition of the carcass as well as quantity. Therefore, cut-out,fat cover and marbling data from the selection and heterosis experiments at Fort Robinson and a series of experiments at South Dakota were examined on a constant carcass weight basis. The cut-out data, i.e. edible portion, fat trim and bone for all of these experiments were obtained by the University of Illinois in cooperative experiments. Response in carcass components to selection on weaning, yearling, or carcass weight on an age constant basis were adjusted by the phenotypic regression of component traits on carcass weight. Adjustment in this manner tends to be a conservative estimate of relative change because the phenotypic regression includes both genetic and environmental effects. Although estimates obtained in this manner underestimate "true" genetic change, they at least afford an indication of direction. The results of the calculations are shown in table 4. Adjusted weight of edible portion, fat trim,

Table 4. Correlated Response in Carcass Composition to One Standard Deviation of Selection for Increased Weight, Fat Thickness or Muscling Score (Weight Constant Basis)

		Correlated Response			
Selected Trait	Data Source[a]	Edible Portion %	Fat Trim %	Bone %	Marbling 1/3 Degree
Weaning Weight SD = 46 lb	1	-.32	.21	.10	-1.0
	2	.36	-.48	.12	-.3
	6	.90	-1.19	.28	-.4
Yearling Weight SD = 72 lb	1	-.47	.46	.01	-1.3
	2	.40	-.65	.25	-.4
	6	.95	-1.47	.52	.0
Carcass Weight SD = 44 lb	5	.23	-.12	.11	-.3
Fat Thickness SD = .17	1	-.89	1.18	-.29	1.1
	6	-1.56	1.75	-.18	.5
Muscling Score	2	.30	-.27	-.02	-.6
	6	.19	-.41	.23	.4

[a] 1 = Half-sib estimates from MARC selection experiment.
2 = Regression of offspring or midparent in MARC selection experiment.
5 = Fort Robinson heterosis experiment (Cundiff et al., 1969, 1971).
6 = South Dakota experiments (Dinkel and Busch, 1973).

and bone were expressed as a percentage of carcass weight. Although expected response estimated by two different methods in the selection experiment contradict each other, method 2 (regression of offspring on midparent) is, in my opinion, the more reliable indicator and is in agreement with expected response from the Fort Robinson heterosis experiment and the South Dakota experiments. It would appear that selection for increased weight at weaning or yearling age leads to a slight increase in percentage of edible meat and bone and a corresponding decrease in fat trim. It also seems apparent that selection for increased growth rate will lead to a slight reduction in marbling and, hence, quality grade.

As we get improved measures of fat covering in live animals through such techniques as ultrasonics or direct probing, we will be able to select animals with less fat thickness after adjusting for differences in weight. Although the values shown in table 4 are the correlated responses to selection for increased fat thickness, the same values, but with a reversal in sign, would apply to selection against fat thickness, which is the generally desired direction.

Muscling score resulted in a positive correlated response in carcass weight and the change in composition was to increase edible portion, decrease fat, and decrease marbling.

It would appear from the data reviewed here that selection for weaning or yearling weight combined with measures of fatness or muscling would lead not only to increased carcass weight at a given age, but to a higher proportion of edible meat as well. However, without special emphasis through progeny or sib testing this type of selection would lead to a slight decline in marbling.

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DIRECT SELECTION FOR TRAITS OR SELECTION FOR INDICATOR TRAITS, i.e. LINEAR MEASUREMENTS

Ralph Bogart

A. Linear body measurements and carcass traits:

It is common knowledge that improvement of a trait through selection depends upon the heritability of the trait and the selection pressure that can be applied. Unfortunately, some traits can not be measured directly and some traits are not accurately measured. Carcass traits, for example, are not measured in the animal under consideration for selection but the inheritance for carcass merit may be determined by relatives of that animal. Body shape is not accurately estimated by visual appraisals. Linear body measurements on the live animal may be of value in predicting carcass traits. Linear measurements on the live animal near time of slaughter would be expected to show closer relations to carcass traits than measurements taken in early life.

Green, Stevens and Gauch have a large number of reports on using live animal measurements to predict weights of wholesale cuts from beef carcasses. In each of their reports, the slaughter weights were fairly constant with 900-950 lb and 1000-1050 lb being two standard sizes at time of slaughter. They took 185 body measurements and had 100 steers in each of the studies reported. Green, Stevens and Gauch (1969a) obtained a multiple correlation, using 14 measurements, with weight of wholesale rib cut of 0.82 or approximately 65% of the variation in weights of rib cuts was accounted for by variations in these 14 measurements. Since their cattle were uniform in weight at slaughter, the correlation of weight at slaughter with weight of rib cut was only 0.27. These workers (1969b) obtained a multiple correlation of 0.80, using 13 linear body measurements, of measurements with weight of round of the carcass. Again, slaughter weight was lowly (0.21) correlated with weight of the round.

Green, Stevens and Gauch (1970a) found that 14 linear body measurements gave a multiple correlation with weight of arm chuck of 0.77. The average weight of arm chuck was 81.6 lb. By use of these 14 measurements 37% of the chucks were estimated within one pound and 92% of them were estimated within 4 lb of actual weights. These workers (1971a) also obtained a multiple correlation of 0.76 between short loin weight and 13 linear body measurements. The average weight of the short loin was 22.5 lb. By use of the 13 measurements, they predicted the actual weight of 92% of the short loins within three pounds. They also observed (1971b) a multiple correlation of 0.72 of 10 measurements with weight of sirloin butt. The average weight of sirloin butt was 24.4 lb and 96% were estimated within three pounds of actual weight. When the combined weights of (1) round, loin, rib, (2) combined weights of round, loin, arm chuck and rib, and (3) the combined weights of round and loin were studied (1972a) the following figures were obtained using 11-13 body measurements:

	1	2	3
Multiple correlation	0.83	0.89	0.81
Weight of combined cuts	137.9	219.4	111.5
Difference between estimated and actual	2.93	3.39	2.45

Green, Stevens and Gauch also related linear body measurements with weights of wholesale cuts in steers weighing 1000-1050 lb at slaughter. They had 100 steers in their studies and took 185 body measurements. These workers (1970b) used 13 measurements in a multiple correlation with weight of wholesale round and obtained a correlation of 0.81. They predicted the weight of wholesale round within two pounds in 66% of the carcasses. Also, by use of 10 measurements, they (1970c) obtained a multiple correlation of 0.79 between measurements and weight of wholesale rib cut. They found that 91% of the wholesale rib cuts were estimated within two pounds.

Green, Stevens and Gauch (1971c) used 14 linear body measurments to obtain a multiple correlation coefficient with weight of wholesale short loin. The average weight of the short loins was 23.4 lb. By use of these 14 linear measurements, they predicted 85% of the loins within two pounds. These workers (1971d) used 9 linear body measurements to obtain a multiple correlation coefficient of 0.74 between actual weight of the arm chuck and the body measurements. The accuracy of prediction was somewhat low because 80% of the weights of arm chuck were estimated within four pounds of actual weight. They (1971e) used 10 linear body measurements to obtain a multiple correlation of 0.74 between wholesale sirloin butt weights and body measurements. The wholesale sirloin butts averaged 27.4 lb and 62% of the wholesale cuts were estimated within one pound. The largest single error was 4 lb.

Green, Stevens and Gauch (1972b) estimated weights of combined cuts of 1. round + trimmed loin + rib, 2. round + trimmed loin + rib + arm chuck and 3. round + loin. They obtained the following figures:

	1	2	3
Multiple correlation	0.85	0.85	0.85
Average weight	151	242	123
Error of estimate	4	6	3

Buric (1966) related linear body measurements and slaughter weights of steers ranging in weight from 800 to 1215 lb with weights of carcass cuts and rib eye area. The most important zero order correlation was slaughter weight in predicting weights of wholesale and retail cuts. The first order correlations with slaughter weight held constant showed that width at shoulders accurately predicted weights of round, rump, loin, rib and chuck. In the second order correlation, weight and heart girth were held constant. With these held constant, length from pins to hocks, width at thighs and depth of chest predicted accurately weight of round. Length from pins to hocks and chest depth predicted weight of rump. Width of shoulders, ~~width~~ length from pins to hocks and width at hocks predicted weight of round. Length from pin bones to hocks and chest depth predicted weight of rump. Width of shoulders, length from pin bones to hocks and width at hocks predicted weight of loin. Width of thighs predicted weight of rib. Width of shoulders, width of thighs and length from pin bones to hocks predicted chuck weight. Variations in width of shoulders accounted for 66-89% of the variance in weight of each of the 5 wholesale cuts and 93% of the variance of the combined weights of the five wholesale cuts.

Orme et al. (1959) observed that live animal and carcass measurements were highly repeatable except for spring of ribs, width of pins and length from the 13th rib to the hocks. At a constant weight, heart circumference was associated with 81% of the variation in rib-eye area. Circumference of body middle and at rear flank and circumference of leg above the hock were significantly related to loin-eye area. They obtained a correlation of -.50 between width at shoulders and width of rump, width of crops, width of round; width of shoulders was also negatively associated with percent of primal cuts but positively related with loin-eye area.

Cook, Kohli and Dawson (1951) studied wither height, heart girth, width at shoulders, length of body and height at floor of chest in relation to slaughter grade and dressing percent. They found that steers that were lower in wither height and height at floor of chest and shorter in length of body had higher slaughter grades and dressing percentages than rangy steers. Also, steers with higher heart girths had higher slaughter grades. Steers that were wide at the shoulders had higher slaughter and carcass grades. Kohli, Cook and Dawson (1951) found that steers that were shorter in wither height and body length and smaller in heart girth were superior in production traits.

Brinks et al. (1964) used photogrammetry measurements for predicting weights and percnetages of wholesale carcass cuts. They found that there is a greater proportion of forequarter and especially of the cheaper cuts as live weight increases. The prediction of weights of wholesale cuts was highly accurate using live weight and linear distances; however, the prediction of percnetages of the wholesale cuts of the carcass was less accurate. Sire groups were ranked based on either estimated or actual determination of weight of hindquarter, round and loin. Also, Clark et al. (1976) found that multiple correlations between weights and 14 linear measurements of live animals obtained by electogrammetry ranged from 0.60 to 0.77 for chuck and flank weight. The four primal cuts were more accurately estimated when combined weights were used than for any one of the cuts.

White and Green (1952) used 25 linear body measurements taken on steers weighing 800 to 1445 lb at slaughter to predict weights of wholesale cuts by employing multiple correlations. They obtained multiple correlation coefficients of 0.99 for cross-cut, 0.97 for rib, 0.98 for loin, 0.87 for trimmed loin, 0.93 for short loin, 0.96 for sirloin butt and 0.93 for round weights. One wonders if these high correlations aren't the result of larger animals having larger measurements and larger wholesale cuts. Kidwell et al. (1959) found that desirable slaughter proportions were animals that were low at withers and hocks and wide in chest in relation to heart girth. The ratio of height at withers to heart girth separated the animals into carcass grades.

Busch, Dinkel and Minyard (1969) used 745 steers on which 18 body measurements were taken to estimate edible portion of the carcass. They found that body measurements and scores on the live animal were of little value in determining the edible portion of the carcass. Only 2-4% of the variation in edible portion of the carcass was determined by variation in body measurements and scores. Slaughter weight was highly related to edible portion of the carcass. Variations in body weight accounted for 75-88% of the variation in weight of edible portion of the carcass.

The heritability of linear body measurements appears to vary greatly. Dawson, Yao and Cook (1955) found heritability estimates of 0.65 for height at withers, 0.63 for distance between the eyes, 0.50 for width of muzzle and 0.40 for chest depth. Height at floor of chest, all length measurements and all width measurements were low in heritability. Wilson et al. (1976) found that width at hocks had the highest heritability (0.19) of all measurements. Body length, rump length, body width and round thickness were all low in heritability. There were some genetic antagonisms between growth and meatiness traits with carcass quality traits.

Brown and Franks (1964) reported the following heritability estimates for measurements on 3-year old cows:

Weight	0.44	Hip width	0.11
Wither height	0.41	Chest depth	0.71
Hip height	0.69	Rear flank depth	0.46
Shoulder width	0.40	Heart girth	0.48

B. The soma scope and ^{40}K counts have been used to estimate the amount of lean and fat in the live animal.

Stauffer (1961) showed that fat thickness in live animals as measured by ultrasonics was highly repeatable but neither fat thickness nor rib-eye as measurements of the live animal was highly predictive of actual measurements of the carcass. The correlations of live animal and carcass measurements for fat thickness and rib-eye area were significant but of a low order. On the other hand, Hedrick et al. (1962) found that live animal measurements with ultrasonics with actual measurements for rib-eye area gave correlations of 0.58 to 0.89 and estimated and actual fat thickness measurements were correlated 0.11 to 0.63. They also found a high correlation of rib-eye estimate at 5 months with actual subsequent measurement of rib-eye in the carcass. Davis et al. (1964) used the Sonaray to estimate loin-eye area and fat thickness. The correlations between Sonaray estimates and actual rib-eye area was 0.87 and between Sonaray estimates and fat thickness was 0.90.

Lohman *et al.* (1966) found that ^{40}K measured by large volume liquid scantillation counter gave estimates of lean muscle mass with a standard error of only 3%. Frahm, Walters and McLelland, Jr. found that ^{40}K counts were highly repeatable and correlations of ^{40}K counts with fat-free carcass mass were 0.87, 0.83 and 0.87 following shrinks of 24, 48 and 72 hours. The correlation of 0.87 following a 24-hour shrink had a standard error of 3.8 kg. The addition of weight with ^{40}K count did not improve the estimate of fat-free body mass. Clark, Hedrick and Thompson (1976) used 56 steers weighing 183-574 kg on which whole body counts for ^{40}K were taken. They determined carcass ether extract, nitrogen, water and gross energy. The R^2 values of ^{40}K with nitrogen, ether extract and water were lower than when specific gravity was correlated with these carcass constituents. The R^2 of ^{40}K + live weight at slaughter with carcass constituents were: Nitrogen 0.87, ether extract 0.87, water 0.84, and gross energy 0.84. The R^2 of ^{40}K + weight for predicting fat-free carcass weight was 0.96.

C. Measurements relating to reproduction.

One problem facing beef cattle producers is calving difficulties, especially among young females. There is evidence that size and shape of the birth canal influences the frequency of calving problems. Bellows *et al.* (1971) has shown that precalving pelvic area is negatively related to calving difficulty. Pelvic area is determined by measuring height and width of the pelvic canal. It appears to be the most important factor in the cow associated with calving difficulty while calf size is the most important factor in the calf associated with calving problems. Larger cows generally have larger pelvic measurements but they also have larger calves than smaller cows; therefore, size of cow does not appear to be important in distocia incidence (Laster, 1974). Also, differences in calf shape as revealed by measurements do not appear to be associated with differences in incidence of distocia. On the other hand, Bellows et al. (1971) has found that hip width, rump length and body weight are all positively related to pelvic area. The order of importance of these three measures are body weight, hip width and rump length. Thus, larger pelvic area is associated with larger skeletal size. What is needed is to coordinate calf size with pelvic area.

Fitzhugh (1976) has pointed out that calf size can be reduced by selection and by management practices. One must keep in mind that reducing calf size at birth may also reduce the vigor of the calf and thus its chances of survival. Melton et al. (1967) found that rapidly gaining bulls develop secondary sex characters more rapidly than slowly gaining ones. He also reported that more advanced secondary sex character development was associated with more weight in the forequarters.

D. Body measurements to determine size and shape of animals.

For many years, cattlemen have used visual appraisals for determining size and scale and for differentiating body shapes which they referred to as type. Hoffman, Van Ess and Long (1977) by visual appraisal placed animals of five body shapes on feed and, at the end of the feeding period, slaughtered them for determining fat-free muscle. The five groups by shape were very angular (longhorn), angular (dairy), non-muscular (beef), muscular (beef), and very muscular (double muscled). Similar animals to the ones in these 5 groups were slaughtered at the time the five groups were started on feed. Both the animals slaughtered early and those slaughtered following feeding were dressed out to determine live empty body weights after which all soft tissue was homogenized. The fat from the homogenized tissue was removed by extraction to compute fat-free muscle. By comparing the analyses of data on animals slaughtered at the beginning and at the end of the feeding period, gain of fat-free muscle was determined and related to feed consumed. Efficiency was measured by kg feed required per kg of fat-free muscle. When lean animal body weight and fat percentage were held constant, there was no difference between groups in efficiency. Fatter animals required more feed. Shape affected efficiency only because muscular animals were leaner at any chronological age.

Kidwell et al. (1959) stated that desirable slaughter proportions for yielding desirable carcasses were low at withers and hocks and wide chest in relation to heart girth.

Research workers at the University of Arkansas have reported interesting results from the use of body measurements and body weight in describing size and body shapes. Brown, Brown and Butts (1973a) used 267 Hereford and Angus bulls that were measured at 4, 8 and 12 months of age. Measurements were height at withers, height at hips, width at shoulders, width at pelvic bones, width at loin, chest and rear flank depth, heart girth, and length of body from shoulder point to pin bones. They developed 5 principal components. Principal component 1 included weight and all the body measurements. It was a measure of overall size and scale. Principal component 2 described bulls of the same body shape and contrasted short, wide bulls with tall, narrow bulls. A large positive principal component 2 would be a comprest animal while a large negative principal component 2 would be a rangy-type bull.

Principal component 3 described bulls that were above or below average in depth at rear flank. Deep-bodied bulls at the rear flank are shorter in body length and more shallow-bodied. Principal components 4 and 5 were different in Hereford and Angus bulls. In Herefords, principal component 4 contrasted bulls that are tall, wide at hips, long-bodied and narrow at the loin with short bulls that are short in height and length but wide at the loin. In Angus, principal component 5 did what principal component 4 did for Herefords.

Approximately 56-68% of the variation in size was accounted for by variation in principal component 1 and all body measurements were about equally important. Ten percent of the variation in dependence structure of the system was due to principal component 2 and was consistent at the three ages. length of body was of less importance than height and width of body.

They concluded that selection for weight, size or gain could result in animals of variable dimensions and shape. It is logical that length, width and depth counteract one another to a certian extent.

In a second paper, Brown, Brown and Butts (1973b) reported that any one of the nine body measurements was positively associated with gain, weight and feed consumption. Certainly this is what would have to exist biologically. A more rapidly gaining animal will become larger and weigh more. Larger animals eat more feed than smaller animals and they would have larger body dimensions. Increases in measurements in Hereford bulls were associated with increases in feed conversion; whereas, in Angus, bulls increases in measures were associated with reductions in feed conversion. Increases in principal component 1 which includes weight and all measurements were associated with increases in gains, weight, and feed consumption. Shapes were associated positively with gain and efficiency of feed conversion. Tall, narrow-bodied bulls ate more feed, gained more and were heavier than short-bodied, wide bulls but were less efficient. Several body shapes gave desirable feedlot performance; therefore, identifying body shapes may be of greater importance in other phases of the livestock economy than in feedlot performance.

Brown, Brown and Butts (1973c) from 9 measures taken at 12 months and records on daily gains, feed consumption, feed conversion and final test weight reported that the genetic correlations between individual body measures at 12 months and measures of feedlot performance were large and positive. Genes with a positive effect on body measures improved feed conversion in Herefords but reduced feed conversion in Angus bulls. Genetic correlations between size as measured by principal component 1 suggested similar relationships between a single measure of overall size and test performance as was found for correlations of individual measures and performance. Shape at 12 months was correlated with performance and several shapes were positively related to rate and efficiency of gains. The genetic correlation of shape and performance suggests that concurrent use of shape and performance data might enable the breeder to differentiate between early and late maturing bulls while increasing genetic merit for growth. Bulls that had larger measures at 12 months tended to mature earlier than bulls that were smaller. Short, wide bulls matured earlier than tall, narrow bulls. Early maturity can be positively correlated with test performance if it results from a proportionately greater increase in growth rate than in mature size; while early maturity may be negatively correlated with test performance if it results from a proportionately greater decrease in size than in growth rate.

Brown, Brown and Butts (1974) used measures and principal components, on 557 individually fed animals, in a stepwise regression to predict gain, feed conversion, feed consumption and final weight. Twenty-five percent of the variation in gain was accounted for by variations in measures and 16% was accounted for by variations in principal components that described size and shape. Sixty-five percent of the variation in final weight was accounted for by variations in body measures and 45% of the variation in feed consumption was explained by variation in body measures. By use of predicted final weight and feed consumption, gain on test and feed conversion was estimated with reasonable accuracy. The important measures for prediction were height, width, length, heart girth, chest depth, and weight.

