5-1956

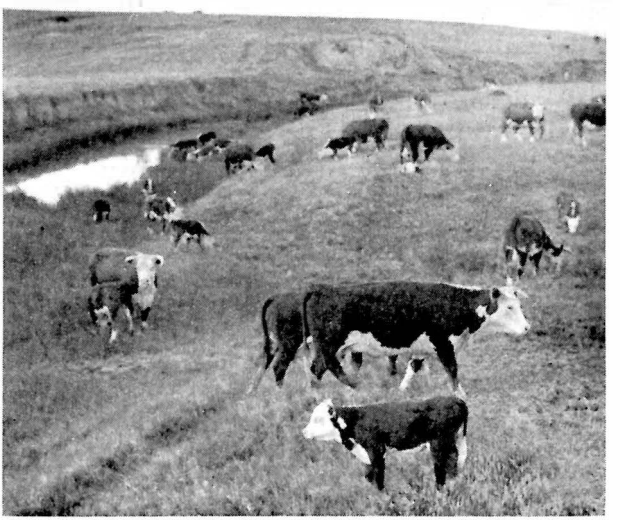
Beef Cattle Breeding Research in South Dakota

C. A. Dinkel
South Dakota State University

A. L. Musson
South Dakota State University

CIRCULAR 130 MAY 1956

beef cattle breeding research in South Dakota



ANIMAL HUSBANDRY DEPARTMENT
Agricultural Experiment Station
SOUTH DAKOTA STATE COLLEGE, BROOKINGS

Contents

beef cattle breeding research in South Dakota

C. A. Dinkel and A. L. Musson[1]

Introduction

Long-range research, designed to help cattlemen improve their herds, is under way in South Dakota. This publication reports the progress to date on this research in beef cattle breeding.

The breeder of purebred beef cattle should guide his breeding program according to the demands of various groups—commerical producer, feeder, packer, consumer. It is important that he consider the wants of each.

The commerical producer has certain requirements in terms of conformation and weaning or yearling weights. The feeder has certain requirements in terms of conformation and rate and efficiency of gain. The packer has certain requirements in terms of yield and carcass quality. The consumer expresses his preference in terms of such things as quality, size of cut, and amount of fat.

Satisfying all these demands is not easy, and it may be that complete satisfaction for all is impossible. Research in progress is concerned with studying methods that might help the breeder come closest to satisfying all these demands.

Since beef cattle reproduce slowly and with few offspring per mating compared to hogs, poultry, or corn, breeding progress is not rapid. Because of this time element and the relatively higher cost of a beef animal compared to a chicken or corn plant, the beef breeding research has been organized on a

[1]Associate Animal Husbandman and Animal Husbandman, South Dakota State College Agricultural Experiment Station.

This work is cooperative with the North Central States and Oklahoma NC-1 Beef Breeding Project and the USDA.

Acknowledgement is made to the superintendents of the outlying stations, the foremen of the main station, and to other personnel who have been associated with the project for data collection and other assistance.

regional basis to allow cooperation among states in the study of this complex problem.

The cooperative nature of this regional research allows closer contact among researchers in all states conducting such investigations and, further, prevents unnecessary duplication of effort. Although 30 or more states are cooperating in the study, it has been estimated that the entire national beef breeding work amounts to about one-half acre of corn breeding research in terms of actual genetic units, where one calf and one kernel of corn are genetic units.

Although performance testing for rapid and efficient gains has received the most publicity, all phases of the problem as outlined, with the exception of consumer preference, are being studied.

Herds on Experiment

The experimental breeding herds of the South Dakota State College Agricultural Experiment Station are carried on three outlying stations—the Antelope Range Field Station, Buffalo; the Range Field Station, Cottonwood; and the Reed Ranch, Presho. The majority of the cattle on this project are carried at the Antelope Range station, while the station at Cottonwood is used to maintain one 20-cow line and to develop the replacement heifers from all the other lines in the project.

Initially Reed Ranch was also used for the study of the production phase of this project, but the problem of selenium toxicity proved to be so severe at this station that the production phase was dropped. The cattle at Reed Ranch are now being used in the study of breeding for resistance to selenium poisoning. Discussion of this problem will be treated in more detail later. All of the cattle are purebred Herefords except for a small herd of grade Herefords and a small herd of grade Angus at the Reed Ranch.