E. Body measurements and weights for determining rate of maturity and mature weight.

Before discussing growth and maturity, terminology that will be used needs defining. Absolute growth rate is the amount gained over time required for the gain; or it is gain per unit of time. In general, gain per day is the method used for expressing absolute growth rate. Relative growth rate is 1. gain per unit of time per unit of body weight at that time, or 2. gain per unit of time per unit of body weight at maturity. Thus, relative growth rate can be growth in relation to the size of the animal at the time it made the growth or in relation to the size of the animal at maturity. Degree of maturity is the fraction of mature size, adjusted for condition, attained at any given age. It may also be defined as that part of mature size attained at any given stage or age. Relative maturing rate is change in current or present size relative to relative degree of maturity. All of these terms can be applied to weight or to body measurements.

Brown, Brown and Butts (1972a) reported that Hereford sires had large influences on mature weights and rate of maturing of their offspring; whereas, Angus sires affected early weight changes but not mature weight. Genetic correlations of mature weight with rate of maturing showed a strong genetic antagonism between these two traits, indicating that selection for early maturing would result in smaller mature weights. In Herefords, genetic correlations of rate of maturing with mature weights indicated that higher maturing rates would result in lighter weights at all ages. However, in Angus, rate of maturing was associated only with lighter weights up to four months of age.

In a later paper (Brown, Brown and Butts, 1972b) found that large gains at young ages were associated with early maturing females; whereas, genotypes required for sustained growth rate into advanced ages were associated with late maturing females. Early maturing females were lighter in body weight prior to four months of age but gained very rapidly from 4-16 months of age, and were smaller in mature size than late maturing females. Heifers with rapid gains after 16 months of age were late maturing and became large in mature weight. They concluded that gains and weights are not regulated by identical groups of genes and that mutual genes do not have isodirectional effects on the two traits. Thus, selection for large gain or for large weights would not cause identical changes in the growth pattern of all individuals. Genetic differences and differences in amount of development which took place between fixed chronological ages caused correlations between these two traits to be different in Angus and Herefords. Genetic variation in development between two fixed ages emphasizes the necessity of considering the stage of development of the animal in any evaluation of singular measures of growth.

Smith et al (1976a) reported heritabilities of weight and degree of maturity at various ages to be:

	Birth	200 days	396 days	550 days	3 1/2 yrs
Heritability of weight	0.68	0.59	0.87	0.82	0.41
Heritability of degree of maturity	0.73	0.64	0.55	0.21	-.26

Animals with high absolute growth rate during pre weaning, those with high growth rates relative to current size or to absolute maturing rate tended to grow slowly at later ages. Animals that were more mature at any given age tended to be more mature at all ages. Variations in mature weight accounted for 19% of the genetic variation in degree of maturity through 550 days. Approximately 50% of the variation in absolute growth rate was independent of mature weight. Selection for growth rate (either relative or absolute) over any age interval would tend to alter the shape of the growth curve of that interval. Selection for absolute growth rate over any interval would tend to increase weight at all ages. Selection for relative growth rate during preweaning would tend to decrease birth weight and weight subsequent to 550 days but to increase weights up to 550 days of age.

Smith et al. (1976b) define mature weight as weight at 6-9 years of age adjusted for differences in condition score. They obtained heterosis of 2.5% for mature weight from crosses involving Herefords, Angus and Shorthorns. There was some indication from using absolute maturing rate that heterosis accelerates the maturing process. Degree of maturity showed significant heterosis at all constant ages except at birth. Relative growth rate showed a significant heterotic effect only during the first wintering period; a time of increased environmental stress.

Fitzhugh and St. Taylor (1971) state that size at any age can be partitioned into the proportion to mature size and the deviations in proportion to mature size resulting from differences in maturing rate. They give 0.22 to 0.46 for heritability estimates of degree of maturity at birth, 6, 12 and 18 months of age. Selection for weight at any given age will tend to make animals more mature at that age. Heavy mature weights were associated with less maturity at any given age. It would be possible to increase absolute growth rate without increasing mature size by selection. Selection for increased degree of maturity in early life tends to increase both absolute and relative growth rate in early life and to decrease both in later stages. Selection for increased body weight at an early age would increase absolute growth rate at other stages without influencing greatly their maturing rates.

Fitzhugh (1976) reported that there is a negative relation between mature size and earliness of maturing. Selection for absolute growth rate will increase time taken to mature. He points out four reasons why breeders might want to change the shape of the growth curve:

1. To improve intrinsic efficiency through increased maturation rate.
2. To resolve genetic antagonism between desired rapid and efficient early

growth and small cow size of lower maintenance costs.

3. To reduce calving problems by reducing birth weights of calves.

4. To lower age at first breeding.

He observed that faster growing animals are less mature and, as a result, they are leaner at any given weight. It must be pointed out, however, that in some species at least, faster growing animals are also fatter (mouse and pig).

F. Body measurements in early life as predictors of subsequent performance.

Flock, Carter and Priode (1962) measured 1425 beef calves of the British breeds at birth and gave each a score for type. Type score at birth and body measurements at birth were not associated or the association was very low with gains to weaning or weaning score. Birth weight was positively related with preweaning gains and to calving difficulties.

G. General Considerations.

It appears that what beef cattle producers would like would be cattle that gain rapidly and convert feed into animal product efficiently. The animals would gain rapidly to 1000 - 1100 lb., after which they would quickly mature so that mature cow size would be about 1100 to 1200 lb. and bull size about 1600 lb. This would reduce maintenance costs of breeding stock. The steers that gain rapidly would also have a high percentage of lean but would have sufficient marbling to give desirable flavor. The small cows would produce a moderately large calf at birth so its early life vigor would be high and it could cause the cow to establish a high level of milk production. These small cows would be able to deliver large calves without problems of dystocia and they would calve regularly each year.

Perhaps such a herd or herds could be developed through selection if there were no genetic or physiological antagonisms. From the research that has been reported, it appears that shape of the animal and shape of the growth curve can be altered by selection. It is not clear from the studies at Maryland whether one could change the proportions of the wholesale cuts through selection or not. Their studies on steers of the same weight indicated that the weights of wholesale cuts could be estimated reasonably accurately from live animal measurements. This same degree of accuracy in estimating weights of wholesale cuts in bulls and heifers would be necessary if selection were to be effective. Also, a reasonably high heritability would be important if genetic changes in proportions of wholesale cuts were to be made.

There may be some antagonisms that will cause problems. In general, when cow size is reduced, calf size at birth is also decreased. Small calves at birth lack the vigor that is important in their survival and in their ability to take all the milk the cow produces. Thus, small calves at birth usually cause the dams to establish a lower level of milk production. If selection could keep size of calf at birth fairly large while cow size is reduced through selection, there probably would be much calving difficulty encountered.

Cattle that mature at smaller sizes usually tend to fatten considerably before reaching the normal slaughter weight of 1000 - 1100 lb. This usually results in lower feed conversion and in carcasses with a lower percentage of lean but with an improvement in marbling. Their relative growth rates are usually high but absolute growth rates are not so high. Cattle that mature at larger sizes are generally growing rapidly in absolute gains but less rapidly in relative growth rate, they produce more lean and less fat in the carcasses up to 1000 - 1100 lb. and they are not well marbled.

The Arkansas studies appear important for the possibility of changing the shape of animals perhaps independently of altering other performance characteristics. By use of linear measurements, bulls that are low-set and broad could be accurately differentiated from tall, narrow ones. These studies indicate that through selection, body shape could be altered more effectively than what could be obtained by selection using subjective visual appraisals of body shape. Their results indicated that high performance (growth rate and feed conversion efficiency) was not restricted to a particular body shape. Thus, selection for weights or gains could result in animals of variable body shapes. It appears that early maturity can be positively associated with performance (rate of gain and efficiency of feed conversion) if it results from a proportionately greater decrease in size than in growth rate.

It should be pointed out that when animals are measured at given ages, weights vary greatly. Animals that are larger will have larger body measurements; therefore, measurements will all show a positive correlation with one another. These positive correlations simply reflect that all are influenced by the sizes of the animals. Actually, it is impossible for animals of the same weight to be larger or smaller than others in length, width and depth of body. Animals of the same weight that are much wider than others must be either shallower or narrower or both. We must not overlook this in our consideration of body measurements. Perhaps one should either measure animals at a constant weight or hold weight constant in mathematical manipulations of the data.

Brown, Brown and Butts (1972a) found a strong genetic antagonism between rate of maturing and mature weight. This means that selection for early maturity would result in smaller mature weights. Genotypes that caused large gains of heifers at early ages were associated with early maturing females; whereas, genotypes required for sustained growth rate into advanced ages were associated with late maturing females.

The heritability estimates of degree of maturity taken at various ages up to 550 days are high and indicate that selection would be effective. Thus, selection for growth rate over any interval would tend to alter the shape of the growth curve of that interval. Selection for absolute growth rate over any interval tends to increase weight at all ages. Selection for weight at any age tends to make animals more mature at that age.

I would like to interject some of my views on altering body shape, body size and maturing rate through selection. First, we need to give thought to which is more effective - to use existing breeds that differ greatly in all of these characteristics in crossbreeding programs to produce what is most desirable or to try to produce a population of animals through selection that possesses all the desirable characteristics. If we decide that by taking weights and body measurements on breeding stock and selecting for animals that will most nearly meet our goal, it appears that either we should first locate the breed that most nearly approaches our goal or we should cross to obtain such animals before we start a program. It appears to me that setting a goal and selecting within each of the existing breeds to bring all breeds to this kind of animal would not be wise. Thus, if a few breeds now closely approach what appears to be most desirable, perhaps expansion of numbers of these breeds along with selection within them would be better than trying to make breeds that deviate greatly from our goal become more like existing breeds that are approaching our goal at present.

Some of the questions I have on body measurements are: what predictive value do linear body measurements in early life have in estimating subsequent performance? What are the relationships of body measurements at an early stage to the same measurements at a later stage? Are body measurements more related to previous performance of animals or to subsequent performance? I have data over a 25-year period involving over 1000 animals during which all bulls and heifers were measured at a constant weight when the animals were placed on feed test and at a constant weight when all animals completed the feed test. By constant weights is meant that animals were weighed each week; therefore, the variation in weights on and off the feed test were within 25 lb. It was my hope that these data would be analyzed in time for inclusion in this report but this is not the case. If they are analyzed soon, I would like to add our material to this report.

There are some questions as to what body measurements are the most meaningful. Certainly, no one is interested in taking any more measurements than necessary. On the other hand, a useful measurement should not be omitted if we are to take and use body measurements. Height of the animal appears to be one important measurement. It can be taken at the hips or at the withers. Perhaps hip height can be taken more accurately than wither height. Body width can be taken at the shoulders, at the hips or behind the shoulders. Some measure of width is important. Body depth can be taken at the rear or at the fore flank. Some measure of body depth is important. Length of body has been measured from the pin bones to the poll or to the point of the shoulders. The measurement from the pin bones to the shoulder point is more of a hypotenuse than a length measurement. There are many measurements that could be taken and I think one needs to have real reason for taking them if they are to be taken.

Do we want to suggest to PRI that certain body measurements be taken and used in selection? I feel that we may want to take measurements but I seriously question the adoption of measurements in a universal selection program until we have more information. It appears that some good starts have been made by investigators but there are several unanswered questions.

Research at Oregon State University indicates that two physiological systems operate in animals and that these are antagonistic to one another. One system is concerned with effective withdrawal of amino acids from the boood stream for building muscle tissue. Animals under strong influence from this system and low in influence from the other system grow rapidly and are lean. The other system influences fat deposition. Animals under strong influence of this system and low in the other system deaminize amino acid, excrete the nitrogen and use the carbonaceous portion as energy source for fattening. Animals under this system tend to grow slowly and to store more fat and less lean than animals under the influence of the other system. What effect selection for earliness of maturity or for body shape would have on the relative importance of these two physiological systems is unknown. One might surmise that selection for low-set, broad bodied animals and for those that mature early might increase the system encouraging fat deposition and decrease the system encouraging lean deposition.

It appears logical that use of body measurements for change in conformation would be more effective than use of scores; body measurements are not subjective and are not influenced by what has been measured. Visual appraisals are often influenced by what one has just previously viewed. If body measurements are to be used for altering conformation, it is imperative that we use them only in conjunction with a good performance testing program. If our goal for conformation is in conflict with good rate of gain, efficiency of feed conversion, fertility or milk production or any combination of these, selection for performance traits along with selection for conformation as determined by body measurements will prevent us from creating undesirability in some traits as a means of obtaining desirability of others.

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Performance Testing and the Livestock and Range Research Station

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The Livestock and Range Research Station (LARRS), formerly the United States Range Livestock Experiment Station, was founded in 1924 by an act of Congress which transferred the Fort Keogh Military Reservation from the War Department to the United States Department of Agriculture. This act made possible development of the Station which is operated in cooperation with the Montana Agricultural Experiment Station.

LARRS is comprised of approximately 56,300 acres of land in an area nearly 10 miles square. The reservation is bounded on the east by the Tongue River. In the Yellowstone River flat, approximately 1,000 acres are under irrigation. The remainder of the Station is rough, broken "badlands", typical of much of the range in the Great Plains area. The land is fenced and cross-fenced into 70-80 pastures ranging in size from 30 to nearly 4,000 acres. The facilities allow separate breeding pastures and enough large pastures for spring, summer, fall, and winter range.

Performance testing studies were initiated at the Station about 1934. Research on development of inbred lines of beef cattle was commenced at the same time. Both studies were conducted concurrently, with the inbred lines involved in the record of performance project.

Practically the entire resources of the Station, including staff, cattle and land, were devoted to these two projects for twenty-five years. The project titles were:

1. Developing and testing methods of measuring performance in beef cattle.
2. Development of superior lines of beef cattle.

Thus it may be said that about half of the fifty year life span of LARRS has been devoted primarily to pioneer research in performance testing and inbred line development.

The important initial contribution of this research was the determination of heritabilities of various economic traits of beef cattle. The first estimates were published in 1946 with added traits and some revision in 1950 and later years. Until the proportionate effects of heredity and environment were determined,we were not too sure whether performance selection was here to stay. After relatively high heritability estimates were obtained, we were convinced that performance testing was the correct approach to beef cattle selection despite the opposition at that time of many breed organizations and breeders.

Our other major performance research dealt with procedural questions such as length of test periods, sex and age corrections, amount of data necessary for accurate selection, and allowable age ranges for testing - to name a few of the questions that had to be answered.

The record of performance project was tremendously productive simply because the Station herd was the first large population of cattle in the U.S. from which detailed performance records were obtained. Therefore, there was considerable "spinoff" information accumulated on a variety of subjects relating to beef cattle production, particularly under range conditions.

Additional data obtained from the record of performance project were:

1. Determination of growth curves and peak productive years of cows in a range herd.
2. Fertility levels and most common factors affecting fertility.
3. Heritable aspect and incidence of eye cancer, prolapse and bloat.
4. Growth curves and expected gains of calves, yearling and 2-yr-old steers on summer range.
5. Dystocia and related calving problems as affected by selection.
6. Relationships between growth, body measurements and carcass quality.

Current Research

The preceding discussion has briefly summarized past studies of performance at LARRS. Other studies are currently in progress that relate to various aspects of performance testing.

Genetic- environmental Interaction Study

In 1961 LARRS and the station in Brooksville, Florida exchanged breeding stock with cattle born in Montana and in Florida divided into two randomized groups for each location. At each location a Miles City and Brooksville closed herd was maintained plus a Miles City herd in which bulls produced at the other location were used.

In brief summary of this study it was found that both herds performed best at their place of origin and that a genetic-environmental interaction did occur. Publications will be forthcoming in the next year as the experiment is just concluded.

New Line Development

A number of approaches to linebreeding have been tested at LARRS. All approaches have been based on rigorous selection for performance. We have started within-breed lines from unrelated matings, related matings, crosses of two inbred lines, and selections of top producing males and females from as many as six lines. In addition, we have worked with various breed combinations, both beef and beef X dual purpose crosses.

The beef "mixer" or composite herd is an Angus X Hereford X Charolais population bred inter se. The beef X dual purpose herd is composed of Angus X Hereford X Charolais X Brown Swiss bred inter se. The Brown Swiss breed has been studied at LARRS since 1955 under range conditions as a single breed, in rotational crosses and in the "mixer" line. The beef "mixer" line has produced about the same weaning weight advantage over the straightbred commercial cattle as is found in rotational crosses of Angus, Hereford and Charolais. The population involving Brown Swiss has consistently produced heavier calves at weaning than the beef breed rotation and has held this advantage for several years.

Other breed combinations are planned involving various breeds with at least one important, superior economic trait to contribute.

Reproduction Research

The objective of Station reproductive physiology research is to increase the reproductive efficiency of range cattle. Essentially this means increasing the pounds of calf produced per cow exposed to breeding. Failure to become pregnant has been the most important reason for reduced levels of calves weaned per cow bred at this location, followed by losses at or shortly after birth.

Age at puberty and conception early during the first breeding period have important effects on the lifetime production potential of beef females. Ages at those events can be altered by changing the genetic makeup of the animal or varying the level of feeding during the first year of life of the heifer.

Reproduction performance in the Station herds have been studied since 1958. It is indicated by our data that 60 percent of our calf losses at birth can be prevented by giving timely and proper assistance to dams experiencing difficulty during calving. Birth weight was the most important causative factor associated with calving difficulty. However, 70 percent of the identified variations in calving difficulty were either present or established at conception. This is why so little can be done to alter calving difficulty by changing environmental factors during gestation.

Another project just begun has as a major objective a measure of correlated responses in a herd in which random mating and selection will be practiced. Correlations between growth and fertility traits will be of primary interest.

Proposed Research

Performance procedures are now well standardized largely due to the efforts of BIF. However, it is my belief that the industry would benefit materially by placing selection pressure on two traits that are now debated more than used in selection. I am referring to birth weights and cow efficiency.

Increased calving of two-year-old heifers, the appearance of the continental breeds and performance selection have contributed to increased calving problems. Increased birth weights due to selection for increased growth is a well-known fact. The trend line for calving difficulty at LARRS illustrates the problem very graphically, increasing from a 3.6 percent average for the twenty year period ending in 1957 up to 5.1 percent through 1976. This represents a 42 percent increase in calves dead at birth or within 24 hours.

We are approaching this problem through a study designed to determine the effect on growth of adding selection for low birth weight to present selection criteria. Our Line 1 herd is being used in this research. Half of the herd is selected as it has for the past forty-three years since it has been closed. The other half is selected on the additional criterion of low birth weight.

The objective is to determine how effectively we can continue to improve growth rate when placing additional selection pressure for low birth weights. An examination of the range in birth weights for the past eight years disclosed as high as a 40 percent variation among the heaviest ten bulls in yearling weight indicating ample opportunity for selection.

We are not presently studying cow efficiency. However, we do believe that lack of a practical evaluation of cow efficiency is a deficiency in field performance testing at this time. The ratio of calf weight ratio to cow weight ratio suggested by Dr. Fitzhugh to the BIF Pre- and Post Weaning Test Committee appears to be a logical proposal to study.

REPEATABILITY AND HERITABILITY OF TESTICULAR TRAITS

AND THEIR RELATIONSHIP TO SEMEN QUALITY AND FERTILITY,

R.H. FOOTE

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Introduction:

A beef cow must produce a calf each year to be an efficient production unit. There are many reasons why any particular cow may not conceive on time or at all, but a big reason why a whole group of 25-50 cows may not conceive through natural service or artificial insemination (A.I.) is the low fertility of the bull or semen used. So both reproductive-wise and genetically one bull is half of a small herd "for better or for worse".

Breeding Soundness.

Breeding soundness is important (Carroll et al., 1963; Elmore et al., 1975). A bull should be healthy and physically fit to serve many cows and ejaculate high quality semen. The Society for Theriogenology has adopted a set of standards for bulls (Ball et al., 1974), which include palpation of the reproductive organs and collection and evaluation of semen.

Semen Quality and Electro-ejaculation.

Semen quality is affected by a great many factors such as heredity, nutrition, season, frequency of ejaculation, age (especially at puberty), disease, stimulation at the time of semen collection and the method of semen collection. There is considerable variation from ejaculate to ejaculate. This may be especially true with elector-ejaculation.

The best method for collecting semen is by the artificial vagina (A.V.), in that one is able to get an indication of libido and semen quality under conditions which simulate more closely natural mating. However, it is often not practical to take time to train bulls to the A.V. Therefore, electro-ejaculation is used most commonly. It is very important to be experienced with this type of equipment and its use with different types of bulls, if one expects to obtain a good response.