Improving the Herd

If a breeder is to make progress in improving his livestock by selection there must be differences among his animals and these differences must be due in part to heredity. The rate of improvement will depend upon how widely the animals differ and how much of these differences are due to heredity (heritability).

For example, if the bulls and heifers saved for breeding had an average weaning weight of 440 pounds and the average of the entire calf crop from which they were selected was 400 pounds, the breeder has "reached" for 40 pounds in the next generation.

The 40-pound difference or "reach" can be attributed in the broad sense to both hereditary and environmental differences. Present estimates of heritability of weaning weight indicate that about 25 percent of these differences are due to heredity and are therefore transmitted. The environmental portion would not be transmitted. In this example then, the breeder would expect the selection to increase weaning weights of the next generation by 25 percent of 40 pounds, namely, 10 pounds. Yearly variations and other environmental ef-

fects will prevent the breeder from measuring this accurately because variations in feed supply to the cow on pasture will prevent the comparison of weaning weights of offspring and parent.

It is apparent from the example that the rate of improvement depends upon how large the "reach" is and this in turn depends upon the extent of the differences between individuals. Rate of improvement also depends upon heritability as indicated above. Because of the importance of these two factors in determining the amount of improvement which can be made by selection, the extent of the individual differences found in the Experiment Station herds and present estimates of heritabilities are included in the discussion which follows. Even though selection is practiced and improvement is brought about, the varation in the characteristics selected for should be affected little if any. The average will be increased, but the uniformity of the calf crop will hardly be affected.

Performance testing is recommended as a herd improvement practice. The records, no doubt, will have value for advertising and publicity purposes. But the greatest value to the producer will be in the improvement of the quality and producing ability of his herd when these records are used as the basis of a sound selection program.

Methods of Breeding

Two of the specific objectives of the project are (1) to study methods of selection for the improvement of beef cattle and (2) to study the effects of inbreeding and of subsequent crossing of inbred lines of beef cattle. The project is designed to compare animals produced by selection alone with animals produced by crossing selected inbred lines.

Inbreeding in beef cattle progresses rather slowly as compared to the familiar cases of poultry and corn. It may be that in beef cattle, selection alone may make as much improvement as can be obtained through hybrids, because of this slow progress in forming inbred lines. Definite results will not be forthcoming for several years as far as the comparison of selection versus inbreeding is concerned. However, much useful information has already been obtained and much more will be obtained which will assist breeders in improving their breeding practices.

At present, five inbred lines are being developed and one 60-cow control line is being maintained. The inbred lines will vary in size from 15 to 25 cows and will be closed to outside breeding. This means that all bull and heifer replacements for each line must be produced within that line.

The control line will also be closed, but, since it is a four-sire line and inbreeding avoided as far as is possible, it is expected that the

matings will be only a little closer than the average for the pure breeds today. The control line is made up mostly of older cows which, when mated to related bulls, produced the foundation animals of the inbred lines. By using bulls from the inbred lines on these cows and using them in such a way that no close matings are made, the control line will be essentially of the same breeding as the inbred lines. This makes possible a direct comparison of the two methods on essentially the same bloodlines.

The four-sire control line is just now being formed and will produce the first outbred calves in 1957. A one-sire herd designated as Line 4 in the following tables has been used as a control line in the past. Lines 5 and 6, which are also shown in the tables, were culled in the fall of 1955.

Records and Management

All calves are ear tagged, tattooed, and weighed at birth. They are carried through to weaning without supplemental or creep feeding. They are weaned during the last week of October when they are weighed and scored for type and condition.

Bull calves are trucked to the main station at South Dakota State College in Brookings where, after a 2-week conditioning period, they are started on the 196-day record of performance trial. Each calf is self-fed individually a ration composed of 35 percent oats, 30 percent corn, 30 percent brome-alfalfa hay, and 5 percent linseed oil meal. Monthly weight and feed consumption records are maintained.

The objective of this trial is to keep the environment as uniform as possible for all calves so differences found in rate and efficiency of gain and type score will be more likely to represent differences in the calves' inherited abilities.

At the end of the 196-day period the calves are again scored for both type and condition, and the data are summarized individually for rate and efficiency of gain. Selections of bulls to go back into the lines are made at this time. At present selections are based equally on weaning weight, rate of gain, and final type score.