If one obtains an excellent sample of semen the first time it is a good indication that the bull produces good quality semen. By good semen I mean samples with the following characteristics;

Volume - several cc or Milliliter

Color - Opaque, milky in appearance showing good sperm concentration, and free from clumps.

Contamination - free from blood, urine and dirt or pus.

Motility - more than 50% vigorous progressively motile sperm when diluted and viewed at high power under the microscope.

Abnormal cells - less than 20% abnormal heads and tails.

Total sperm - at least 5 billion sperm per ejaculate in mature bulls well past puberty.

If a poor sample of semen is obtained the bull should not be classified as a poor semen producer until at least 3 to 4 samples of poor quality are obtained. It is best to obtain these over a period of 2 to 3 days, but up to 3 successive samples can be collected per day if 30 minutes are allowed between each collection. When samples are collected in succession sperm concentration will decline. This is shown in Figure 1 in a study by Foster et al. (1970). Note also that the sperm concentration per milliliter is lower in samples obtained by electroejaculation as compared to use of the A.V.

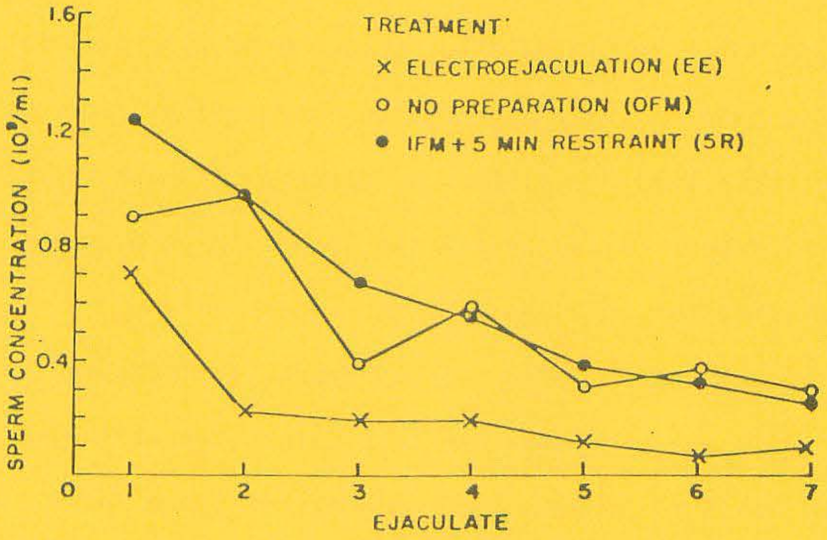

Figure 1. Changes in sperm concentration for beef bulls collected seven successive times by three different methods. (Foster et al., 1970)

Even, having done all this, semen evaluation does not guarantee fertility. The correlation between semen quality and fertility is not high. Nevertheless, it is a useful guide. Several years ago Dr. Wiltbank obtained the following results.

Table 1. Relationship of Semen Quality of Beef Bulls to Their Fertility (unpublished data by Dr. Wiltbank).

Semen classification	No. of bulls	Conception rate Mean	(Range)
Good semen quality	29	60%	(14-100)
Doubtful quality	11	48%	(31-57)
Poor quality	11	30%	(0-69)

It certainly would pay to eliminate most of these bulls with poor quality semen from the breeding herd, but the range in fertility was great.

The Testes.

Several years ago an Angus breeder called me and said he had purchased a good bull (good type and high priced), but obtained no progeny. We examined the bull and found a pair of small hypoplastic nonfunctional testes. The bull was sterile. About this time Dr. Elliott of American Breeders Service observed that their high performance tested beef bulls seemed to be poor sperm producers. This was only an observation, but one of some concern to us.

By that time we and others (Boyd and VanDemark, 1957; Hahn et al., 1969b; Willett and Ohms, 1957) had reported that testicular size was highly correlated with the ability of bulls to produce large numbers of sperm cells. We studied dairy bulls from puberty to maturity (Foote et al., 1977), and Almquist et al. (1976) studied beef bulls and again found this relationship to hold true.

From manual palpation studies we felt that testicular consistency was related to semen quality. But individual persons differed in their palpations. So we designed an objective device to measure consistency or firmness and called it a tonometer. We also used a special tape to measure scrotal circumference.

Use of the Scrotal Tape and Tonometer.

It is important to stabilize the bulls in a squeeze chute. The scrotal tape is slipped over the two testes. The point at the maximum diameter is measured with the tape on snugly but not tightly. If the testes are drawn close to the body, as in cold weather, they should be massaged down to avoid wrinkling of the scrotum. Symmetry of the testis should be noted at this time.

The tonometer is applied to the rear and along the midline of each testis (Hahn et al., 1969a). The baseplate is placed squarely on the testis without it directly compressing the testis. The other hand is held in front of the testes to steady them positioned against the tonometer.

Repeatability of Measurements.

The equipment is simple to use and different individuals can be trained to obtain nearly the same results when independently measuring a series of bulls This is clear from Table 2, based upon 2 people measuring 60 bulls.

Table 2.

REPEATABILITY OF TESTIS MEASUREMENTS

Measurements	r
Scrotal circumference	.98
Tonometer 1, left testis	.95
" 2, right "	.90
" 1, left "	.99
" 2, right "	.97

The correlations between all sets of paired observations approach 1.0. Thus, measurements taken by trained people at different times and places should reflect animal differences and not operator differences, primarily.

Factors Affecting the Measurements.

Scrotal circumference obviously changes as the animals grow (Coulter et al., 1975; 1976b). Much needed are standard testis growth curves for various breeds. We have data presented in Table 3 for Holstein and Angus bulls. These data were obtained from work we did with A.I. studs, so the number of beef bulls is limited. The curves for Angus and Holstein bulls are similar. However, testes of Angus bulls appear to develop a little more rapidly during the first 1-3 years, but in mature bulls are slightly smaller than in Holstein bulls. Testicular development in Simmenthal bulls is similar to Angus, based upon a report by Kupferschmied et al. (1974).

Table 3.

CHANGES IN TESTICULAR SIZE IN HOLSTEIN AND ANGUS BULLS WITH AGE

Age in months	Scrotal circumference			
	Holstein		Angus	
	No. of measurements	Measurement (cm)	No. of measurements	Measurement (cm)
6-12	371	30.0 ± 3.3[a]	3	33.5 ± 3.1[a]
12-18	696	34.9 ± 2.4	19	36.1 ± 3.0
18-24	597	37.4 ± 2.2	19	40.1 ± 4.0
24-30	510	39.1 ± 2.9	43	40.0 ± 2.7
30-36	488	40.1 ± 2.3	37	39.5 ± 3.2
36-42	466	40.8 ± 2.7	38	40.6 ± 2.5
42-48	431	41.2 ± 2.5	18	40.5 ± 3.1
48-54	375	41.6 ± 2.5	25	40.3 ± 3.1
54-60	361	41.7 ± 2.9	8	39.7 ± 2.5
60-72	616	42.1 ± 2.7	16	40.0 ± 2.3
72-84	307	42.6 ± 2.7	21	41.0 ± 2.4
84-96	219	42.6 ± 3.9	21	41.1 ± 2.9
96-108	158	43.3 ± 2.5	23	42.1 ± 2.3
108-120	116	43.5 ± 2.6	18	42.1 ± 2.3
120-132	82	43.9 ± 2.7	12	41.6 ± 2.0
132-144	62	43.5 ± 2.8	8	40.0 ± 2.9
144-156	30	43.1 ± 2.6	6	40.3 ± 2.1
156-168	16	41.5 ± 2.7	3	41.0 ± 3.0
168-180	6	41.8 ± 3.9	1	39.0 ±
Total	5909		339	

[a]Mean ± standard deviation.

Testicular consistency changes somewhat with age (Coulter and Foote, 1976a). Testes of young bulls with a thin scrotal covering are firm. They become considerably softer by three years of age and then gradually increase slightly in firmness to maturity. Season had a slight effect, in that scrotal circumference did not increase quite as much during the winter months.

Thus, until adequate correction factors are available the most reliable comparisons are the direct ones - that is, bulls of the same breed and similar age compared within the same year-season.

Relationship Between Testis Measurements and Semen Quality.

The high correlations between testis size and sperm concentrations have been mentioned previously. The relationship between tonometry measurements and semen quality are given in Table 4. The tonometer is not correlated with sperm numbers. But testis firmness is related to the other measures of semen quality.

Table 4.

CORRELATIONS BETWEEN TONOMETER RATIOS AND SEMEN CHARACTERISTICS FOR HOLSTEIN BULLS OF DIFFERENT AGES

Tonometer ratio correlated with:	Age groups in months	
	17-22	72-150
Volume	−.14	0.13
Sperm concentration	0.23	−.18
Total sperm	0.22	0.06
% unstained sperm	0.84**	0.59*
% normal sperm	0.66*	0.63*
% motile after 1 day at 5°C.	0.80**	0.68**
% motile after pellet freezing	0.61	0.63*
% motile after ampule freezing	0.69*	0.64*
60 to 90-day % nonreturns	—	0.67**

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

The older group of bulls had extensive fertility data, which was significantly correlated ($r = .67$) with the tonometer values.

These relationships have been confirmed in another study (Foote et al., 1977) when bulls again were ejaculated regularly. Many ejaculates must be collected in order to evaluate precisely semen quality. We collected 16 ejaculates per bull over a period of four weeks. Under field conditions the correlations will not be as high. This will be because semen quality is evaluated poorly, but this does not invalidate the value of the tonometer.

Leidl and Schefels (1971) reported that the tonometer detected changes in the testis induced by experimental irradiation. The spermatogenic function was temporarily destroyed. As the testes regenerated this was detected by an increase in the firmness of the testes several weeks before sperm production returned to normal. This time lag is expected due to the time required to form and transport spermatozoa. The tonometer was more effective than palpation in detecting the changes. A similar situation might be expected following exposure to hot conditions.

Elmore et al. (1976) reported that Angus, Charolais, and Horned and Polled Herefords did not differ in testis size. These workers found that bulls with smaller testes tended to be those with questionable semen quality.

Predictability of Future Performance.

It would be valuable to be able to predict future breeding ability from present performance. Realistically we would not expect to be able to do this with great accuracy because of all the future unpredictable accidents, stresses and other environmental insults that will affect individual bulls differently. The correlations between measurements on young bulls and similar ones at maturity are summarized in Table 5. The correlations for measurements at 1-2

Table 5.

Correlations between testicular measurements in mature[a] Holstein bulls and those on the same bulls when they were 12 to 23 and 24 to 35 mo of age

Testicular measurements at different ages correlated with those taken at 60 to 71 mo[a]	Correlation coefficients[b]	
	Scrotal circumference (n = 160)	Testicular consistency (n = 116)
12-23 mo, X_1	.48	.38
24-35 mo, X_2	.56	.44
$X_1 + X_1^2$	.48	.39
$X_2 + X_2^2$	.56	.67
$X_1 + X_2$	.58	.50
$X_1 + X_2 + X_2^2$	.58	.69

[a] Bulls 60 through 71 mo of age were considered mature.

[b] All correlation coefficients are highly significant ($P < .01$).

years of age with those at 5-6 years of age can be substantially increased by a second measurement at 24-35 months of age. However, even a single measurement is useful in identifying the poorest bulls in a group. Correlations computed for intermediate years (not listed) generally ranged from .50 to .85.

By evaluating semen quality and measuring testis size and consistency it should be possible to identify those bulls at an early age which are likely to have poor reproductive rates. Those with the lowest predicted value should not be used or sold as breeders, or if extremely valuable otherwise, these bulls should be tested with a small group of females.

Heritability.

We have studied the heritability of these traits, based upon several thousand measurements on 1521 Holstein sires (Coulter, Rounsaville and Foote, 1976). These results are summarized in Table 6. The average heritability

Table 6.

HERITABILITY OF SCROTAL CIRCUMFERENCE

Age group in months	No. of observations	No. of sires	Heritability
6-11	319	52	.62
12-17	297	48	.78
18-23	538	78	.58
24-29	463	75	.88
30-35	425	72	.58
36-41	414	79	.73
42-47	367	72	.65
48-53	317	78	.42
54-59	297	63	.64
60-65	266	63	.77
66-71	227	55	.21
Av.	389	70	.67

for scrotal circumference was 0.67, which is high relative to many biological traits. The overall heritability estimate for tonometer values was 0.34. Thus, we have traits that are sufficiently heritable that they may be worth selecting for.

Conclusions.

The correlation of scrotal circumference with spermatozoal output of .81, and the high repeatability of .98 between technicians taking the measurements (Hahn et al., 1969b), combined with the ease with which this measurement can be taken, means that bulls with the capacity for producing large numbers of spermatozoa could be identified easily. Phenotypic selection of the top bulls evaluated would be expected to result in bulls with markedly larger testes and with capacity for producing billions more sperm per week.

Large testis size is highly correlated with ovulation rate in related female mice and larger testes in rams is indicative of multiple ovulations in ewes (Land, 1973). No reports were found concerning this relationship in cattle, but it likely would be of little importance because of the predominantly single ovulation in cattle.

Identification of sires with firm testes (higher tonometer readings) could be important in identifying bulls expected to produce high quality semen This would be important to identify before dairy bulls were placed on a progeny test or beef bulls were sold for breeding purposes.

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Serving Capacity and Libido Tests for Bulls and their Relationship to Breeding Performance

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Some knowledge of the factors influencing sex-drive and mating behaviour of bulls is necessary if we are to properly select and use them in natural mating programs. Numerous studies have indicated that lack of sex-drive and/or mating ability constitutes a major cause of bull wastage. Although a breeding soundness examination (B.S.E.) can serve to prevent many undesirable bulls from entering a breeding program, this may not detect bulls with low libido or impaired mating ability.

Blockey (1975) illustrated the importance of including an assessment of mating behaviour when he submitted 548 bulls to both a normal B.S.E. and to a serving capacity test. He found 113 bulls unsound for breeding as shown in Table 1. Of these, 31 were detected as having clinical signs of abnormalities only when they served or attempted to serve in the serving capacity test. The abnormalities diagnosed included penile deviations, penis-prepuce adhesions, spondylosis deformans, and joint diseases. A further 17 bulls were culled on the basis of poor serving capacity. This resulted in 48 bulls which would have probably passed a normal B.S.E. being eliminated from the breeding program as poor prospective breeders.

The assessment of libido and mating ability in bulls is important not only because it can help in the detection of physical abnormalities. The genetic basis of libido and mating ability in different animal species, including the bovine, has been well proven and it has been shown that bulls vary considerably in their reproductive capabilities. Information is lacking on breed differences in the mating behaviour of bulls, particularly in relation to natural breeding. There is evidence that beef bulls in artificial insemination centres require different stimulus patterns for optimal results than do dairy bulls and may have more prolonged reaction times than the latter. Breed differences in mating behaviour among bulls of European breeds have been reported and references have been made to "sexual sluggishness" encountered in Zebu bulls.

There does not appear to be any relationship between libido and semen production in bulls so it is possible to obtain good semen from bulls of low libido and vice versa (Table II). This emphasizes the importance of assessing both factors for best bull usage.

Historical

Much of the work on sexual behaviour in bulls has been with dairy bulls in A.I. centres. The incentive for earlier work came from problems encountered in maintaining libido in some bulls at these centres (Bonadonna, 1956). Later work was stimulated by the realization that knowledge of the sexual behaviour of bulls could lead to management practices which increased the sperm harvest (Hale and Almquist, 1960; Amann and Almquist, 1976).

Anderson (1945) summarized the earlier methods of measuring sexual behaviour in the bull as follows:

1. By exposing him to a suitable stimulus on different occasions and estimating the percentage of times that copulation and ejaculation occurred.

2. By comparing the number of completed copulations and uncompleted copulations in a given time period.

3. By observing the time elapsed between the exposure of a bull to a suitable stimulus and the first copulation ("provocative time").

"Provocative time", renamed "reaction time", was investigated in bulls by Mercier et al. (1949) and Fraser (1960). Almquist and Hale (1956) obtained a reliability coefficient of 0.68 with 28 bulls with this measurement. They warned that the accuracy of this assessment could be influenced by prior stimulation and stressed that the stimulus conditions for each test must be specified.

To facilitate its study, sexual behaviour in bulls was differentiated into the categories of libido, and ability to copulate, by Anderson (1945). This arbitrary division into components was followed by Aamdal (1950) and by Hültnas (1959) who both considered it necessary in order to analyze and describe service in the bull. The recognition of hereditary factors affecting both libido (Olson and Petersen, 1951; Bane, 1954; Hültnas, 1959), and mating ability (Eriksson, 1939, 1950; De Groot and Numans, 1946; Bane, 1954) further reinforces the case for studying sexual behaviour in the bull in these two categories.

Testing Procedures

The simplest way to determine whether a bull has libido or not is to observe him in a confined area with one or more females which are in heat. This can also help determine whether he has some disability which prevents him from mating or not. Likewise it may be useful to spend some time observing the bull in the breeding pasture although most workers consider that sporadic observations of this nature are usually of no value. These types of tests will not give results which can be used to quantitatively assess a given bull, nor will they provide a controlled basis for comparisons between bulls.

Quantitative and comparative studies of libido and mating ability in range beef bulls have been hampered by the lack of a simple, repeatable, testing method. Osborne et al. (1971) described a test for use with untrained young beef bulls.

These authors employed a five minute test in which individual bulls were exposed to an individual female in a small, easily observed pen. Further modification (Chenoweth and Osborne, 1975) resulted in the use of ovariectomized heifers in which estrus had been induced and an expanded scoring system utilizing 11 categories for libido, and four for mating ability. The procedures employed in this program were as follows:

Virgin cross-bred heifers were ovariectomized by flank laparotomy and allowed three months to recover. Immediately prior to their use they were treated as follows:

Day 1	6-7 a.m.	10mgm.	dexaprogesterone acetate in oil.	I/m.
Day 2	6-7 a.m.	10mgm.	dexaprogesterone acetate in oil.	I/m.
Day 3	6-7 a.m.	10mgm.	dexaprogesterone acetate in oil.	I/m.
Day 4	5-6 p.m.	5 mgm.	stilboestrol diproprionate in oil.	I/m.

Most heifers showed signs of estrus 12-20 hours after the last injection and remained in this state for approximately 6-8 hours. Heifers required for use on succeeding days were given 5 mgm. stilboestrol diproprionate i/m on the preceding evenings. With this technique, heifers were used on up to four successive days.

The examination for libido and mating ability was performed in a small yard where the bull and heifer could be easily observed. Bulls were admitted individually and were allowed exactly five minutes with one of the prepared heifers. The criterion for selection of a heifer was that she would stand while other heifers mounted her. If, the selected heifer proved to be inadequately prepared when subsequently exposed to the bull, she was replaced. All reactions and movements of the bull during the test were recorded on magnetic tape. When this was replayed, libido was scored as follows:

0 = bull showed no sexual interest.
1 = sexual interest showed only once (e.g. sniffs at perineal region).
2 = positive sexual interest in female on more than 1 occasion.
3 = active pursuit of female with persistent sexual interest.
4 = one mount or mounting attempt. No service.
5 = two mounts, or mounting attempts. No service.
6 = more than two mounts or mounting attempts. No service.
7 = one service followed by no further sexual interest.
8 = one service followed by sexual interest, including mounts or mounting attempts.
9 = two services followed by no further sexual interest.
10 = two services followed by sexual interest, including mounts, mounting attempts or further services.

Each bull was tested twice at each testing period and the worst result of the two was discarded.

Separate categories were used to describe mating ability as follows:

Group 1 = bulls which served satisfactorily.

Group 2 = bulls which made mounting attempts which did not culminate in service. This was either due to inexperience, faulty mating technique or pathological factors.

Group 3 = bulls which mounted but did not achieve service due to lack of cooperation by the female. This reflected factors such as lack of confidence by the bull or low libido.

Group 4 = bulls for which there was no record of mating ability due to lack of sufficient activity for an assessment to be made.

The testing procedure proved useful with young bulls, particularly those of Brahman type, as a score could be given which was not dependent upon the bull serving or even mounting. In 56 2-year-old bulls assessed by this system prior to their use in controlled mating trials, the correlation between the libido score and pregnancy rate was r = .32, while between their semen score and pregnancy rate it was r = .13 (unpublished data). This showed that the libido score, in these bulls, was more effective in predicting pregnancy rate than was the quantitative assessment of seminal quality. However, one disadvantage with this testing system for routine use with beef herd bulls was that considerable time and effort was necessary to prepare the heifers.