After weaning, the heifer calves are moved to the field station at Cottonwood where they are wintered on a ration calculated to produce about 1 pound daily gain. The heifers are weighed and scored for type in the spring when they are put on pasture without supplemental feeding. They are weighed and scored for type again in the fall at approximately 18 months of age, when selected heifers are returned to their home ranch to go into the breeding herds. Selections are based equally upon weaning weight, 18-month weight, and final type score. These heifers replace the older cows that are culled because they fail to meet standards on weaning weight or fail to calve regularly as well as for the usual reasons for which cows must be culled.

Line Differences

A numerical designation has been given the lines and these, together

with the station where they are maintained and the performance for some of the characteristics measured since the lines have been closed, are presented in table 1.

In the case of weaning weights, adjustments have been made for differences in age at weaning, sex, and age of dam. Weaning weights presented are adjusted to the basis of a 190-day-old bull calf from a 6-year-old dam. The 18-month weights of the heifer calves are adjusted to a common age of 550 days. Efficiency of gain of the bull calves is adjusted to the basis of an initial weight of a 400- to 499-pound calf. All other data are unadjusted. These adjustment factors are available upon request.

The inbreeding coefficients presented in the table can be more

Table 1. Summary of Line Performance, South Dakota Beef Breeding Project

		All Calves				Bull Calves			Heifer Calves	
Line	Year	Inbreeding Coefficient	Birth Weight	Adjusted Weaning Weight	Weaning Type	Rate of Gain*	Adjusted Efficiency of Gain	Final Type	Adjusted 18-Month Weight*	Final Type
					Cottonwood					
7	53	.06	71	396	3	2.58 (6)	656	3	788 (4)	2—
	54	.06	76	400	3	2.55 (5)	650	3	715 (10)	3
	55	.09	78	422	3					
	Av.	.07	75	406	3	2.56	653	3	752	3+
					Antelope Range					
6	53	.12	68	459	3+	2.22 (5)	632	3	705 (1)	3—
	54	.09	72	396	3+	2.36 (4)	623	3	734 (3)	3
	55	.03	67	409	3+					
	Av.	.08	69	421	3+	2.29	628	3	720	3
1	53	.06	80	476	3	2.79 (3)	601	3—	774 (4)	3
	54	.12	79	452	3	2.95 (2)	555	4+	808 (8)	3+
	55	.10	81	412	3					
	Av.	.09	80	447	3	2.87	578	3—	791	3+
4	53	0	67	438	3+	2.60 (4)	655	3+	740 (6)	2—
	54	0	65	405	3+	2.44 (9)	655	3	741 (6)	3+
	55	0	69	408	3+					
	Av.	0	67	417	3+	2.52	655	3+	740	2—
2	53	.16	74	464	3	2.66 (4)	648	2	757 (10)	3+
	54	.20	73	425	3+	2.59 (9)	629	3	747 (13)	3—
	55	.11	76	426	3+					
	Av.	.16	74	438	3+	2.62	638	2—	752	3
3	53	.15	74	425	3—	2.76 (3)	624	2	742 (5)	2—
	54	.14	69	384	3—	2.40 (4)	681	3	739 (5)	3
	55	.13	76	362	3+					
	Av.	.14	73	390	3	2.58	652	3+	740	3+
5	53	.13	65	390	3+				678 (2)	3+
	54	.13	68	364	3	2.20 (2)	656	3	734 (3)	3
	55	.11	67	395	3					
	Av.	.12	67	383	3	2.20	656	3	706	3

*Figures in parentheses indicate the number of animals.

readily understood by considering that the mating of half-brother to half-sister results in an offspring with 12 percent inbreeding and the mating of parent to offspring or brother to sister gives 25 percent inbreeding.

The following scale is used in scoring cattle for type.

SCALE	FEEDING STOCK	BREEDING STOCK
1+ 1 1—	Fancy	Show type
2+ 2 2—	Choice	Suitable for purebred herd
3+ 3 3—	Good	Suitable for commercial herd
4+ 4 4—	Medium	Not recommended for use
5+ 5 5—	Common or cull	Cull

Weaning Weight. Since climatic and management factors may vary between the outlying stations, comparisons of lines at different stations are not valid for the weaning data. The post-weaning performance is a little more comparable since the bulls are fed out together in Brookings and the heifers are all carried in one group through the winter and following summer. How much pre-weaning differences carry over and affect post-weaning performance is not known, but the 2-week conditioning period prior to the performance test is an attempt to minimize some of these effects.

Since weaning weights are not comparable between ranches, the lines at Antelope Range offer the most valid comparison of the differences among the lines. The 3 years of data presented in table 1 indicate that Line 1 has produced an average of 64 pounds per calf more than has Line 5. The differences among these lines are large enough to be economically important to a commercial producer selling calves at weaning time.

Much larger differences have been found between calves. At the Antelope Range Station in 1953 weaning weights ranged from 316 to 558 pounds after adjustment for age, age of dam, and sex. That this large variation is not peculiar to the cattle which the Experiment Station owns has been demonstrated by data collected in private herds by both Extension and Experiment Station personnel. In fact, Experiment Station data are quite typical of the variation found in private herds.

The largest amount of such data available is that collected through the South Dakota Extension Service Demonstration Project, in cooperation with breeders throughout the state. Some of these cooperating breeders have been performance testing for post-weaning gain the past 7 years. Some have also been taking weaning weights for the past 3 years.

These data have been made available for analysis by the Extension Service and include weaning

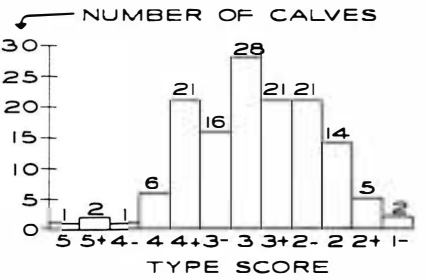
weights on 646 calves sired by 62 bulls on eleven ranches. Since the environmental differences were large from year to year and ranch to ranch the analysis was made by comparing sires in the same year on each ranch. This reduced the effective number of bulls to 38. Highly significant differences[2] were found between the average weaning weight of calves from bulls carried on the same ranch and produced in the same year. Highly significant differences were also found for year to year and ranch to ranch variations indicating that these environmental differences are important and must be taken into consideration.

These data indicate that about 36 percent of the individual differences in weaning weights are inherited. Several estimates available from other stations indicate that these hereditary differences are about one-fourth of the total. These estimates, along with the amount of variability present in weaning weights, indicate that selection should increase weaning weights by about 20 pounds per generation or an average improvement of 4 to 5 pounds a year. Although this amount does not seem large, relatively few years of constant selection would be required before the results would be apparent to the eye as well as to the scale.

There is another area in which selection can help improve weaning weights in most herds today. In addition to selecting on the basis of the individual's weaning weight, selection can also be practiced on the mothering ability of the cow herd.

Some of the variation apparent in the data presented is no doubt due to differences in milking ability of the cows. Selection in this direction should also result in heavier calves at weaning. Estimates of the heritability of milk production in dairy breeds indicate that the amount of milk produced is inherited to about the same extent as weaning weight in calves.

Type. Thus far line differences in type or conformation have not been large at weaning time. Individual differences are naturally greater than are the line averages indicated in table 1. Type scores at later ages indicate more variability as is shown in the graph. Individuals have varied from 1 to 5.



The bull calves are scored at 14 to 15 months of age and the heifer

[2]Statistical analysis is necessary for data of the nature presented herein. Significance of differences refers to the probability of these differences occurring by chance alone and therefore not being true sire differences. Highly significant indicates that there is a 1 in a 100 chance of being wrong in saying that a difference exists between sires. A significant difference means that there is a 5 in 100 chance of being wrong. This terminology is used throughout the publication.

calves at about 18 months. Averages of these scores are indicated as final type for each sex class in table 1 for the lines and in table 2 for the individual sires. Analysis of the Experiment Station data indicates that about one-tenth of the individual differences in type are due to inheritance, and highly significant differences were found between sire groups.

Essentially the same estimate was obtained from the data collected by the Extension Service. In this case, the estimate was 13 percent. Should these estimates prove to be reliable, a smaller percentage of what is "reached for" in type when the selections are made will eventually be obtained in the offspring as compared to weaning weight. These estimates as well as the others calculated from the Experiment Station data are based on relatively few data and need to be verified as more data become available.