A serving capacity test for beef bulls was developed which minimized this problem (Blockey, 1976). The procedure for this test follows:

1. Non-estrous cows were placed in service crates.
2. Bulls were sexually stimulated prior to their exposure to the test by allowing them to watch other bulls mount the restrained cows for 10 or more minutes.
3. Bulls were admitted to the yard containing the restrained cows at the bull:female ratio of 5:2 or 5:3.
4. The duration of the yard test was 40 minutes.
5. The number of services performed by each bull during that period was recorded as his serving capacity score.

This test was applied to 75 bulls (aged 2-5 years) which were then mated in groups with heifers at a bull to female ratio of 1:5. The heifers had been ovariectomized and given an intramuscular injection of 0.75 mgm. estradiol benzoate (in oil), 16.5 to 18.5 hours previously. It was found that the serving capacity scores of groups of bulls was highly correlated with their performance under simulated pasture mating conditions.

Recent trials at the San Juan Basin Experiment Station, Hesperus, Colorado, compared both the libido score and serving capacity tests on yearling bulls (Table II). The overall repeatability of both, when used as recommended, was similar. However, a large number of bulls did not complete a service in the 30 minute serving capacity tests and thus relative information on their sexual behaviour was lacking. It was concluded, at least with yearling bulls, that a more descriptive assessment system which was not dependent on service, such as the libido score, would provide more information on individual bulls. Some features of the serving capacity test such as pre-stimulation of the bulls and the use of non-estrous females restrained in service crates were considered to constitute valuable improvements to the testing procedure which should be retained.

Other studies with these same bulls showed that a single measurement of testosterone or luteinizing hormone in the peripheral blood had little relationship to the libido score or serving capacity results (Table II). Also, measurements of scrotal circumference and seminal quality were not significantly related to libido or serving capacity, confirming previous findings. This illustrates the importance of assessing all of these factors for best bull selection and usage.

How Do Short Tests Compare with Long Tests?

Almquist and Hale (1956) considered that limited tests to investigate the nature of sexual responses of bulls provided essentially the same information as longer tests with less demands on time and energy. Fraser (1960) showed that 50 percent of 120 bulls tested achieved copulation or undertook a copulatory attempt within two minutes of encountering an estrous cow. Osborne et al. (1971) stated that a five minute exposure of each bull to an estrous female (either naturally or artificially induced) provided a practical and adequate method of assessment of libido and mating technique.

Blockey (1975), however, considered that a five minute test was too short for an adequate assessment of the reproductive capabilities of bulls. In his work, some faults in mating ability did not become apparent until the bulls had been stressed for some time in a serving capacity test. It would seem that accurate definition of pathological problems affecting mating ability may, at times, require an extended observation period.

Recent work with 117 yearling bulls at Fort Lewis, Colorado (Chenoweth and Brinks, unpublished data) showed that when they were exposed to two 30 minute serving capacity tests, the total number of services obtained did not differ significantly between the first and second tests (Table III). When 10 minute periods of these tests were compared both within and between the tests, there was no significant difference between them in the number of services. In other words, with these bulls, a 10 minute test gave us as much information about serving capacity as did tests of longer duration.

One advantage of a shorter test is that there is less opportunity for agonistic encounters between the bulls during the test; a source of concern even with yearling bulls because of the possibility of an injury occurring. Even with a shorter test there is some possibility of injury occurring when bulls are tested in groups. The current test procedure which is being evaluated is to admit two prestimulated bulls to two restrained heifers for a 10 minute test. Care is taken to ensure that the bulls do not compete for the same heifer. Two exposures are given, preferably on different days, and the worst result is discarded. At present, both the libido and serving capacity scoring systems are being used.

In Conclusion

Bulls vary considerably in libido and mating ability and the major influence on these factors in young bulls is genetic.

Libido and mating ability assessment can contribute to fertility prognosis in young beef bulls destined for natural service. Although not a practical proposition for all bulls undergoing routine examination for breeding soundness, certain groups of bulls such as young bulls coming off feeding trials, and sale bulls of registered breeders, and bulls destined for artificial breeding should be considered for such an assessment.

Several procedures for evaluating sex-drive in bulls are described. Each has inherent advantages and disadvantages. They do provide a means of quantitating sex-drive so that comparisons can be made between bulls. If a quantitative assessment is not necessary, it is of value to observe the actions of a bull placed in a restricted area with one or more estrous females. Most bulls should attempt a service within 5-10 minutes unless the female is non-receptive or the bull's attention is diverted. Old bulls may have slower patterns of excitation. One should attempt to observe a bull on several different occasions and with different females if his original test result is poor. One advantage of pre-exposing young bulls to receptive females in a controlled situation is that it can give them greater breeding confidence and competence when they are initiated into the breeding pasture.

Libido tests in bulls have applications apart from fertility prognosis. Accurate assessment of the sex-drive of bulls could be of value in studies investigating hormonal, environmental and genetic influences on this trait. Evaluations of the results of fertility and estrous detection trials employing naturally mated cattle should include such an assessment of the entire or teaser bulls employed. The use of high libido bulls in mating programs with selected groups of "problem" females such as first calf heifers could markedly increase their conception rate at first oestrous.

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TABLE I

Breeding Soundness Examination and Serving Capacity Test of 548 Beef Bulls; Reasons for Rejection as Poor Potential Breeders

	Culled (total)	Physical exam.	Semen exam.	Serving capacity exam.
Locomotor abnormalities	54	38	--	16
Genital abnormalities	42	24	3	15
Poor serving capacity	17	--	--	17
Total	113	62 (55%)	3	48 (43%)

(Blockey, 1975)

TABLE II

Simple Correlations Among Reproductive Traits in 113 Yearling Bulls

Behavioural and Hormonal Values

	r
Serving capacity score 1 and serving capacity score 2 (services)	.61
Libido score 1 and libido score 2	.65
Libido score 1 and best libido score	.79
Libido score 2 and best libido score	.93
Serving capacity score 1 and resting testosterone	.07
Serving capacity score 1 and resting L.H.	.06
Best libido score and resting testosterone	.08
Best libido score and resting L.H.	.02
*B.S.E. score and serving capacity score 1	.19
B.S.E. score and best libido score	.15
Scrotal circumference and serving capacity score 1	.17
Scrotal circumference and best libido score	.06

*Breeding soundness examination as per Society for Theriogenology.

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TABLE III

Analysis of Two 30 Minute Serving Capacity Tests* on 117 Yearling Bulls, on the Basis of 10 Minute Intervals

Number of Services

	1st 10 min	2nd 10 min	3rd 10 min
1st test	52.00	51.00	50.00
2nd test	64.00	44.00	49.00

Analysis of Variance

Source	DF	MS	F
Total	5		
Tests	1	2.67	0.06
10 min intervals	2	62.17	$1.32^{n.s.}$
Error	2	47.17	

*Bulls were tested in groups of 4-6, with 2 restrained heifers.

TABLE IV

Heritabilities of Selected "All or None" Traits within Paternal Half Sib Groups

	Total no. bulls	No. with trait	Heritability
Defects of penis	629	38	0.13
Prepuberal adhesions	629	9	1.39
Defects of prepuce	629	5	0.85
Defects of testicles	629	100	0.36
Defects of epididymis & vas deferens	629	40	0.49
Defects of feet & legs	629	8	0.59

McNitt, J. M.S. Thesis, C.S.U. 1965

Genetic Aspects of Age and Weight at Puberty[1]

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Reproductive efficiency of both cows and bulls plays a major role determining net return for cow-calf producers. Since most heifers are bred as yearlings and since there is increased use of yearling bulls, age and weight at puberty are important in determining reproductive efficiency of the herd.

Several studies have reported on the importance of nutrition and managment factors relating to onset of puberty. The effect of crossbreeding or onset of puberty has also been investigated but these studies will not be reviewed in this presentation.

It is my opinion that most heifers and to a somewhat lesser extent, most bulls have the potential to reach puberty and serve as satisfactory breeders at yearling ages given adequate nutrition and management. However, the cost of doing so may vary greatly. Cattle with inherent ability to reach puberty at early ages can probably reach puberty at less cost in terms of added nutition and more intensive managment regimes than cattle with later inherent age at puberty.

The objectives of the study I will review were two-fold:

1) Study the factors affecting onset of puberty in heifers along with determining the hereitability of puberty.

2) Study the genetic relationship of age at puberty in heifers with reproductive traits in half-sib bulls.

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[1]Presented at Beef Improvement Federation Symposium, May 16-18, 1977, Bozeman, MT

DATA

Records on age and weight at puberty were collected on 357 registered Hereford, Angus, and Red Angus at the San Juan Basin Research Center, Hesperus, Colorado, during the years 1972, 73, 74 and 76. Both inbred and linecross heifers were studied.

Two types of analyses were performed. The first used percentage of heifers reaching puberty by four specified ages (325, 345, 365, and 385 days of age). The second analysis used age at puberty but included only heifers reaching puberty at the end of the test period. Factors studied for their possible effect on puberty included year, age of Dam (2, 3 or 4+) mating system (inbred or linecross), line of sire, sire/lines, weaning age, height, and weight.

Reproductive measures were taken on half-sib yearling bulls during the same years and were used to study the relationship described in objective 2 of the study. There were 180 yearling bulls involved.

RESULTS - OBJECTIVE 1

Average values presented in table 1 indicate relative variation by age of dam, mating system and line of sire classifications, for each of the five analyses. In each analysis inbred heifers ($F \geq 10\%$) were delayed in comparison to linecross heifers. Breed differences obtained by pooling lines indicate Red and Black Angus to be younger at puberty than Herefords, and Red Angus younger than Black. Comparisons among Hereford lines reveal that the Royal and Monarch lines are among the latest reaching puberty in all analyses with Prospector and Ouray among the earliest lines.

Table 1. Averages for measures of puberty by age of dam, mating system, and line of sire.

	Percent Reaching Puberty at Specified Ages (days)				
	325 (%)	345 (%)	365 (%)	385 (%)	Average Age (days)
Age of dam					
2	4.7	27.2	55.0	57.1	345.8
3	2.7	18.2	40.3	67.2	363.5
4+	6.8	23.7	43.8	63.7	354.7
Mating system					
inbred	3.2	20.9	45.4	58.5	356.6
linecross	6.2	25.2	47.4	66.8	352.6
Line of sire					
Brae Arden	0	13.4	35.6	54.7	356
Colorado	0	9.1	50.4	76.0	365
Don	1.5	6.3	53.1	68.0	363
Monarch	0	6.7	34.6	36.5	361
Prospector	0	21.6	34.0	78.8	350
Royal	1.8	14.2	24.2	53.4	365
San Juan	2.4	12.4	29.1	59.2	349
Tarrington	2.0	14.8	25.4	44.5	358
Electra	7.0	17.7	48.6	53.3	369
Ouray	7.5	16.2	26.9	57.2	333
Hermosa	4.7	18.5	30.1	47.2	368
Dolores	34.4	80.1	33.0	86.0	332
Mancos	14.9	35.3	75.5	80.5	349
Select	0	55.8	89.0	93.0	348
Overall Mean	4.7	23.0	46.4	62.7	355

Previous studies have indicated a reduced average age of puberty with increased weights. Results of this study follow this trend indicating an increase of .3 to 1.8% of heifers reaching puberty prior to specified ages for each 10 lb. increase in weight. Height indicated a similar trend. In considering heifers at constant ages, weaning age is an indication of the relative importance of differing proportions of the life spent pre and post weaning. The effect of weaning age indicates an advantage of a reduced pre-weaning portion of life. At 385 days of age 5% more heifers would be expected to reach puberty by weaning ten days earlier, similar results were obtained at each of the other three ages. Heritability for age of puberty was estimated to be 7.5%. Age and weight at puberty had an estimated genetic correlation of .42.

Correlations among the different measures of age at puberty in heifers calculated from line of breeding means are shown in table 2.

Table 2. Correlations Among Measures of Puberty From Line of Breeding Means

		% Reaching Puberty (days)		
% Reaching Puberty (days)	Age at Puberty	365	345	365
325	-.61			
345	-.55	.69		
365	-.50	.59	.82	
385	-.57	.52	.59	.86

RESULTS - OBJECTIVE 2

Table 3 presents the estimated genetic correlations between age at puberty in heifers with reproductive traits measured on their half-sib yearling brothers. The estimated genetic correlations of scrotal circumference, percent normal, percent primary abnormalities and percent secondary abnormalities all show a favorable relationship with age at puberty in heifers, i.e. improved reproductive measures in bulls are associated with earlier ages at puberty in heifers.

Table 3. Estimated Genetic Correlations Between Reproductive Traits in Bulls with Puberty Age in Half-Sib Heifers

	Bull Traits				
Heifers	Scrotal Circumference	% Normal Sperm	% Primary Abnormalities	% Secondary Abnormalities	Motility
Age at Puberty	-.71	-.37	.36	.09	.33

Standard errors of these correlations are not known but are presumed high due to limited numbers.

There appears to be no other estimates of genetic correlations among reproductive traits between sexes in beef cattle in the literature. However, Land (1973) noted that testis diameter is higher in those breeds of sheep having the highest ovulation rate. Land and Falconer (1969) reported positive line correlations between testis weight and ovulation rates in mice, and Land (1973) reported a correlation of testis weight and ovulation rate of .97 in mice selected for ovulation rate. He noted that most of the increase in testis weight resulted from increased body weight.

Correlations between line means for heifer measures of puberty and bull measured of reproductive traits are shown in Table 4.

Table 4. Correlations Among Heifer and Bull Traits From Line of Breeding Means

	Heifer Traits				
	Age at	% of Puberty (days)			
Bull Traits	Puberty	325	345	365	385
Scrotal circumference	-.36	.12	.12	.21	.29
% Normal Sperm	-.37	.21	.17	.35	.45
% Primary Abnormalities	.36	-.12	-.29	-.35	-.38
% Secondary Abnormalities	.34	-.23	-.11	-.11	-.21
Motility	-.29	.35	.58	.71	.64

All correlations by line means again indicate a favorable relationship between reproductive traits in yearling bulls and measures of puberty in their half-sib sisters.

Correlations of line means among reproductive traits in bulls are also of interest and are shown in Table 5.

Table 5. Correlations Among Reproductive Traits of Bulls from Line of Breeding Means

	Scrotal Circumference	% Normal Sperm	% Primary Abnormalities	% Secondary Abnormalities
% Normal Sperm	.58			
% Primary Abnormalities	-.51	-.83		
% Secondary Abnormalities	-.42	-.81	.51	
Motility %	.25	.52	-.59	-.29

Scrotal circumference is correlated to semen traits in a favorable manner indicating that as scrotal circumference increases, measures of semen quality improve.

CORRECTION FACTORS FROM FIELD DATA

J. H. Anderson and R. L. Willham

The American Angus Association provided 499,894 weaning weight records adjusted to 205 days of age which were analyzed to evaluate the influence of sex, creep and age of dam and to derive correction factors for these effects that statistically equalize the means and the variances of the weights. The data represent a 27 year period, 1950-1976, and represent 1996 herds from 48 states. Sixty-nine percent of the records were collected since 1970.

The data were classified as to region of origin, sex, creep or noncreep, age of dam, herd, cows and contemporary groups. A contemporary group represents a group of calves within a year which are subject to the same environmental conditions. The data were analyzed by a mixed model which absorbed the random herd, cow and contemporary group effects and least squares solutions were obtained for the fixed sex, creep management and age of dam effects (Anderson, 1977). The model was:

$$y_{ijklmn} = \mu + A_i + M_j + S_k + AM_{ij} + AS_{ik} + MS_{jk} + H_l + C_{lm} + D_{ln} + e_{ijklmn}$$

where y is the weaning weight record and μ is the overall mean, the fixed effects are age of dam (A), creep management (M) and sex (S), the interaction of the fixed effects are AM, AS and MS and the random effects are herd (H), contemporary group (C), cow (D) and nonobservable random error (e). Cows and contemporary groups are nested within herds. This model accounts for any selection that may occur between cows since age of dam effects were fit within cows. A sex bias is often present in this type of data due to the effect of castration in males. This sex bias was circumvented by removing any data with bulls and steers in the same herd group.

The initial analyses were done within six regions of the continental United States. These regions are the Northeast, Southeast, Midwest, Southwest, Great Plains and Pacific. These regions reflect rather general differences and the results indicate that the effect of sex, age of dam and the interaction of sex by age of dam are similar in each region. The effect of creep feeding varies considerably depending upon the amount and quality of forage, the level of supplementation, the composition of the ration and the condition of the cows. A summary of the regional analyses is given in Table 1.

Table 1. Summary of regional analyses

Region	N	Least Squares Mean	Creep Records (%)
Northeast	12,855	440	48
Southeast	36,890	422	31
Midwest	84,385	431	54
Southwest	51,667	432	26
Great Plains	140,664	435	24
Pacific	31,776	442	14
Overall	358,237	433	32

Correction factors that would equalize both the means and the variances are suggested for sex and age of dam. A multiplicative adjustment is considered for sex and an additive adjustment is used to correct for age of dam differences within sex. A correction for creep feeding is not suggested because the creep effect is variable. The creep effect may be eliminated on a within contemporary group basis by managing all calves within the group alike.

The additive age of dam within sex correction factors are given in Table 2. Age of dam is corrected within sex because the interaction of age of dam by sex has a significant effect upon weaning weight. Age of dam is corrected to a mature cow base. The corrections for age of dam in Table 2 are less than the age of dam corrections that BIF recommends. However, the BIF correction factors for age of dam are not breed specific and the corrections given in Table 2 are specific to the Angus breed, primarily since 1970.

Table 2. Additive correction factors for age of dam within sex for Aberdeen Angus 205 day weights.

Age of dam	Male	Female
2 year old	45 lbs.	37 lbs.
3 year old	21 lbs.	18 lbs.
4 year old	9 lbs.	7 lbs.
5 year old	2 lbs.	2 lbs.
6 to 9 year old	0 lbs.	0 lbs.
10+ year old	9 lbs.	9 lbs.

The multiplicative sex correction factors are:

heifer	1.10
steer	1.03
bull	1.00

The sex corrections are adjusted to a bull base.

The Angus breeders in the United States should use correction factors to adjust for the influence of sex and of age of dam within sex. The additive corrections for age of dam within sex given in Table 2 should be applied first. Then the multiplicative sex adjustment should be applied and the resulting data will be corrected to a bull calf from a mature cow base. These corrections will tend to equalize both the means and the variances of the weaning weights.

Reference:

Anderson, J. H. 1977. Factors affecting weaning weights of beef cattle. Unpublished Ph.D. Thesis. Library, Iowa State University, Ames, Iowa.

RATIOS vs. DEVIATIONS FOR WEANING WEIGHT

J. H. Anderson and R. L. Willham

The appropriate method of comparing weanling calves within the herd has been the subject of very little research. In the past, it was believed that there was a positive relationship between the contemporary group mean and the variance of the group weaning weight deviations. In other words, as the means increase, the variances also increase. To equalize the variances, the ratio was used instead of a deviation for comparison. This would be satisfactory if the means are known without error and the coefficients of variation squared are equal.

The American Angus Association provided 499,894 weaning weight records adjusted to 205 days of age for analysis. The data are age of dam and sex adjusted using the correction factors outlined by Anderson and Willham (1977) that were derived from the same data. The data includes 17,984 contemporary groups from 1996 herds.

An initial analysis was performed on the data that utilizes the mean and the variance of each contemporary group to find a transformation of the original scale such as the square root or logarithm that reduces the correlation between the means and the variances (Hinz and Eagles, 1976).

The transformation estimated from this data was $\chi^{0.80}$ where χ is a record. This transformation is very close to the original scale and is estimated with error as the mean and the variance of each contemporary group are measured with error. The error of the calculated transformation is large when the differences among contemporary groups are small relative to the variation within contemporary groups. This was the situation in this case where the variances were relatively homogeneous and thus a transformation is not needed.

The deviation and the ratio were then compared by fitting a simple linear regression of the variance of the deviation and the variance of the ratio on the weaning weight mean. The R-squares from each analysis were 0.06 and 0.03 for the ratio regression and the deviation regression respectively. This indicates that 6 and 3 percent of the total variation are explained by the two regressions. These are both close to zero and this indicates that there is very little relationship between the means and the variances for either the ratio or the deviation. The correlations between the means and the variances were −0.24 and +0.16 for the ratio and the deviation respectively.

A box graph of the variances of the deviations and the ratios versus the weaning weight means for each contemporary group are given in Figures 1 and 2. A box represents the observations over a 70 pound weaning weight range. Each box contains 90 percent of the observations over the specified range and is an indicator of the scatter of the variances for each weight range. The means of the variances for each box are also included. With deviations, the variances show more scatter as the means of the groups increase (Figure 1). However, with ratios the variances show less scatter as the mean of the groups increase (Figure 2).