Rate of Gain. Average daily gain of the bull calves for the 196-day performance test are indicated in table 1 as rate of gain. The number

Table 2. Performance of 28 Sire Groups Tested During the 1951-54 Period

	Bull Calves				Heifer Calves		
Sire	No. of Calves	Av. Rate of Gain	Av. Adjusted Feed/Cwt Gain	Av. Final Type Score	No. of Calves	Av. 18-Month Wt.	Av. Final Type Score
012	3	2.79	601	3—	13	792	3
014	3	2.76	624	2	10	739	3+
101	20	2.64	634	3+	41	742	3
011	4	2.61	646	3+	—	—	—
228	6	2.58	656	3	13	702	3+
001	4	2.54	639	2—	—	—	—
219	13	2.52	636	3+	13	734	3+
003	5	2.50	627	3	4	748	3+
920	5	2.46	654	3+	13	742	2—
023	7	2.45	637	3—	10	661	3
401	3	2.45	643	3+	—	—	—
026	10	2.45	610	3—	18	692	3
402	14	2.42	640	3	13	662	3+
010	4	2.38	714	2—	—	—	—
030	5	2.36	624	3—	5	762	3+
041	4	2.36	778	2—	—	—	—
022	6	2.34	682	2—	—	—	—
013	2	2.32	670	3	—	—	—
601	9	2.32	649	3—	23	672	3+
032	7	2.22	641	4+	10	703	3
009	4	1.98	733	2—	—	—	—
008					17	671	2—
015					6	683	3
027					6	677	3+
028					7	693	3
132					5	724	3
339					4	743	3+
602					8	703	3+

in parentheses following the gain indicates the number of calves fed out from each line. The differences between lines in this respect are not as large as the sire differences obtained in the project before the lines were closed and before selection had been practiced for gaining ability. All but one of the sires of the calves represented in table 1 had been selected on the basis of their gaining ability.

Table 2 presents the averages for all sires tested in the project during the period, 1951-54, and more nearly represents the variation present in the population of bulls from which the breeder is selecting. These are averages and the individual variation from calf to calf is much larger.

The gains of the 138 bulls tested during this period ranged from 1.8 to 3.2 pounds per day with an average of 2.4 pounds. Analyses of these data indicate that about one-third of these individual differences are due to heredity. Reports from other stations show that these hereditary differences may be as high as one-half or two-thirds. Although more data are needed to establish this definitely, even the lower figure would indicate that improvement in rate of gain is possible.

Improvement has been made in the past by selection on weight-for-age. The effectiveness of this selection can be increased, however, when all animals are carried under the standard environmental conditions of a performance test.

An example of the large effects of environment can be seen from the comparison of two bulls, 101 and 402, which have been used in the Experiment Station herd. Sire 101 was calved April 26, 1947 and gained 2.94 pounds daily during the 1947-48 performance test. Sire 402 was calved August 13, 1947 in another herd and was carried under a different feeding program. In May 1949, Sire 101 weighed 1,534 pounds and Sire 402 weighed 1,530 in spite of the fact that he was 3½ months younger. The weight-for-age of these two bulls indicated that they should be quite close in their gaining ability, and since 101 was one of the faster gaining bulls in his test they were both saved for breeding.

In subsequent tests of the offspring of these bulls, the average gain for 20 sons of 101 was 2.64 pounds and for 14 sons of 402 was 2.42. The average 18-month weight of 41 daughters of 101 was 742 pounds and of 13 daughters of 402 was 662. The differences between the offspring of these two bulls are actually larger than is indicated by the figures because many of the calves from Sire 101 were inbred while those from Sire 402 were not. Corrections for the depressing effects of inbreeding were not made.

Since the two bulls came from different herds, this is an extreme example. However, any tendency for a breeder to feed his better looking calves heavier than the poorer calves can produce the same kind of effects, which prevent accurate estimation of breeding value. Also any tendency to favor slower gaining calves in an effort to keep them uniform with the faster gaining calves will produce the same

A weighing trailer is used to determine weights.

masking of individual merit and prevent accurate selections between the two groups. This example also bears out the statement that environmental differences between farms and ranches are large enough to prevent comparison of the gains made on one ranch with those of another. This is discussed in more detail later.

Efficiency of Gain. Efficiency of gain or feed per hundred pounds of gain is affected by variations due to differences in weight at the start of the performance test. An analysis just completed has yielded adjustment factors which will correct the efficiency of gain measured so that it will more nearly reflect the inherited capacity of the animal rather than reflect his size. These factors were calculated using the 400- to 449-pound calf as the average calf and calculating the other weight classes in relation to this control group.