The box graphs of Figures 3 and 4 show how the scatter of variances decrease as the numbers per contemporary group increase. The graphs indicate that approximately 10 individuals per contemporary group are needed for more homogeneous group variances.

Either the ratio or the deviation would be appropriate for making comparisons of individuals from different contemporary groups. The contemporary group should contain a minimum of 10 individuals to obtain a more reliable estimate of the mean. Group size can be increased by sex adjusting the data as well as age adjusting the data and including all sexes in the contemporary group. Then the ratios or deviations can be calculated with larger group size.

References:

Anderson, J. H. and R. L. Willham. 1977. Correction factors from field data. Report to BIF. May 16, 1977. Bozeman, Montana.

Hinz, P. N. and H. A. Eagles. 1976. Estimation of a transformation for the analysis of some agronomic and genetic experiments. Crop Sci. 16:280.

Figure 1.

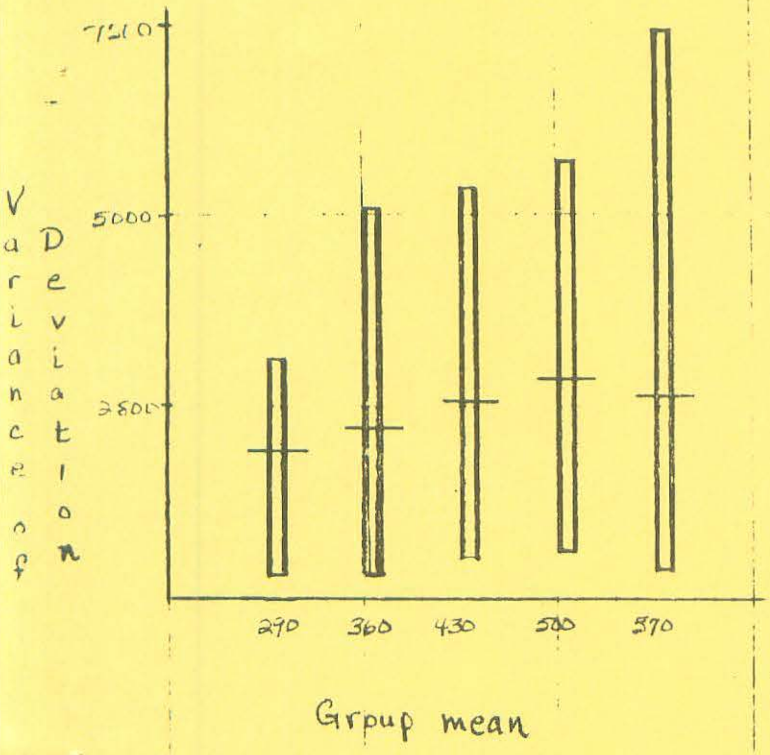


Figure 2.

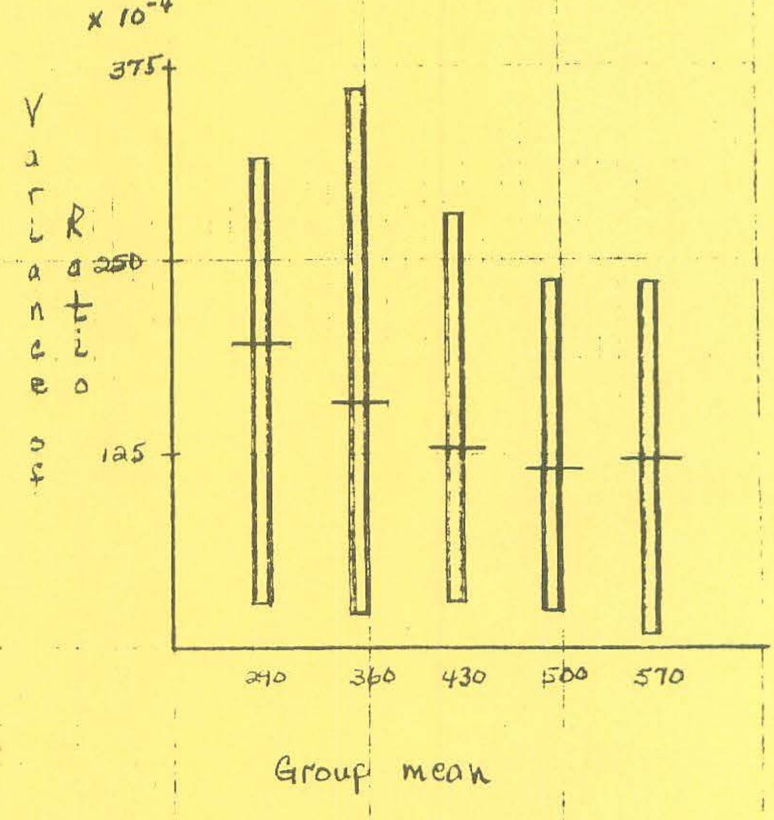


Figure 3.

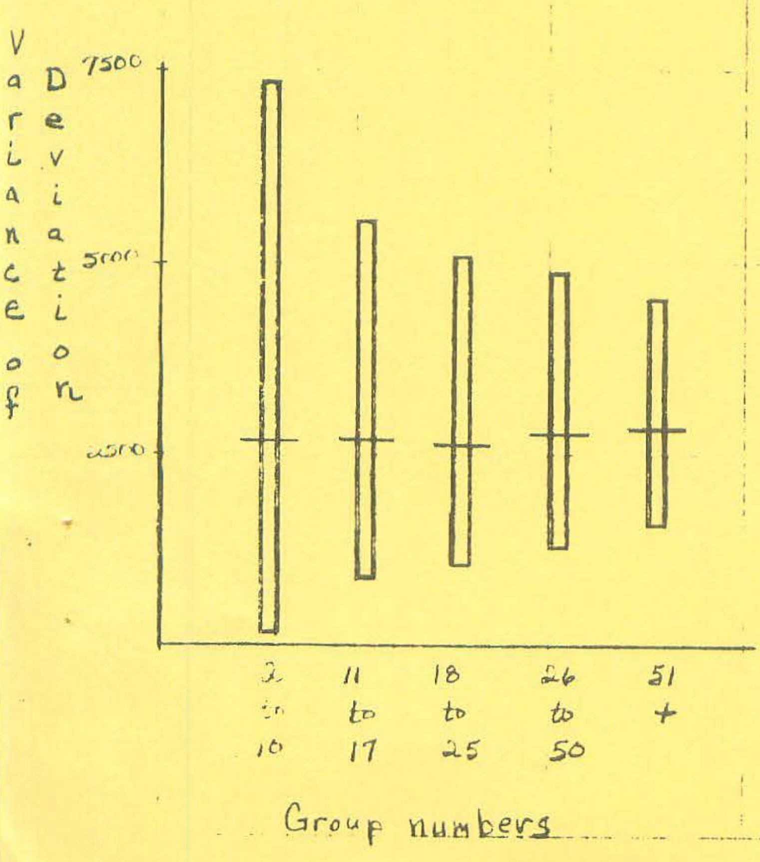
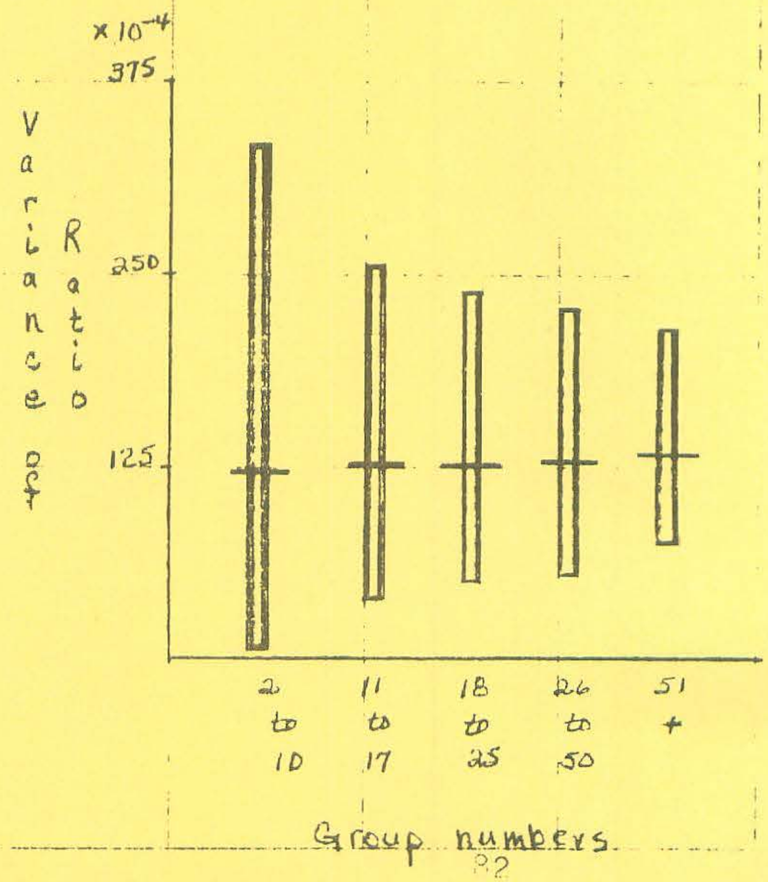


Figure 4.



DIRECT AND MATERNAL BREEDING VALUES

R. L. Willham and J. S. Brinks

In September of 1976 Jim and I had occasion to visit concerning breeding values currently being estimated in beef breed performance programs. The new BIF guidelines contains a section on ESTIMATED BREEDING VALUES specifically for growth (weaning and yearling weight). We would like to propose that this section be expanded to include maternal breeding values. These maternal breeding values would more nearly evaluate the milk production potential of the individual based on the weaning weight ratios looked at as a trait of dams.

To clearly separate breeding value estimates of the direct effect of growth from the maternal effect of milk, we propose to eliminate the information on the maternal half sibs from the regular values calculated for weaning weight and use only the individual ratio, the average ratio of his paternal half sibs, and the average ratio of his progeny for weaning weight. The yearling breeding value could still contain the maternal half sibs.

We would propose that the calculation of maternal breeding values be made on all sires reported in the current sire evaluation programs. This would add to the sire evaluation and keep the time down on evaluation. Possibly a pedigree evaluation is all that milk production in beef is worth.

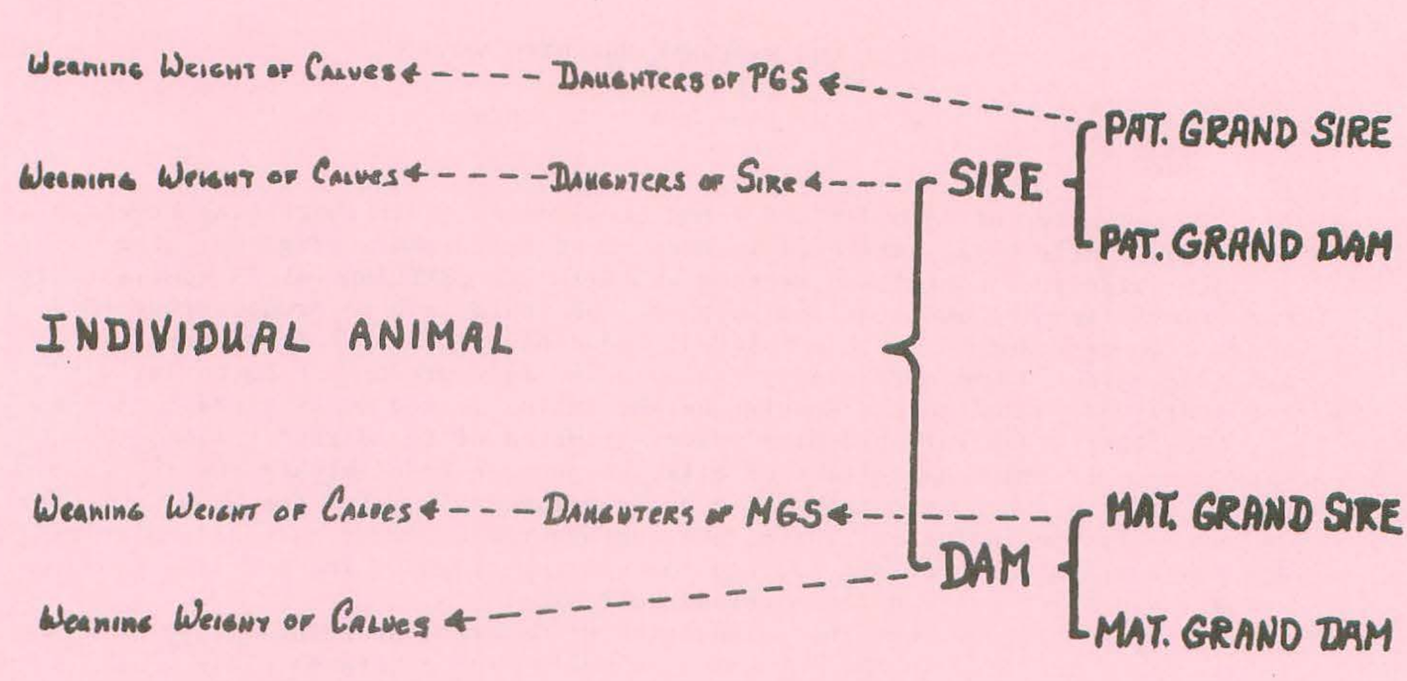
What follows is a proposal for an addition to the guidelines section on estimated breeding values. These are the GUIDELINES for maternal breeding values.

GUIDELINES FOR MATERNAL BREEDING VALUES

The selection worksheets sent out at weaning and at yearling time give the estimated breeding value of the animals for the ability to grow. These new values have to do with maternal ability and, in particular, with milk production potential. These maternal breeding value ratios and the yearling breeding value ratios can both be used to merchandize yearlings as well as select herd replacements.

There exists in the breeds many strains that grow lean tissue rapidly. Progress has been made in this highly heritable trait. The time is now to develop objective means of evaluating yearlings, especially bulls, on their potential to sire daughters that have mothering ability or milk in the right amount to wean a heavy calf and yet rebreed for the next calf. This is difficult to accomplish because of the sex-limited nature of the trait and the time required to measure it. If the dairy approach is used there will be a six year progeny testing program before calves of daughters of a sire can be used as the selection criterion of sires. This is the reason for developing these maternal breeding value ratios rather than adding on the daughter evaluation to national sire evaluation programs. Estimating maternal breeding value ratios using all breed data is proposed.

Now let us consider how these maternal breeding value ratios are calculated. The following is a pedigree diagram of an animal of interest:



Note that, with the exception of the calves by the dam, each set of weaning weights are from daughters of a sire, meaning that the maternal ability being measured is passed on a generation, so it is genetic. The maternal breeding value ratio uses four pieces of information when they are available. These are as follows:

1. The average weaning weight ratio of calves of daughters of the paternal grand sire. The diagonal value for this average is

$$\frac{1 + (m-1)R}{nmH} + \frac{n-1}{8n}$$

   where m = average number of calves per daughter, n = number of daughters, R = repeatability, and H = heritability.
2. The average weaning weight ratio of calves of daughters of the sire. The diagonal value for this average has the same structure.
3. The average weaning weight ratio of calves of daughters of the maternal grandsire. The diagonal value for this average has the same structure.
4. The average weaning weight ratio of calves of the dam. The diagonal for this average is

$$\frac{1 + (m-1)R}{mH}$$

   where m is the number of calves of the dam.

The equations for the calculation are as follows:

$$\left.\begin{array}{ll} \text{Sire} & \left\{\frac{1 + (M_{R1} - 1)R}{N_{R1}M_{R1}H} + \frac{N_{R1} - 1}{4N_{R1}}\right\} \cdot \beta_1 + \frac{1}{8}\beta_2 = \frac{1}{4} \\ \text{PGS} & \frac{1}{8}\beta_1 + \left\{\frac{1 + (M_{R2} - 1)R}{N_{R2}M_{R2}H} + \frac{N_{R2} - 1}{8N_{R2}}\right\}\beta_2 = \frac{1}{8} \end{array}\right\} \text{Solve Together}$$

$$\left.\begin{array}{ll} \text{Dam} & \left\{\frac{1 + (M_{R3} - 1)R}{M_{R3}H}\right\} \cdot \beta_3 + \frac{1}{4}\beta_4 = \frac{1}{2} \\ \text{MGS} & \frac{1}{4}\beta_3 + \left\{\frac{1 + (M_{R4} - 1)R}{M_{R4}N_{R4}H} + \frac{N_{R4} - 1}{8N_{R4}}\right\}\beta_4 = \frac{1}{8} \end{array}\right\} \text{Solve Together}$$

M_{R1} = average number of calves per daughter of SIRE

M_{R2} = average number of calves per daughter of PGS

M_{R3} = number of calves of DAM

M_{R4} = average number of calves per daughter of MGS

N_{R1} = number of daughters of SIRE

N_{R2} = number of daughters of PGS

N_{R4} = number of daughters of MGS

Maternal Abiltiy Breeding Value = $1.00 + B_1V_1 + B_2V_2 + B_3V_3 + B_4V_4$

V_1 = average WW ratio of daughters of sire - 1.00

V_2 = average WW ratio of daughters of PGS - 1.00

V_3 = average WW ratio of daughters of dam - 1.00

V_4 = average WW ratio of daughters of MGS - 1.00

These averages are weighted heavily for maternal ability rather than growth rate. Any information that is available is combined into a single breeding value as was done with the regular breeding values for weaning and yearling weight. This procedure would have little information if it were not for the opportunity to look up the weaning ratios of all calves of the daughters of the paternal or maternal grandsire in the herds in which they were used.

Real problems exist in including fertility information. The values of m and n of the relatives with the value of the possible average number of calves (m') would give a good picture of fertility if one could assume that all calves were recorded, but they are not in most performance programs. Use of the calf crop percentage of the dam is probably all that is practical at this time. This is unfortunate because fertility is much more important than milk production. However, this will serve to get breeders thinking about measuring maternal traits.

Use of maternal breeding value ratios by breeders can help breeds maintain their superior maternal performance while still improving feedlot growth rate. Without these maternal performance indications it would be possible to lose a maternal advantage by going all out for size and growth rate. This represents another opportunity for creative breeders to develop sound breeding programs. The breeds that survive the intense competition for the commercial man's germ plasm dollar will be those breeds having an association that provides them a sound performance program and breeders willing to adopt the new technology in practical breeding programs.

NOTES ON THE PREDICTION ERRORS OF EXPECTED PROGENY DIFFERENCES: EFFECTIVE PROGENY NUMBERS

R. L. Willham

We have had a difficult time selling "possible change", "prediction error" or "standard error" of EXPECTED PROGENY DIFFERENCES. And yet we all firmly believe that some measure of the error should be included in reports of sire evaluation. British researchers have used a value called effective progeny number that possibly has some merit in our beef industry. The proposal is to define a quantity that is a function of the prediction error yet is easily understood by rank and file beef breeders using sire evaluation. Let's call it EFFECTIVE PROGENY NUMBER as opposed to actual progeny number. The EFFECTIVE PROGENY NUMBER is the value of the lead diagonal for a particular sire after absorption of the group effects less the variance ratio used to solve the sire equations and regress the EPD values. Actually one should use the reciprocal of the inverse element found on the lead diagonal, but this includes the variance ratio and several sire evaluation programs are not getting inverses but solving the equations by iteration.

A look at the lead diagonal is informative. The structure is as follows:

$$\sum_i \left(N_{ij} - \frac{N_{ij}^2}{N_{i\cdot}}\right)$$

where the model is $y_{ij} = \mu + g_i + s_j + e_{ij}$ and N_{ij} = number of progeny by sire j in the i^{th} contemporary group and $N_{i\bullet}$ = number of progeny by all sires in the i^{th} group. Note the summation over all groups the sire appears in.