The analysis indicated that calves weighing less than 299 pounds required 114 fewer pounds of feed per hundred pounds of gain than the control group. The 300 to 349 pound calves required 43 fewer pounds of feed. The 350 to 399 pound group required 32 pounds less feed. The 450 to 499 pound group required 27 pounds more feed and the calves weighing 500 or over required 69 pounds more feed. The comparison in tabular form follows:

INITIAL WEIGHT	DIFFERENCE IN FEED REQUIRED
Under 299 lb.	—114 lb.
300 to 349	—43
350 to 399	—32
400 to 449	0
450 to 499	+27
Over 500	+69

It appears that more satisfactory adjustment could be obtained if the factors had been calculated on 25-pound ranges rather than 50.

There were 138 calves from 21 sires represented, and because this is a rather small amount of data, these adjustment factors will be recalculated as more data become available. Highly significant differences between sires for efficiency of gain of their calves were found in this analysis. The average feed required per hundredweight of gain for each of the sire groups is given in table 2, and line differences are indicated in table 1.

Individual differences in efficiency of gain have varied from 530 to 725 pounds of feed per hundredweight of gain. After adjustment for initial weight this range was 543 to 801. Available estimates of heritability for feed efficiency indicate that from one-third to one-half of the individual variations are due to heredity. Theoretically, one generation of selection for improved efficiency should result in a reduction of about 30 to 35 less pounds of feed required per hundred pounds of gain. Continued selection should result in additional improvement in feed efficiency.

Present recommendations are that the breeder select on rate of gain and not attempt to select for efficiency of gain directly. Indications are that rate of gain and efficiency of gain are correlated to the extent that selection for rate of gain will automatically improve efficiency of gain. This relationship needs to be determined more accurately in order that the breeder may be satisfied that he is obtaining the maximum improvement in both characteristics by selecting for one.

This phase of the study requires a large amount of data which will not be available for some time. The measurement of efficiency of gain requires that the amount of feed eaten by each calf be recorded, therefore the direct measurement of this characteristic involves much time and labor. Some satisfactory indicator of efficiency of feed utilization is needed, and it may be that rate of gain will be useful and practical in this regard.

18-Month Weight. The performance test for growing ability of the heifers is conducted on the range. Since the cow herds are maintained under range conditions, the selected heifers from this test should be better adapted than if they were carried on a feed program similar to the performance test of the bulls.

Performance test is sometimes thought to mean a feedlot test. Actually it should imply that the animals being tested are carried under environmental conditions as near alike for all animals as is possible and at a level of nutrition that will allow the individual to express its inherited abilities.

The heifers' fall weights as yearlings are used as selection factors comparable to rate of gain in the feedlot for bulls. As was pointed out previously the heifers are carried in the same lot during the first winter and in the same pasture during the following summer. The number of heifers and their average weight adjusted for age differences

are given for each line in table 1, under 18-month weight. There are rather large differences in average 18-month weight among these lines, ranging from 706 to 791 pounds. However, some of these averages are based on relatively few calves and these differences should be considered only as indications of possible line differences which must be confirmed with additional data.

Differences in ability to sire calves that will be heavier at 18 months of age do exist between bulls as shown in table 2. Here the individual variation is from 472 to 913 pounds and sire averages range from 661 to 792. Available estimates of heritability for this characteristic indicate that about 60 percent of individual differences are due to differences in heredity. The net return to a commercial producer selling yearlings could be affected considerably by whether he used a bull similar to 008 or 402 or whether he used any one of the other bulls that are average or above.

Carcass Studies. At present all the needed carcass information on the different lines of breeding is not being obtained due to lack of sufficient facilities. Detailed carcass studies are made on the bulls which are not considered good enough to be used for breeding. This usually amounts to about one-half of the calf crop.

The present practice is to sell direct for slaughter those animals which are below average in index considering weaning weight, rate of gain, and conformation. These bulls are sold direct to the packer and individual identification of each carcass is provided by the packer. Some 14 different measurements or scores are taken in an effort to determine the best means of evaluating carcass merit and also to evaluate our lines on carcass merit.