Now, let's ask what this number says. We know that the sum of the numbers on the left hand side of each sire equation sums to zero or

$$\sum_i \left(N_{ij} - \frac{N_{ij}^2}{N_{i\cdot}}\right) - \sum_{\substack{ij' \\ j'\neq j}} \left(\frac{N_{ij}N_{ij'}}{N_{i\bullet}}\right) = 0$$

where j' are the other sires. Take one contemporary group and consider the lead diagonal for sire j. This is

$$\left(N_{ij} - \frac{N_{ij}^2}{N_{i\cdot}}\right).$$

The effective number of progeny for analysis purpose depends on how well the sire is compared with the reference sires in each contemporary group. If sire j has all the progeny in the particular group then the contribution to the lead diagonal of sire j to his total is

$$N_{ij} - \frac{N_{ij} N_{ij}}{N_i}$$

and when $N_i = N_{ij}$ we have $N_{ij} - N_{ij} = 0$

and there is no contribution to the effective progeny number of sire j in the i^{th} group. Now if half the calves are progeny of sire j then

$$N_{ij} - \left[\frac{\left(\frac{N_i^2}{2} \right)}{N_{i\cdot}} \right]$$

$$N_{ij} - \frac{N_i^2}{N_{i\cdot 4}} = (N_{ij} - \frac{N_i}{4})$$

which if $N_{ij} = 10$ equals 5. When N_i increases in size and N_{ij} is a smaller fraction of $N_{i.}$ then the effective progeny number approaches the actual. If there are 10 progeny in a contemporary group of 100 then the actual number of progeny is 10 and the effective number is nine. Adding all the contemporary groups in which a sire contributes will give the effective number and this can be compared with the actual number. The effective number of reference sires appearing in a large number of herds with a few number per herd will have the higher value compared to a test bull with the same number of progeny in one herd. This is as it should be.

The lead diagonal or more precisely its reciprocal is used to obtain the prediction error in some instances. This effective progeny number is directly related to the prediction error since the prediction error actually equals

$$PE = \sqrt{(\text{inverse element*})\text{Error Variance}} \ .$$

Thus, two constants are added, one the variance ratio* and the error variance which are both constant for all sires.

From a theory point of view and from a practical one as well, the lead diagonal of the sire equations after absorption of group effects should be a reasonably accurate way to compare the prediction error of EPD values for the bulls in sire evaluation.

I would propose that this be included in the new GUIDELINES of BIF in the National Sire Evaluation section.

CUSTOM PROGENY TESTING

R. L. Willham

Real opportunity exists for state beef cattle improvement associations to operate a custom progeny testing program within their state. Such a program exists in Iowa conducted by the Iowa Beef Improvement Association. The program along with the central bull testing program in Iowa is solvent and provides a real service opportunity for IBIA. It is appropriate for BIF to develop guidelines for such a custom progeny testing program. What follows is a proposal for such GUIDELINES. The guidelines in their final form should be included in the next BIF guidelines.

GUIDELINES

The Beef Improvement Federation developed guidelines for national sire evaluation on a breed by breed basis in April of 1971. Several major beef breed associations have developed and implemented breed national sire evaluation programs.

These breed national sire evaluation programs in one way or another are using a reference sire system so that bulls evaluated under different progeny tests can be fairly compared through the reference sires used in all the progeny tests. Progeny from reference sires serve as the basis of comparison. The sponsoring agency (i.e. breed associations) contributes the following to a program.

1. The reference sire system.
    a. Designate the particular sires to be used as reference sires.
    b. Coordinate the distribution of reference sire semen to the progeny tests.

2. Specification of a uniform progeny test.
    a. Defines the particulars of the test.
    b. Assures randomization of cows within age-breed-management groups to sires.
    c. Supervises the tests to assure equal treatment of progeny groups.

3. Periodically analyzes all production data into expected progeny differences that can be used to rank all sires involved on the traits measured and produces a sire listing using these results.

Such a sire evaluation program is a means whereby all breeding stock breeders can utilize breeding technology, whether large or small, yet conduct their own creative, sound breeding program. Any breeder can integrate this type of a program into his own especially if he can contract or locate commerical cows that can be bred to his bulls already selected on their own performance.

State beef improvement associations have a real opportunity to help the breeders interested in testing bulls in sire evaluation find commercial cows and to help progressive commercial producers utilize their AI and recording ability to make extra money and develop a herd of females sired by some of the top sires in the breed or breeds. The BCIA organization can operate as the middle man between the breeder and commercial producer. This eliminates contact between the two making the test more credible in all eyes and with adequate record supervision by the BCIA more reliable than the progeny test might have been without the supervision.

The requirements necessary to progeny test are that the commerical producer have A.I. capability, know how to keep performance records, have his cow herd identified, and be willing to make a contract. The real problem involved in implementing such a sire evaluation program over a breed is finding available test herds in which to progeny test. Well managed commercial herds that can do A.I. and keep a good set of records are limited in numbers. This offers opportunity since the organizations sponsoring such programs are actively engaged in helping their breeders find such test herds.

The opportunity to do custom progeny testing on a commercial besis is great. The breeding stock breeder can contract his progeny test without having to be actively involved or own any of the calves. This is advantageous to him in cost and labor as well as making his test more credible in the eyes of his customers and fellow breeders. To test numerous bulls in one progeny test reduces the numbers of progeny from reference sires necessary on a per bull tested basis. It also gives more direct comparisons, within a test, on the sires being evaluated. In a custom progeny testing situation, the progeny test can be conducted correctly since this is the major concern, development of meaningful data. Consistent test procedures, appropriate allocation and randomization of cows to each sire, and equal treatment of progeny groups are essential to the progeny test.

The general structure of the progeny test procedure necessary to follow in custom progeny testing for sire evaluation programs is as follows:

1. Enrollment of the test herd in the program.
    a. Identification of the cows and designation of cow groups.
    b. Identification of the bulls to be tested.

2. Acquistion of the semen from breeders and from reference sires.

3. Conduct of the A.I. breeding (60 days maximum).
    a. The keeping of the breeding records which involve A.I. dates.
    b. The pregnancy checking of the cows after the breeding season.

4. Calving season.
    a. The keeping of accurate birth dates and other data such as calving ease, birth weight, etc.

5. Weaning.
    a. Weighing of calves and possibly calves within a prescribed age limit.
    b. The sorting of sexes for the feedlot phase or the growing program if heifers are not to be involved in the feedlot test.

6. Feedlot program.

a. Weighing in and out of a warm up period if calves come from several locations.
b. Final weights after a 140 day gain test on full feed and other trait evaluations as yearlings.

7. Carcass evaluation.
   a. USDA carcass tags can be assigned at birth and will be used as ID throughout the test.
   b. After the feedlot test, the Federal Grading Service at the nearest packing plant must be contacted. The FGS will do all the carcass evaluation and return data to the purchases of the tag initially.

8. Heifer performance.
   a. Subsequent performance of heifer sets from sires may be contracted if they are not slaughtered.
   b. Long yearling weights and possibly the performance of their first calf could be involved.
   c. The set of heifers could also be used in sire-daughter matings to test for genetic defects of the sire. This would require more data collection and verification of matings, pregnancy, and calving.

Any custom program would be on a continuing basis so the yearly cycle of records would be yearling and carcass evaluation of last years calf crop, the calving of the current calf crop, the contracting for breeding and the breeding of next years calf crop, the weaning evaluation of the current calf crop and the culling of progeny test cows after the pregnancy exam. The record keeping is standard procedure. The ability to settle cows by artificial insemination is the critical issue in custom progeny testing.

Progeny testing 7 or more bulls requires (BIF guidelines) that there be 40 progeny from the reference sire set. A reasonable fee for delivering complete data on a calf by a breeder sire could be established. This is cheaper than the test could be conducted by the breeder himself if he had to set the test up and run it.

Attached are example forms used by IBIA.

Minutes of Board of Directors
Beef Improvement Federation
Bozeman, Montana
Holiday Inn
May 17, 1977

NEW DIRECTORS

The meeting was called to order by President Martin Jorgensen at breakfast starting at 6:30 a.m. Present were new directors Tom Shaw from Idaho (Western States director), Wayne Eschelman from Washington (Director at Large), Mark Keffeler, South Dakota (Director at Large), Dick Spader, Angus Association (Representing Breed Associations), Craig Ludwig (re-elected) American Hereford Association (Representing Breed Associations). Directors from previous terms who were present include Butts, Chestnut (retiring), Wolf, Cundiff (ex officio), Hubbard, Vaniman, Durfey, Warwick, Whaley, (re-elected), Nelson, de Baca Jorgensen, Bennett, Gosey (Regional Secretary), Berg, Allen, Eller (Regional Secretary) and Cooper.

MINUTES - TREASURERS REPORT

A motion carried which was made by Allen and seconded by Bennett that the minutes be accepted as presented to the directors and printed in the guidelines. Wolf moved to accept the treasurers report and to commend the treasurer for the low cost of operation. The motion was seconded by Durfey and carried.

Financial Status
Beef Improvement Association
May 1, 1977

Savings Account	$ 9190.68	
Interest on Savings Account	119.16	
Cash on Deposit	1079.51	4/29/77
Accounts Receivable *	6350.00	
*Dues billed May 1, 1977	$16,739.35	

Income Itemized May 1, 1976 - May 1, 1977

Membership	$ 3,250.00
Conference	5,674.87
Proceedings	172.00
Carcass Data	242.80
	$ 9,339.67

Itemized Expenditures, May 1, 1976 - May 1, 1977

Conference and Meeting Expenses	$ 7,117.20	(May and October)
Telephone	528.89	
Clerical	1,168.30	
Printing	1,915.69	
Postage	795.28	
BIF Secretary itemized	1,105.31	
Carcass Data	179.40	
	$12,810.07	

de Baca's Itemized Expenses

Travel Expense	$ 245.60	
Copy Machine	310.86	
Printing	179.97	
Postage	29.59	
Secretarial	278.78	**
Phone	38.12	**
Supplies	22.38	
	$ 1,105.31	

** Presently paid direct

EARLY WEANING

One of the early items of consideration was relative to recommendations for performance testing of early weaned calves. Heretofore, early weaned calves have been classified as irregular. There are many individuals that are needing, by virtue of management, to wean groups of cattle at ages earlier than those allowed in BIF recommendations. Arguments included the the fact that the Simmental Association had discussed early weaning needs at their performance committee meeting the day prior to this meeting, C. K. Allen indicates that the Polled Hereford Association has gone ahead with the system irrespective of BIF not having recommendations, President Jorgensen indicated the drought compelled him to early wean and make adjustments in his data accordingly. Dr. Cundiff indicated that there should be sufficient data to make age of dam correction on early weaned calves. The consensus of the committee was that the Farm & Ranch subcommittee should move immediately to get us their recommendations (prior to the end of this conference).

GUIDELINES

PROCEEDINGS

The next item of business was relative to the Beef Improvement Federation Guidelines. Generally speaking they are revised each biennium. Dr. Hubbard indicated that revision should be based only on a need to update them. Subsequent to this conference there may be a need for doing so. Other alternatives are to print an addendum which can go out to the membership and be sent through UPDATE. Also discussed were the proceedings of the annual conference, their costs, the method of indexing and numbering pages. Some board members indicated that the system of sectioning the proceedings by color rather than by continuous paging is undesirable. The secretary indicated that this was done last year in order to expedite the perilly submitted papers in view of the fact that one lengthy paper was late in being submitted.

ELECTION

MOTION - ELIGIBILITY FOR OFFICE

The next item of business was election of officers. There was an item of misunderstanding concerning the eligibility of board members for election to offices. This question arose due to the fact that President Jorgensen had served one year as President and the bylaws indicated that an officer can serve two terms as an officer BUT it is not specifically stated in the bylaws that anyone director is limited to two terms as director. Traditionally the President has been an ex officio board member even after having served his two elected terms. To avoid further confusion Chestnut moved and Wolf seconded that all board members (including ex officio) may be eligible to be elected to office. The motion carried. Vice President Bennett took over the meeting for President Jorgensen during the election. Mark Keffeler nominated Martin Jorgensen to succeed himself as President. It was moved by Nelson seconded by Durfey that nominations cease and unanimous ballot be cast for Jorgensen. The motion carried. President Jorgensen resumed the chair. He opened nomination for Vice President. Vice President Bennett asked not to be re-elected to the Vice Presidency due to excessive commitments. Don Vaniman nominated Whaley. Cooper seconded the nomination. Durfey moved unanimous ballot. Motion carried.

Eller moved to re-appoint de Baca Secretary-Treasurer. It was moved by Durfey and seconded by Allen that an unanimous ballot be cast. Motion carried. The meeting was recessed to be resumed at 6:30 on the morning of May 18.

LISTENING SESSION

Meeting was recalled to order at 7:00 a.m. on May 18 by President Jorgensen. It was suggested that some effort be made to expand the midyear meeting to include a listening session in which we might get additional ideas for Beef Improvement Federation by letting members representatives come to present their ideas and their complaints to the board meeting or prior to the board meeting. President Jorgensen appointed a committee consisting of Jim Gosey as chairman, Dixon Hubbard, C. K. Allen and Ken Ellis to communicate with people in the various regions concerning inputs. It is requested that the committee report back by regions prior to September 1 and that we report to the midyear conference either with participants or plans as to how to proceed.

AD HOC COMMITTEES

Ad hoc committees on crossbreeding and linear measurements and presented reports: These are at the end of ad hoc committees. The crossbreeding committee has subdivided itself into several people that are giving several distinct tasks in combining information, bibliography and altimately recommendations. The linear measurements committee submitted a report of recommendations. It was moved by Mark Keffeler and seconded by Bennett that the linear measurements ad hoc committee be redirected to provide the board with justification for or against linear measurements and in the event of justification that they recommend what linear measurements should be taken and how they should be taken. The board desires the accumulation of bibliography and knowledge to decide whether it should be involved in making recommendations on linear measurements.

CROSSBREEDING REPORT

Preliminary Report of Ad Hoc Committee
Crossbreeding Committee - May 17, 1977

Present - Ken Ellis Chairman
Tom Marlow
Larry Cundiff
Marvin Koger

Report of Committee:

This was the first opportunity for members of this committee to meet and discuss directly the proposed content, format and thrust of the publication planned on crossbreeding from the Beef Improvement Federation.

Specific sections will be headed by different members of the committee, however, it was unanimously agreed that in order to take advantage of the training, knowledge, experience and expertise of all committee members that all outlines, written information, etc., be circulated to all members as it is prepared for review and suggestions.

Category suggestions and responsibilities agreed upon are: (not necessarily listed in the order they would appear in the publication)

Selected Reference and Reading list of publications on Crossbreeding	Larry Cundiff Tom Marlowe
Review and summary of research (although research will be quoted and utilized throughout the publication)	
Utilization of Heterosis through crossbreeding Methods of crossbreeding Gradients and Levels of Crossbreeding Advantages and Dis advantages	Dick Willham Ron Nelson
The Role of Straightbreds in Crossbreeding Programs Significance and Utilization of dairy breeds and Brahman-based breeds	Marvin Koger Bob Vantrease
The use of Crossbred Sires	Dick Willham Ken Ellis

CROSSBREEDING REPORT CONTINUED

Suggested outlines for basic content of each: Specific section or segment are due to be written and forwarded to the chairman (with copies to all other committee members) by June 10.

These outlines will be reviewed and suggestions made. Cundiff, Marlow, Koger and Willham will be together at Texas A&M in mid June for a joint technical committees meeting of the NC-1, S-10 and WRCC-1 projects and will jointly review the outlines. Following this review initial draft writing will begin.

Preliminary Report of Ad Hoc Committee
Linear Measurements - May 17, 1977

LINEAR MEASUREMENTS REPORT

"In keeping with BIF policy over the years to standardize and co-ordinate the use of various performance tools, the committee on linear measurements felt that measurements for linear height have now reached a point of wide enough general use and acceptance that it would be beneficial to the industry to standardize the points of reference for comparisons.

In this light the committee recommends the linear measurements for height be taken and cited for a specified age at two locations - - over the hooks and over the shoulders above the fifth rib. It further recommends that these measurement will be most beneficial when adjusted to relatively logical production points, such as 205 days & 365 days - - within the BIF age ranges currently used for adjusted weights. Further measures and adjustments can be beneficial at 6 month intervals to maturity.

LINEAR MEASUREMENT REPORT CONTINUED

The linear measurement committee felt that no recommendations were in order or appropriate with regards to what linear measurements if any were most desireable."

Eller reported on the RECORD UTILIZATION committee.

BIF Record Utilization Committee Report
Bozeman, Montana
May 17, 1977

The following committee members attended: A. Eller, L. Nelson, R. BreDahl, M. Cook, D. Busch, M. Crandall, J. Gosey, C. Greig, J. Sagebiel, G. Ufford, D. Whitman and 12 other persons.

RECORD UTILIZATION REPORT

Chairman Eller called the meeting to order and asked each person to introduce themselves. Eller asked the secretary to read the minutes of last year's meeting.

The following items were discussed:

1. Sub-committee on "Recommended Improvement Programs for Commercial Producers" - L. A. Nelson, Chairman, and L. A. Maddox. Nelson distributed a draft of a proposed brochure. Eller asked for comments from those present. Also, persons were encouraged to give or send their comments to Nelson soon. Then Nelson's committee was instructed to revise the draft and distribute it to the Records Utilization Committee for their comments, etc., prior to July 1, 1977. The committee recommends that BIF then publish and distribute this brochure.

2. Chairman Eller asked M. Crandall to report for the Sub-committee on "Utilization of Performance Records and Crossbreeding Programs for Small and Medium-Sized Herds". Pros

and cons of crisscross and terminal sire programs and alternating sire breeds was discussed. Eller instructed Nelson's committee to incorporate some recommendations regarding breeding systems and records use in the brochure on "Improvement Programs for Commercial Producers".

3. Report of the Sub-committee on "The Beef Industry and Performance Records" - R. Willham, R. BreDahl, and G. Ufford. BreDahl gave the report and stated that currently three different drafts were in existence. Chairman Eller reviewed these and the concensus was for BreDahl to duplicate his draft and distribute it to the Records Utilization Committee for their comments and suggestions and then that he prepare a final manuscript to be delivered to Secretary de Baca. The target date for completion of this brochure is September 1, 1977.

RECORDS UTILIZATION REPORT CONTINUED

The committee recommends that it be published by BIF and distributed to states, breed associations, industry, etc.

4. A sub-committee composed of Jim Gosey, Joe Sagebiel and M. K. Cook were asked to present, using transparancies, examples of variation in performance data presented in final performance reports and sale catalogs at central test stations. These presentations were made by Sagebiel and Gosey. The committee agreed that the data itself and the format is quite variable, making for less than optimum usage. The committee agreed to ask Secretary de Baca to write a letter to performance organizations, test station supervisors and managers, and state beef Extension specialists in charge of performance programs urging that BIF guidelines be followed in computing performance data on test station bulls and that catalog performance data be presented in the most simple, usable and understandable form possible.

5. J. D. Mankin, Extension Specialist from Idaho, presented for the committee what Idaho is giving breeders on their P.T. program in the way of management information in addition to normal performance measures (adj. 205 day weights and ratios). This information entails no additional input or trouble on the part of the breeder and has been well received and very useful. Chairman Eller asked J. D. Mankin to write a popular article on the subject of computer generated management information for the breeder and include the Idaho program. He was asked to get this article to Eller who will get it to de Baca, who will send

it out to the livestock press as a news release. The committee also agreed to ask Secretary de Baca to include a short version of this in the BIF UPDATE and urge performance organizations to give their members management information developed from data collected in the normal manner (i.e. calving interval, no. calves born in each 20 day period of the calving season, the period in the calving season in which each cow calved and a yearly comparison, pounds of calf weaned in each 20 day period of the calving season, etc.).

RECORD UTILIZATION REPORT CONTINUED

6. Daryl Strohbehn, Extension Specialist from Iowa, gave a presentation on their use of small programmable calculators (TI SR52) in on-the-farm performance programs. He also demonstrated such a machine which can quickly calculate adj. 205 day weight, ratio, sire averages, etc. The committee was impressed and asked Strohbehn to make programs and information available on request, which he agreed to do.

There being no further business, the meeting was adjourned at 3:00 p.m. on May 17th.

Respectfully submitted,

A. L. Eller, Jr., Chairman
L. A. Nelson, Secretary

BIF BROCHURES

It is the wish of the board that the pamphlets on the beef industry and performance records and one on a recommended improvement program for commercial producers be in the hands of the secretary by September 1. It is further recommended by the Record Utilization committee that the secretary correspond with member organizations.

1. Urging bull test stations to use the Beef Improvement Federation approach and to simplify their presentations as recommended by BIF. This should avoid the duplication of materials presented and reduce confusion
2. To see what possibilities there may be in their including computer management analysis into their programs. This includes the approaches utilized by J. D. Mankin and the Idaho Beef Improvement Association. Hubbard asked approval on the committee recommendations on Record Utilization; seconded by Eller and carried.

The next report was by William Durfey on REPRODUCTION.

Durfey indicated that we needed greater emphasis on measurement and determination of breeding values in reproductive traits (he was not specific as to which traits). The committee on reproduction recommends more work in the area of reproduction. Beef Improvement Federation should communicate with the agricultural research service concerning a need for further research on reproduction traits.