There are only a few bulls from each line which go to market each year, and since these bulls are consistently from the low end in regard to quality, this method of carcass evaluation for the lines is not very satisfactory. A much better test would be afforded by the use of a grade herd of cows from which calves sired by bulls from the different lines could be obtained. The calves would be carried through feedlot tests and on into the packing plant for carcass evaluation.

In the earlier days of the project, a grade herd was available and the progeny from 11 sires were carried through such a program. Some of the results of this work are presented in table 3. Statistical analysis of these data indicated a highly significant difference between sires for rate of gain and dressing percentage. Area of the eye muscle (which is used as a measure of the amount of lean meat), market grade, and carcass grade were not significantly different in this study.

A recent report from the Miles City Range Field Station[3] showed highly significant differences between sires for all of these characteristics except carcass grade. These estimates of heritability indicated that improvement could be

[3]Shelby, C. E., Clark, R. T., and Woodward, R. R., "The Heritability of Some Economic Characteristics of Beef Cattle," *Journal of Animal Science* 14:372, 1955.

Table 3. Over-all Summary of Progeny Testing 145 Steers and Heifers Representing 11 Sires

	Year and Sire Number															
	1944		1945		1946		1947				1948	1949		1950		1951
	1	2	2	3	3	4	5	601	4	6	10	601	23	15	602	602
No. of calves	12	12	12	11	8	7	9	10	10	9	9	6	10	7	8	5
Days on feed	283	271	289	299	286	306	239	294	278	289	264	245	248	293	276	204
Av. init. wt.	376	399	342	347	378	364	431	398	390	392	391	392	405	391	397	500
Av. final wt.	895	908	910	909	913	912	934	931	902	898	907	927	916	868	835	928
Av. daily gain	1.83	1.88	1.96	1.88	1.87	1.79	2.11	1.81	1.84	1.75	1.95	2.18	2.06	1.63	1.59	2.00
Feed per 100 lb. gain																
Concentrates	592	591	624	645	601	650	659	638	625	643	789	684	680	614	614	824
Roughages	247	243	131	136	228	219	305	305	300	319	237	219	224	195	195	—
Market grade*	AA—	AA	AA	AA	AA—	AA	AA—	AA—	AA	AA	AA	AA—	A+	A+	A+	AA
Carcass grade*	AA	AA	AA	AA	AA—	AA—	AA—	AA—	AA—	AA	AA	A+	AA—	AA—	A+	AA
Dressing percent	60.3	60.7	60.9	59.5	60.0	59.4	60.3	60.1	62.3	60.7	61.1	58.6	60.6	60.6	59.7	60.8
Area of eye muscle (sq. in.)	10.76	11.61	10.51	11.04	10.62	10.77	10.83	10.33	10.37	9.98	11.21	10.61	10.84	9.84	9.65	10.84

*AA+ High Choice; AA Medium Choice; AA— Low Choice; A+ High Good; A Medium Good; A— Low Good.

achieved through selection for all carcass characteristics with the possible exception of carcass grade. These results are based upon 635 steers from 88 sires.

Since selection for improved carcass merit must necessarily be based on information obtained from progeny or other relatives, progress in improving these carcass characteristics will be slower than for those characteristics which can be measured on the individual itself. However, progress can be made even though at a slower rate.

Summary of Differences. It should be emphasized that the differences between lines indicated in table 1 are not considered as definitely established but only as indications. More data are needed before proof is established. Differences in performance of these lines are similar to those found among inbred lines of other types of livestock. All lines are not affected by inbreeding in the same way or to the same extent.

It is rather rare to find a line that excels in all characteristics, but usually there will be some that exceed the others when all factors are averaged. For example, if future research supports the differences shown in table 1, Lines 1 and 2 appear to exceed the others when weaning weight, rate of gain, 18-month weight, and final type are considered. Line 1 is low in final type but makes up for this in weaning weight, rate of gain, and 18-month weight. Line 2 is much better in final type but is lower in the other respects.

If selection improves weaning weights of Lines 3 and 7 in spite of the depression usually brought about by inbreeding, these could also become over-all good lines. Considering only rate of gain and final type score, Line 3 has been one of the best producing lines.

Inbreeding results with other animals and plants indicate that over-all merit declines as the inbreeding increases. Usually some characteristics are affected to a greater extent than others. There have been some indications that inbreeding will also affect beef cattle the same way. Estimates as to the amount each characteristic is affected should be available during the next year. In this regard it should be remembered that the primary advantage of inbreeding is not usually measured through the performance of the inbred animals themselves but on the progeny of the cross of two inbred lines.