The second area of research which the committee directed itself to concerned measures used to predict bull fertility. They indicated that it is obvious that variations have been identified but question whether indeed it has been proved that they relate to conception. It was moved by Durfey and seconded by Eller that BIF should go on record encourging more research on bull fertility. The motion carried.

MOTION-DEFEATED

2 MOTIONS - CARRIED

Durfey continued relative to concern over calving intervals, calving and calf livability history and abnormal presentations. Cundiff indicated that we should be careful of analyzing calving intervals in that we might be penalizing the cow that is a very early calver and has cycled prior to our observation of breeding willingness. Durfey moved that the reproduction committtee recommendation on changes in female fertility recommendations be accepted. It was seconded by Whaley and the motion was defeated. Durfey moved the adoption of changes in female fertility recommendation excepting calving interval recommendations. Eller seconded the motion carried. Durfey moved to amend the male guidelines consistent with the society for Theriogenology. Motion carried.

BIF REPRODUCTION COMMITTEE REPORT
May 17, 1977
Bozeman, Montana

Members of the Committee present were: Bill Durfey, chairman, Glenn Butts, Secretary, Jim Brinks, Don Kress, John Massey, Merlyn Nielsen, T. D. Rich, Keith Vander Velde and Bob Bellows substituting for Ray Woodward.

Breeding Values for Maternal Performance for Reproduction

Following brief discussion, it was the consensus of the committee that we do not presently have adequate information necessary to develop a recommendation that breeding values be calculated for maternal reproduction. Thus, further discussion was tabled upon motion duly made, seconded and passed.

Research Needs

1. Upon motion duly made, seconded and passed the Committee recommends that BIF encourage research to evaluate the accuracy and value of breeding value estimates for reproductive performance utilizing existing research data.

2. Upon motion duly made, seconded and passed the committee recommends the BIF encourage research to evaluate various measures used to predict bull fertility and their relationship with actual conception rates.

National Cow Summaries

Following brief discussion, it was duly moved and seconded that it be recommended that the BIF Board consider the need to establish a committee for National Cow Summaries. Motion passed.

Other Topics

REPRODUCTION REPORT

Upon motion duly made, seconded and passed discussion of (1) environmental influences on reproduction rate, (2) embryo transfer and, (3) sex ratio control, was tabled.

Revision of Guidelines

A subcommittee composed of Merlyn Nielson, chairman, Glenn Butts, Don Kress and T. D. Rich was appointed to review the female portion of the Guidelines as they relate to reproduction and specifically to develop a recommendation for including "calving interval" in the Guidelines. Based upon the report of this subcommittee and upon motion duly made, seconded and unanimously passed, the Reproduction Committee recommends that the following be inserted in the BIF Guidelines in lieu of the current Guidelines as they relate to female reproduction:

REPRODUCTION

Reproduction or fertility is the most important trait in beef cattle. Breeders are urged to record reproductive performance in both the female and the male and to build these data into their herd records. They are urged to use these data in culling and selection, even though heritabilities may be low. Recommendations for this section are based on experience and limited research information. Research workers are urged to further study reproductive traits and measures for further refinement and improvement.

FEMALE

The following recommendations are made for scoring and recording traits associated with the female.

General Reproductive Performance:

1. Pregnancy status - - score 0 for open and 1 for pregnant.
2. Age at first calving - - measured in days.
3. Calving date - - record in a conventional manner but store and carry in Julian calendar form.
4. Calving interval - - calculated as the number of days between birth dates of successive calves.
5. Calving and Calf livability history - - score as follows:

    Score 0 - - cow open
    score 1 - - cow aborted
    score 2 - - calf dead or died at birth
    score 3 - - calf died preweaning
    score 4 - - calf weaned

REPRODUCTION REPORT CONTINUED

Calving Difficulty

1. No difficulty and no assistance - - score 1.

2. Minor difficulty, some assistance - - score 2.

3. Major difficulty, mechanical assistance with jack or puller - - score 3.

4. Cesarean section, very difficult or other surgery - - score 4.

5. Abnormal presentation - - score 5.

NOTE: Scores 1 through 4 may be averaged for data summarization, but 5 should not be included.

There was discussion relative to scoring abnormal presentations of calves at birth. It was the concensus of the committee that the calving scores should be reviewed as they relate to abnormal presentations and perhaps this should be a topic for a furture BIF Symposium.

A copy of a letter and enclosures from Dr. Lawrence Rice relative to the BIF Guidelines as they relate to reproduction of the male was distributed and reviewed by the committee. A subcommittee of Keith Vander Velde was appointed to review and make appropriate recommendations for amendment of this portion of the Guidelines. Based upon the report of this subcommittee and upon motion duly made, seconded and unanimously passed by the committee, it is recommended that the BIF Guidelines as they relate to male reproduction be amended to read as follows. (Note: The appendix referred to herein is attached as Exhibit A):

MALE

The following are the guidelines for physical examinations and semen evaluation in screening yearling bulls. These recommendations are especially intended for bulls which have completed post-weaning gain test at either central test stations or on breeders' farms.

REPRODUCTION REPORT CONTINUED

I. Physical Examination (very important)
   A. Palpation of scrotum and its contents - - score 0 for unacceptable (abnormalities of scrotum and testes) and 1 for acceptable.
   B. Examine extended penis and prepuce for injury or abnormalities - - score 0 for unacceptable and 1 for acceptable.
   C. Palpate internal glands rectally - - score 0 for unacceptable and 1 for acceptable.

II. Conditions and equipment
   A. Bulls should be restrained in a chute providing
      1. firm footing
      2. means of support to prevent bull from collapsing during ejaculation, or manual massage.
   B. Bulls may be collected by artificial vagina and mount animal, electric ejaculation, or manual massage.
   C. Laboratory equipment - minimum
      1. binocular scope with 200 to 1000X magnification
      2. means of maintaining semen sample at 37 degrees C from collection through microscopic evaluation (insulated jacket for for collection cone, water bath in lab or van, slide warmer and microscope stage warmer).
      3. morphology stain (Bloms stain, eosin-nigrasin, fine grain India ink, etc.).

III. Semen Evaluation*
   A. % motility - - observation
   B. Morphology**
   C. Scrotal circumference - record in centimeters.

*As recommended by the Society of Theriogenology. A scoring system which has been adopted by the Society of Theriogenology is included in the Appendix to these Guidelines. However, it should be emphasized that this system was developed based on data collected for the Angus, Charolais, Hereford and Simmental breeds and

REPRODUCTION REPORT CONTINUED

there may be significant breed differences and exceptions to which this system may not be applicable. For additional information contact the Society of Theriogenology, Association Building, Ninth and Minnesota, Hastings, Nebraska 68901

**Percentage primary abnormalities counted on a stained smear at 1,000 magnification. Primary emphasis should be on % normal sperm. Head and midpiece abnormalities are expecially important; i.e., primary abnormality.

Most bulls with gross deficiencies or abnormalities detected by physical examination should be culled.

Scrotal circumference measurements should be scored as actual measurements. Percent primary abnormalities may be expressed as a ratio for the group of bulls tested together.

The scrotum, penis, and rectal examinations should be recorded as acceptable or unacceptable. If unacceptable, the report should tell why.

The screening examination should be performed by experienced, competent personnel.

Exhibit A

BREEDING SOUNDNESS EXAMINATION

SOCIETY FOR THERIOGENOLOGY

REVISED SEPTEMBER 1976

MOTILITY

Classification	Score
Very Good	20
Good	12
Fair	10
Poor	3

MORPHOLOGY

Classification	Primary Abnormalities	Total Abnormalities	Score
Very Good	<10	<25	40
Good	10-19	26-39	24
Fair	20-29	40-59	10
Poor	>29	>60	3

SCROTAL CIRCUMFERENCE
(All Breeds Except Brahma)

Classification	Age (Months) 12-14	15-20	21-30	30+	Score
Very Good	>35	>37	>39	>40	40
Good	30-35	31-37	32-39	33-40	24
Poor	<30	<31	<32	<33	10

SPHEROIDS

Less than 5/HP field = Occasional = +5% Primary Abnormality

5 to 15/HP field = Few = +15% Primary Abnormality

15 to 25/HP field = Many = +25% Primary Abnormality

More than 25/HP field= Multitudes = +35% Primary Abnormality

SCORING SYSTEM

Classification	Scrotal Circumference	Morphology	Motility
Very Good	40	40	20
Good	24	24	12
Fair	--	10	10
Poor	10	3	3

Satisfactory Potential Breeder	60-100 Total Points
Questionable Potential Breeder	30-59 Total Points
Unsatisfactory Potential Breeder	0-29 Total Points

Next was the FARM AND RANCH COMMITTEE REPORT. It was indicated that the secretary should relate in the next UPDATE the importance of birth weights and the need for currency on a within breed basis of evaluation of birth weight and birth weight adjustment. Also the secretary was urged to remind BCIA's and breeds to incorporate the BIF changes in Age-of-Dam adjustments and calculation of 205 and 365 day weights.

SYSTEMS ANALYSIS

On recommendation of the FARM AND RANCH COMMITTEE an AD HOC COMMITTEE ON SYSTEMS ANALYSIS is to be established. It is to look not only at the Farm and Ranch committee needs in determining cow efficiency, but was also to look at other aspects of systems analysis as it might benefit the purposes of Beef Improvement Federation and its usefulness to the industry. This committee was created on a motion by Allen seconded by Bennett with the specific charge that their efforts include inputs that are attainable and outputs that are understandable. Rich Benson will be in charge of assembling the committee which should include inputs from Dr. Cundiff, Dr. Fitzhugh, Dr. Klosterman, Dr. Brinks, and Willham provided they agree, upon Benson's communication, to serve. This committee is to report directly to the board. Any correspondence should be directed with carbon copies to de Baca, Hubbard and Bennett.

FARM AND RANCH COMMITTEE REPORT

FARM AND RANCH TESTING COMMITTEE REPORT
Bozeman, Montana
May 17, 1977

The first item of business was a report by Don Vaniman, Chairman of the Subcommittee, on the effect of age of dam on birth weight of calf. He reported on a survey of breed associations, a copy of which is attached. That survey showed that most breed associations are using the BIF recommended birth weights and are making no distinction between age of cows.

The Angus (65 lbs.), Red Brangus (75 lbs.), Charolais (85 lbs.) and Beef Friesian (77 lbs.), make no distinction between males and females. Breed associations using breed standards which used different birth weights for males and females include Limousin (80 & 75 lbs.), Maine-Anjou (90 & 84 lbs.), Murray Gray (65 & 60 lbs.), Simmental (98 & 90 lbs.) and Tarentaise (75 & 70 lbs.).

Chairman Bennett raised the question concerning calving difficulties associated with larger birth weights as a correlated response to selection for rapid growth and larger mature size. Dr. Cundiff was asked to comment. He stated that birth weight is highly heritable and responds well to selection. He stated that Dr. Dickerson has suggested an index against increased birth weight. He stressed the importance of measuring it. Marlowe reported that adequate data are available for looking at breed, sex and age of cow differences in regard to birth weight.

A motion was made, seconded and passed that all members be encouraged to record birth weights. Motion was amended to include recording of calving difficulties. The importance of this kind of information on A.I. bulls was stressed.

Cundiff suggested that both the Sire Evaluation and the Farm & Ranch Testing Committees endorse the collection of data on fertility traits on all animals and and that data on both the individual animal and his relatives be used in computing breed values for bulls. Dr. Anderson (?) pointed out that the Angus Association used weighted offspring average values in computing breed values such that the average offspring of a cow all weighted by 1/2, average of the daughter of a sire by 1/4, average of the daughter of the paternal grandsire by 1/8 and the average of the daughters of the maternal grand dam by 1/8.

FARM AND RANCH COMMITTEE REPORT CONTINUED

Richard Benson gave a brief presentation of Systems Evaluation approach to total beef production within the herd. He then recommended that BIF establish an ad hoc committee to develop an equation to evaluate efficiency (individual animal productivity) - - a decision making model. After considerable discussion, a motion was made, seconded and passed that the Farm and Ranch Testing committee recommend to the BIF Board that such a committee be sanctioned.

The subcommittee on irregular age calves did not report because the chairman was absent; however, someone stated that the scientists present at the discussion thought the irregulars should be included in the ratios but that no 205 day weights should be computed.

Andy Bostian raised the question of how fertility and weaning weights should be tied together. This was discussed pro and con. The scientists present agreed that true heritability of fertility traits is probably higher than present estimates indicate. The majority opinion appeared to be that the records should show regularity of reproduction along with weaning weights. Marlow presented research results to show that a higher fertility of 10 percentage points was equal to 77 lbs. additional weaning weight on a 76% calf crop (5680 vs 5852 lbs.).

A motion was made, seconded and passed that the Committee on Reproduction look at this matter and come up with recommended guidelines.

Respectfully submitted,

James Bennett, Chairman
Thomas J. Marlowe, Secretary

It was also emphasized that the last paragraph of the Farm and Ranch Committee be brought to the attention of the reproduction committee.

BIRTHWEIGHTS

By means of a motion Variman asked for BIF to establish standards for adjustment of actual birth weights. In his own case he has used a combination of MARC data and his own data with a breed standard adjustment for age dam. Eller referred to his agreement on needs for this type of adjustment. He seconded the motion and it carried.

SEX ADJUSTMENT

It was moved by Butts seconded by Wolf that the five pound deviation between bulls and heifers be used for BIF standard in birth weight adjustment for sex. Variman suggested that the standard birth weight be changed to 75 lbs. for males and 70 lbs. for females. Motion carried.

EARLY WEANING

RETURN TO COMMITTEE

The next item of consideration was a return to the early weaning matter. It was moved by Eschelman that the problem of out of age limit calves be referred back to the committee and that we ask for a final report by September 1. It was seconded by Eller. Further discussion indicated that this problem should include not only these individual calves that are out of age limits but the weaning of the entire age groups that are within the normal weaning contemporary age limit yet the average age might be below the minimum age. This should make up for management situations brought about by specific needs for weaning early. Further comments included the calculation and ratios on contemporary groups without calculation of adjusted weights rather than the use of the word irregular. The motion carried. Also it was recommended that further study be given to adjustment factors for early weaned calves with the same committee continuing with this responsibility and Don Variman added to the subcommittee. The Secretary was instructed to contact Larry Benyshek subcommittee chairman and also that committee chairman (Farm and Ranch) Bennett should contact Benyshek and further spell out this need.

Central Test Committee Report
Bozeman, Montana
May 17, 1977

Central Test Committee Report

Present at the meeting were: Bill Mc Reynolds, W.S.U., Pullman, WA; Jack Newman, Agriculture Canada, Lacombe, Alberta, CANADA; Tom and Mary Shaw, Test Center and Registered Herefords, Caldwell, ID; Forrest Ireland, Belvedere, SD; Lewellyn Tewksbury, NDBCIA, Mercer, ND; Ralph Neill, IBIA, Corning, IA; John Greig, Estherville, IA; Glenn Burrows, Clayton, NM; Clair R. Acord, Utah State University, Utah; Rulon V. Osmond, Cache Valley division select Sires Inc., Logan, UT; J. C. Nolan, University of Hawaii, Honolulu, Hawaii; and Bobby J. Rankin, NMSU, Las Cruces, NM.

Items Discussed:

1. Report of Ad hoc committee on adjusted yearling weights. The group supported the following as most useful:

   First choice:

   $$\left(\frac{\text{init test wt}-\text{BW}}{\text{Init. age}} \times 225\right) + \left(\frac{\text{Final test wt.}-\text{Init test wt.}}{\text{Days on test}} \times 140\right) + \text{BW} + \text{AOD factor}$$

   Second Choice:

   $$\left(\frac{\text{Final test wt.}-\text{B. wt.}}{\text{Age}} \times 365\right) + \text{B. wt.} + \text{A.O.D. factor}$$

2. General discussion of age ranges, linear measurements, birth weights and maturity end points. No recommendations.

   Third choice:

   $$\left(\frac{\text{Wt. nearest after 365 day}-\text{B. wt.}}{\text{Age}} \times 365\right) + \text{B.wt.} + \text{A.O.D.}$$

BULL TESTS & BIF

According to a survey eleven of the forty bull test station answering the survey are complying with BIF standards at this time. The secretary is instructed to relate this to the testing stations.

YEARLING WEIGHTS TABLED

Concerning the adjustment of yearling weights, after substantial discussion, it was moved by Vaniman seconded by Allen that the recommendations of the alternatives for adjusting 365 day weights at test stations be tabled until data are run by Meat Animal Research Center and Breed Association personnel to check validity of the three alternatives.

The board instructed the secretary to relate appreciation of the board to the subcommittee that has struggled with a method of adjusting the 365 day weights now through two years of conflict.

The next committee report was by Wolf on CARCASS EVALUATION

Carcass Evaluation Committee Report
Bozeman, Montana
May 17, 1977

CARCASS EVALUATION COMMITTEE

I. Last year's recommendation that all member organizations recalculate carcass data on quality grade prior to 1976 was discussed. Some organizations have done this. The committee decided that this is not a critical matter, and should be left to the discretion of the individual organization.

II. C. K. Allen presented suggested revisions to the BIF Beef Carcass Service (BCDS) brochure. During the discussion it was emphasized that the USDA Grading Service offers two carcass information services: First, the original carcass evaluation service, which is primarily designed to provide carcass data to persons who own the carcass. Second, the Beef Carcass Data Service, the orange tag program, which is designed to provide Carcass Data to persons who may not own the carcass but who were financially interested at some point during its development.

It is recommended by the committee that the BCDA brochure be revised to explain more clearly the two carcass information systems and how to make the best use of each system.

III. Presently the USDA Grading Service furnishes carcass information for maturity, marbling and quality grade using letter or word designations such as "A," "Small" and "choice". For computation purposes letter and word designations must be converted into numerical form. The committee suggests that the USDA Grading Service convert to the numerical system recommended in BIF Carcass Contest pamphlet, page 4.

As an additional improvement in reporting marbling, the committee recommends that a decimal system be used for each of the eleven degrees of marbling described on page 4 of the Carcass Contest pamphlet. For example: Small marbling is designated as 5 and would range from 5.0 through 5.9. Presently, the grading service uses a percentage system in increments of 10% for final grade. Thus the conversion to a decimal system should be simple. The final decision on these recommendations will be with the USDA Grading Service. Fred Williams from the USDA Standardization Branch attended the meeting and agreed to contact the Grading Service to request the recommended changes and report back to the Carcass Evaluation Committee.

CARCASS EVALUATION REPORT

IV. The committee discussed carcass contests and various methods of placing carcasses. It appears that presently no one system can satisfy all members. Therefore, it is recommended that the committee compile several systems that have been used by different groups for consideration by anyone seeking guidance in formulating a carcass contest.

Respectfully submitted,

Jim Wolf, Chairman
C.O. Schoonover, Secretary

NEW BROCHURE

Wolf moved that the BCDS brochure be revised to include, "How to obtain carcass data", and also that BIF should indicate to USDA that their brochure should be similarly changed. This motion was seconded by Allen and carried. Wolf moved that the Carcass Evaluation Committee report be accepted as presented. It was seconded by Allen and carried.

NOMINATING COMMITTEE

It was a motion by Whaley that the chairman appoint a nominating at the midyear meeting to submit the names of candidates for offices. This was seconded by Nelson and carried. The secretary was instructed to list the names of all officers and directors in each issue of UPDATE together with their year of termination and to also include the names of the chairman of the standing committees.

MERCHANDISING COMMITTEE

The next item of business was the report from the Merchandising Committee. Wolf moved to reaffirm support for the production of marketing system for genetically superior beef cattle being proposed (anticipatedly into action by 1977) by South Dakota and surrounding states. Seconded by Gosey and carried.

Merchandising Committee Report
Bozeman, Montana
May 17, 1977

The meeting was called to order by Chairman Don Nelson. Present were Stephen Garst, Coon Rapids, IA; Martin & Mary Jorgensen, Ideal, SD; John Jameson, Canton, IL; Art Roberts, Billings, MT; F. E. Mars, Las Vegas, Nevada; Josephine Carter, Marshall, VA;

Steven Blumenthal, Houston, TX; Jim Volz, Elmore, MN; Chris Dinkel, Brookings, SD; Tom Chrystal, Scranton, IA; Bob Cook, Billings, MT; Roger Brownson, Bozeman, MT; Dick Spader, American Angus Association; Dale Davis, Belgrade, MT; Don Nelson, Danville, IA; and Dean Frischknecht, Corvallis, OR.

Minutes of last year's meeting were read and approved.

There was a discussion on the Special Project Proposal for Merchandising and Marketing Genetically Superior Beef Cattle being developed by South Dakota, Nebraska, Minnesota, Kansas, Michigan and Iowa. Dixon Hubbard, USDA, presented pertinent information regarding this system. He indicated there is as much as $100 per head more value to genetically superior cattle that are marketed at the right time.

MERCHANDISING COMMITTEE REPORT

Hubbard stressed the importance of breeders of genetically superior bulls offering to the commercial cattlemen buying these bulls an opportunity for feeding out and merchandising these cattle so they share in potential profits. He stressed retained ownership through the feedlot and marketing through designated slaughterers, processors and retailers.

Steve Garst indicated the boxed beef concept can help get a return on true value of a superior product. He also indicated the hamburger market continues to increase in the United States. Also, beef carcasses are being fabricated in new ways to best take advantage of different grades and weights of carcasses.

Moved by Tom Chrystal, seconded by Steve Blumenthal that this committee recommend continuing support for the Special Project on Merchandising and Marketing Genetically Superior Cattle. Motion passed unanimously.

This Committee discussed the breeding background of a performance-bred steer. It is recognized that characteristics of economic importance to all segments of the cattle industry are fertility of breeding stock and mothering ability of beef cows as evidenced by production of a good big calf each year at weaning time. After weaning the characteristics of economic importance are growth rate, feed efficiency and carcass merit. Freedom from inherited defects is also of economic importance to the cattle industry.

In merchandising performance it is the breeder's responsibility to document or show just where the superiority is in his cattle. Records of total performance in regard to these traits of economic importance will verify the degree of superiority.

We recognize there is a profit in merchandising beef. We know that a part of the profit realized in the sale of the final product must be returned to the producers of a superior quality product.

Respectfully submitted,

Don Nelson, Chairman
Dean Frischknecht, Secretary

NATIONAL SIRE EVALUATION

The next item of business was the report of the National Sire Evaluation Committee. Cundiff moved to accept the report. There was no change and no action relative to the report other than acceptance on a second by Vaniman which carried.

National Sire Evaluation Committee Report
Bozeman, Montana
May 16, 1977

The National Sire Evaluation Committee met May 16, 1977 with Larry Cundiff, presiding.

Three items were discussed:

1. Question - Should guidelines for state commercial progeny testing compatible to National Sire Evaluation procedures be printed in BIF Guidelines?

After extended discussions, pro and con, a majority expression favored the printing of such guidelines. A draft of proposed guidelines, developed by Dr. Willham and others based on the progeny used by the Iowa Beef Cattle Improvement Association is attached.

2. The problem of understanding or interpreting "Possible Change" (also referred to as accuracy or standard error) was discussed.

Alternative approaches were discussed. Suggestions considered included:

1. Effective number as an addition or as an alternative (see attached report by Richard Willham).
2. Probability that true expected progeny differences are above average.
3. No statement at all.

After discussion a "straw vote" was taken. Five voted in favor of Possible Change or no change in present guidelines. There were no expressions in favor of effective number.

Ten expressions were in favor of probability and no expression favoring no statement.

The consensus was to appoint a subcommittee to consider and develop guidelines recommending appropriate probability statements.

NATIONAL SIRE EVALUATION CONTINUED

3. Should guidelines for calculations of Maternal Breeding Value be developed and printed?

A general discussion evolved and a paper by Richard Willham and James Brinks was circulated. Larry Cundiff explained the concepts involved.

An unanimous "yes" was expressed in response to the question, "Are we in favor of the concept?"

The meeting was adjourned.

MIDYEAR BOARD MEETING

The midyear term meeting will be held Monday, October 3, 1977 at Kansas City according to a motion by Jim Berrett seconded by Allen which carried. The motion also allowed latitude for having a board session on the night of Sunday, October 2.

BIF 1978

The 1978 Beef Improvement Federation Conference will be held at Blacksburg, VA on May 22, 23 and 24. The motion was seconded by Gosey and carried.

Actions of the committee with unanimity included the appointment of Dr. Eller to be program chairman and to accept the topics Breeding Values and Data Adjustment Rational. The secretary (de Baca), program chairman (Eller) and Committee chairman (Hubbard) are to have a complete report on the program by the midyear meeting. Some reference should be made in this program to the fact that this is the 10th anniversary of Beef Improvement Federation.

THANKS MONTANA

The board expresses their appreciation to the Montana Beef Performance Association and the various breeds which cooperated with it in the co-sponsorship of the conference and the social activities, to Dr. Peter Burfening of Montana State University who so ablely coordinated the conference, to Mrs. Andrea Lawrence, secretary of Montana Beef Performance Association, who laid the groundwork for all the physical facilities and many important details for the conference, to Roger Bronson, Montana State University for a fine job of conducting and helping with the tour and to

Mr. Don Vaniman and his many capable assistants who gave unselfish help in the conduct of the conference itself.

The secretary (de Baca) asked that the BIF board appoint a committee to search out and suggest possible replacements for the secretary-treasurer's position effective June or July 1, 1978.

Respectfully submitted,

Robert C. de Baca

RdeB
jc

Attendance - BIF Conference, 1977

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BIF AWARD'S PROGRAM

The Commercial Producer Honor Roll of Excellence

Chan Cooper	MT	1972
Alfred B. Cobb, Jr.	MT	1972
Lyle Eivens	IA	1972
Broadbent Brothers	KY	1972
Jess Kilgore	MT	1972
Clifford Ouse	MN	1973
Pat Wilson	FL	1973
John Glaus	SD	1973
Sig Peterson	ND	1973
Max Kiner	WA	1973
Donald Schott	MT	1973
Stephen Garst	IA	1973
J. K. Sexton	CA	1973
Elmer Maddox	OK	1973
Marshall Mc Gregor	MO	1974
Lloyd Nygard	ND	1974
Dave Matti	MT	1974
Eldon Wiese	MN	1974
Lloyd De Bruycker	MT	1974
Gene Rambo	CA	1974
Jim Wolf	NE	1974
Henry Gardiner	KS	1974
Johnson Brothers	SD	1974
John Blankers	MN	1975
Paul Burdett	MT	1975
Oscar Burroughs	CA	1975
John R. Dahl	ND	1975
Eugene Duckworth	MO	1975
Gene Gates	KS	1975
V. A. Hills	KS	1975
Robert D. Keefer	MT	1975
Kenneth E. Leistritz	NE	1975
Ron Baker	OR	1976
Dick Boyle	ID	1976
James D. Hackworth	MO	1976
John Hilgendorf	MN	1976
Kahua Ranch	HI	1976
Milton Mallery	CA	1976
Robert Rawson	IA	1976
Wm. A. Stegner	ND	1976
U. S. Range Experiment Station	MT	1976

1977

John Blankers	MN	1977
Maynard Crees	KS	1977
Ray Franz	MT	1977
Forrest H. Ireland	SD	1977
John A. Jameson	IL	1977
Leo Knoblauch	MN	1977
Milton Mallery	CA	1977
Jack Pierce	ID	1977
Mary & Stephen Garst	IA	1977

The Seedstock Breeder Honor Roll of Excellence

John Crowe	CA	1972
Dale H. Davis	MT	1972
Elliot Humphrey	AZ	1972
Jerry Moore	OH	1972
James D. Bennett	VA	1972
Harold A. Demorest	OH	1972
Marshall A. Mohler	IN	1972
Billy L. Easley	KY	1972
Messersmith Herefords	NE	1973
Robert Miller	MN	1973
James D. Hemmingsen	IA	1973
Clyde Barks	ND	1973
C. Scott Holden	MT	1973
William F. Borror	CA	1973
Raymond Meyer	SD	1973
Heathman Herefords	WA	1973
Albert West, III	TX	1973
Mrs. R. W. Jones, Jr.	GA	1973
Carlton Corbin	OK	1973
Wilfred Dugan	MO	1974
Bert Sackman	ND	1974
Dover Sindelar	MT	1974
Jorgensen Brothers	SD	1974
J. David Nichols	IA	1974
Bobby Lawrence	GA	1974
Marvin Bohmont	NE	1974
Charles Descheemaeker	MT	1974
Bert Crane	CA	1974
Burwell M. Bates	OK	1974
Maurice Mitchell	MN	1974
Robert Arbuthnot	KS	1975
Glenn Burrows	NM	1975
Louis Chesnut	WA	1975
George Chiga	OK	1975
Howard Collins	MO	1975
Jack Cooper	MT	1975
Joseph P. Dittmer	IA	1975
Dale Engler	KS	1975
Leslie J. Holden	MT	1975
Robert D. Keefer	MT	1975
Frank Kubik, Jr.	ND	1975
Licking Angus Ranch	NE	1975
Walter S. Markham	CA	1975
Gerhard Mitteness	KS	1976
Ancel Armstrong	VA	1976
Jackie Davis	CA	1976
Sam Friend	MO	1976
Healy Brothers	OK	1976
Stan Lund	MT	1976
Jay Pearson	ID	1976

L. Dale Porter	IA	1976
Robert Sallstrom	MN	1976
M. D. Shepherd	ND	1976
Lewellyn Tewksbury	ND	1976

1977

Harold Anderson	SD	1977
Wm. Borror	CA	1977
Rob Brown, Simmental	TX	1977
Glenn Burrows, PRI	NM	1977
Henry & Jeanette Chitty	FL	1977
Tom Dashiell, Hereford	WA	1977
Lloyd De Bruycker, Charolais	MT	1977
Wayne Eshelman	WA	1977
Hubert R. Freise	ND	1977
Floyd Hawkins	MO	1977
Marshall A. Mohler, Red Poll	IN	1977
Clair Parcel	KS	1977
Frank Ramackers, Jr.	NE	1977
Loren Schlipf	IL	1977
Tom & Mary Shaw	ID	1977
Bob Sitz	MT	1977
Bill Wolfe	OR	1977
James Volz	MN	1977

Continuing Service Awards

Clarence Burch	Oklahoma	1972
F. R. Carpenter	Colorado	1973
E. J. Warwick	ARS-USDA, Washington,DC	1973
Robert de Baca	Iowa State University	1973
Frank H. Baker	OK State University	1974
D. D. Bennett	Oregon	1974
Richard Willham	Iowa State University	1974
Larry V. Cundiff	U. S. Meat Animal Research Center	1975
Dixon D. Hubbard	USDA-FES, Washington,DC	1975
J. David Nichols	Iowa	1975
A. L. Eller, Jr.	VPI & State University	1976
Ray Meyer	South Dakota	1976

1977

DON VANIMAN, EXECUTIVE SECRETARY, AMERICAN SIMMENTAL ASSOCIATION
BOZEMAN, MT

Don has been an extremely enthusiastic, aggressive and directional performance man. He has built a breed on performance concepts, performance methods and performance execution. Every Simmental must have performance records in order to be registered. Their association has been very innovative in breed building, in advertising, development of sire and dam summaries and other programs. Don was previously executive secretary of the Montana Beef Performance Association. His continuing service to Beef Improvement Federation has been invaluable. No man has been more prompt in servicing committee activities or providing information in or out of the Beef Improvement Federation offices.

LLOYD SCHMITT, STANFORD, MT

Lloyd has been a champion of the performance movement for many years. He was instrumental in the development of Beef Improvement Federation. Indeed he represented the Western States and was Vice President of the first Board of Directors of BIF. He drew the one year term when the rotational system was established that first year. Lloyd Schmitt was most widely known during the early performance days for his conduct and ownership of a performance indexing center at Stanford, MT which was one of the very outstanding bull testing stations programs.

Commercial Producer of the Year

Chan Cooper	MT	1972
Pat Wilson	FL	1973
Lloyd Nygard	ND	1974
Gene Gates	KS	1975
Ron Baker	OR	1976

1977 Commercial Producer of the Year

STEVE AND MARY GARST, a husband-wife team from Coon Rapids, IA were named Commercial Producer of the Year by Beef Improvement Federation.

Steve Garst is general manager of The Garst Company, a family-owned company engaged in a variety of agricultural and agribusiness enterprises. His wife, Mary, in her role as cattle manager for the company bears responsibility for extensive beef breeding programs. The nominees come from a family tradition of agricultural innovation started in the 1920's by Steve's father, Roswell Garst. The elder Garst was a pioneer in the use and production of hybrid seedcorn. The Garst family has long recognized the value of genetic improvement in both plant and animal agriculture.

Steve and Mary Garst entered the cattle business in 1955. They were among the earliest users of artificial insemination and later, performance-tested bulls. They began crossbreeding in the mid 1960's, and pioneered in the use of exotic crossbreeding in 1968. Their cow herd today totals nearly 4,000 head. Adding replacements, feeders and others their total cattle enterprise includes some 7,000 head. The Garst Company is involved in numerous other agricultural enterprises including hybrid seedcorn production, fertilizer, chemical and feed sales, farm management, grain storage and grain and livestock export trade.

Breeders of the Year

John Crowe	CA	1972
Mrs. R. W. Jones	GA	1973
Carlton Corbin	OK	1974
Leslie J. Holden	MT	1975
Jack Cooper	MT	1975
Jorgensen Brothers	SD	1976

1977 SEEDSTOCK PRODUCER OF THE YEAR

GLENN BURROWS, a Polled Hereford breeder from Clayton, NM, was selected Beef Improvement Federation Seedstock Producer of the Year for 1977.

The New Mexico rancher together with his wife Missie are recognized throughout America for the outstanding job that they have done in breeding performance Polled Herefords. The Clayton Numodes and the Princess Numodes have made rather than met competition and official test and customer herds. Burrows purchased his foundation cattle soon after graduation (1933) from OKLAHOMA STATE UNIVERSITY. These animals were of straight Anxiety 4th breeding. Sires of Plato Domino and Mark Donald ancestry were injected into the line breeding program in 1950. The Burrows intensive performance selection dates to 1950. It initially followed the procedure developed by Knox and Koger and has keep pace with research. Burrows is a charter member of Performance Registry International and was an early president. He helped organize and sponsor the Tucumcari New Mexico bull test and has participated without interruption in the feed trials and performance leadership across the industry.

Organizations of the Year

Beef Improvement Committee, Oregon Cattlemen's Assn.	1972
South Dakota Livestock Production Records Assn.	1973
American Simmental Association, Inc.	1974
American Simmental Association, Inc. (Breed)	1975
Iowa Beef Improvement Association (BCIA)	1975
The American Angus Association (Breed)	1976
The North Dakota Beef Cattle Improvement Association (BCIA)	1976

1977 BREED ASSOCIATION OF THE YEAR

THE AMERICAN ANGUS ASSOCIATION is the BIF Breed Organization of the Year for the second year in a row. In 1976 Angus breeders reported 75,456 weaning weights and 27,964 yearling weights on the Angus herd improvement record program. The active year in AHIR records pushed the total number of weaning and yearling records collected by the association to 761,454 since 1959. The maternal selection work sheet instituted by the Angus Association in 1976 was one of the most recent and innovative programs which were in addition to a very constructive program. Also a new fertility and weaning report form was introduced in 1976. In 1976 the Angus association sponsored the Liberty Bell Angus Sire Evaluation contest as its most significant event of the bicentennial year. 17 sires were progeny tested on the program and became part of the 4th group report of the Angus Sire Evaluation. This is the 18th year of AHIR.

1977 STATE BEEF IMPROVEMENT ORGANIZATION OF THE YEAR

THE IOWA BEEF IMPROVEMENT ASSOCIATION, is the Beef Improvement Federation's State Organization of 1977. The Iowa Beef Improvement Association is a second time winner. Among the many services offered by IBIA are included: Data processing, grading and weighing of calves, central bull testing, on-farm bull testing, weaning and yearling records and a sire summary as a part of the data processing.

Iowa Beef Improvement Association operates 6 central test stations and tested 8 different groups of bulls in 1976. They totalled 868 bulls. Also IBIA conducts the largest National Sire Evaluation program in the nation. The Iowa Beef Improvement Association custom progeny tested 117 in 21 cooperator herds. 3,000 calves were weighed in sire evaluation in 1976. These are but a few of the IBIA activities.

The Pioneer Awards

Jay L. Lush	Iowa State University	Research	1973
John H. Knox	New Mexico State University	Research	1973
Ray Woodward	American Breeders Service	Research	1974
Fred Willson	Montana State University	Research	1974
Charles E. Bell, Jr.	USDA-FES	Education	1974
Reuben Albaugh	University of California	Education	1974
Paul Pattengale	Colorado State University	Education	1974
Glenn Butts	Performance Registry International	Service	1975
Keith Gregory	US Meat Animal Research Center	Research	1975
Bradford Knapp, Jr.	USDA	Research	1975
Forrest Bassford	Western Livestock Journal	Journalism	1976
Doyle Chambers	Louisiana State University	Research	1976
Mrs. Waldo Emerson Forbes	Wyoming Breeder	Breeder	1976
C. Curtiss Mast	Virginia BCIA	Education	1976
Dr. H. H. Stonaker	Colorado State University	Research	1976

1977 PIONEER AWARDS

RALPH BOGART - Professor of Animal Science, Oregon State University
Corvallis, OR - - Research

Dr. Ralph Bogart's research and teaching had a very great effect on the performance movement. His activities in applying performance principles began with his early work in artificial insemination in the early 1940's. He taught Animal Husbandry and Animal Breeding in particular at the University of Missouri and since the early 1940's was professor of Animal Breeding at Oregon State University. His research centered on selection for performance characteristics and his greatest contributions probably come in the studying of the physiology related to changes due to selection. A great deal of Bogart's research was physiological in nature in an effort to interpret genetic change.

HENRY HOLZMAN - South Dakota State University - - Education

Henry Holzman began his work with Extension Education in 1934 when he was emergency Agricultural Assistant in Harding County South Dakota. With in the next year or two he took over as county extension agent and remained there until 1940. He moved from there into the position of district Extension Supervisor remaining 8 years after which time he became Livestock Specialist for the West River Country of South Dakota. He remained as Extension Livestock Specialist until his retirement in 1963. Holzman started the performance movement in South Dakota. He organized performance evaluation activities in the early 1950's and brought about the organization of an association in 1956. He was also instrumental in the development of the Western Junior Livestock Show at Rapid City which has been in operation successfully for 40 years.

MARVIN KOGER - Professor of Animal Science, University of Florida - -
Research

Marvin Koger began his career in New Mexico where he worked under the tutelage of a former Pioneer Award winner - - John H. Knox. His research has been primarily with the performance evaluation and genetic improvement of commercial beef cattle. He was one of the first scientists to publish research papers concerned with performance recording of beef cattle. His influence in beef cattle breeding circles has been of major importance both in North and South America.

JOHN LASLEY - Professor of Animal Science, University of Missouri, Columbia, MO - - Research

Dr. Lasley has been at the University of Missouri since 1949. His contributions to the research in livestock improvement have been many and significant. In his early professional activities he was at the San Carlos Indian Reservation in Arizona where for 9 years he had the task of inseminating 30,000 head of Hereford cows. This was a combination of breed improvement and development of insemination techniques. His studies greatly advanced the knowledge of spermatozoa physiology. Among other things he developed the live-dead differentiation system and the cold shock technique of sperm evaluation. He has been active at the University of Missouri in swine and beef cattle breeding research. His main personal interest lie in studying physiological-genetic relationships. He is the author of a textbook on livestock genetics which is in its third edition and printed in four languages. He is also coauthor on another textbook. His publications in animal production with specific emphasis on breeding include 176 scientific & popular articles.

W. C. MC CORMICK - Tifton, Georgia - Research

W. C. Mc Cormick helped develop the first central test station in the Southeast. The impact of this station and the Polled Hereford herd assembled at Tifton, Georgia, is recognized nationally. Among his accomplishments it should be mentioned that the practices used in building the famous R. W. Jones herd of Polled Herefords were in some measure the result of consultation with Dr. Mc Cormick.

PAUL ORCUTT - Bozeman, MT - - Education

Paul Orcutt was the founder of the Montana Beef Performance Association (MBPA) which has remained as one of the most successful State Testing Associations in the United States. The fact that this self-supporting group with full-time Executive Secretary and staff is still successfully competing with commercial and breed association record keeping systems is due to his efforts in formulating sound rules and converting a significant portion of the Montana cattle producers to the performance concept. He accomplished this goal as Montana Extension Livestock Specialist and later as Secretary of Montana Beef Performance Association.

J. P. SMITH - Amarillo, Texas - Education

J. P. Smith initiated the movement to found the American Beef Performance Registry Association later known as Performance Registry International (PRI). Three of his contributions to early performance testing advances are of particular importance; the initiation of the present PRI, the first demonstration of performance cattle at a major livestock show (Chicago International, 1953), and the first successful major sale of performance tested cattle from a central test station. He supervised the Texas Tech Research Farm and their central test station for many years.