It is expected that some 5 to 8 years will be required before the inbreeding has reached a level sufficiently high to expect any hybrid vigor in the crosses of inbred lines. Even at this point the inbreeding will still be one-half or less of the inbreeding commonly achieved in inbred lines of corn before they are crossed. It appears that hybrid vigor percentagewise will have to be greater in beef cattle than it is in corn if this is to be a commercially useful method of producing beef.

Dwarfism Research

The amount of time and facilities available for the study of dwarfism in beef cattle has been limited, but some efforts have been put forth in this direction.

Profilometer

In 1952 and 1953, a field test was performed in an effort to evaluate the profilometer[4] as a useful tool in distinguishing the normal animals carrying the dwarf gene from those that were not carriers. Breeders in the state cooperated by allowing Experiment Station personnel to profile bulls which either had been progeny tested for dwarfism or were in the process of being tested. In addition, some Experiment Station bulls have been progeny tested for the dwarf character and these were included in the study.

Of the 96 bulls initially profiled, 41 were proven or partially proven by matings either to known carrier cows, daughters of known carrier bulls, or matings to their daughters.

The results and the amount of proof available for each bull are shown in table 4. The number predicted "carrier" which progeny tested "carrier" was 23. Six were predicted "clean" and progeny tested "clean." Nine were predicted "carrier" which were progeny tested or partially progeny tested "clean." Three predicted "clean" progeny tested "carrier." Results of this test indicate the need for improved accuracy before use of the profilometer is recommended.

Blood Count

A test for adrenal cortical insufficiency was applied to four dwarfs and seven normal beef cattle in an attempt to discover means of separating the two normal groups. The test was based on the effect of ACTH upon the number of eosinophil cells in the blood stream. Results were negative, indicating for the small sample studied that there was no difference in the adrenal cortical reserve between the dwarf and normal individuals. The dwarf individuals did average lower in initial eosinophil level than did the normals, that is, before the injection of the drug. This difference was investigated further to determine if animals carrying the dwarf gene might average lower than normal animals which did not carry it. Eosinophil counts of cattle kept under various conditions failed to establish this difference.

The experiment was not designed to study causes of variation in level of eosinophils, but it appeared that ration differences, differences in worm infestation, and whether a cow was dry or not might have an effect upon eosinophil level. Further research would be necessary to establish these relationships.

Present Work

At present the South Dakota Experiment Station is cooperating

[4]The profilometer was developed by P. W. Gregory and co-workers at the California Experiment Station.

with the Iowa Experiment Station in the study of the dwarf problem. The carrier cows which are available in the Experiment Station herd are being used to progeny test bulls which were classified clean or carrier at birth by the Iowa workers. Further research is planned.

Table 4. Summary of Profilometer Studies in South Dakota

Bull No.	Profile	Calves From Own Daughters			Calves From Daughters of Known Carrier Bulls			Calves From Known Carrier Cows		
		Normal	Dwarf	Dead	Normal	Dwarf	Dead	Normal	Dwarf	Dead
3	Carrier								4	
4	Carrier								1	
5	Carrier								1	
6	Carrier								1	
7	Carrier								1	
8	Carrier								1	
10	Carrier								1	
13	Carrier								1	
14	Carrier								1	
15	Carrier								1	
16	Carrier								1	
18	Carrier								1	
19	Carrier								1	
20	Carrier								1	
21	Carrier								1	
22	Carrier								1	
24	Carrier							13	3	
29	Carrier								1	
38	Carrier								1	
39	Carrier								1	
40	Carrier								1	
41	Carrier								1	
42	Carrier								1	
9	Clean							30		
26	Clean							16		
30	Clean				18			7		
32	Clean				50					
34	Clean				20			8		
36	Clean	75						15		
33	Clean								1	
35	Clean								1	
43	Clean								1	
2	Carrier							10		
12	Carrier							16		
23	Carrier							16		
25	Carrier							15		
27	Carrier							16		
28	Carrier	75						30		
31	Carrier				50					
37	Carrier				38					
44	Carrier				40					

Field Testing

In 1954 a new phase was added to the project which allows comparison of the performance tested bulls produced in the production phase of this project with bulls presently in use in commercial herds in the state.

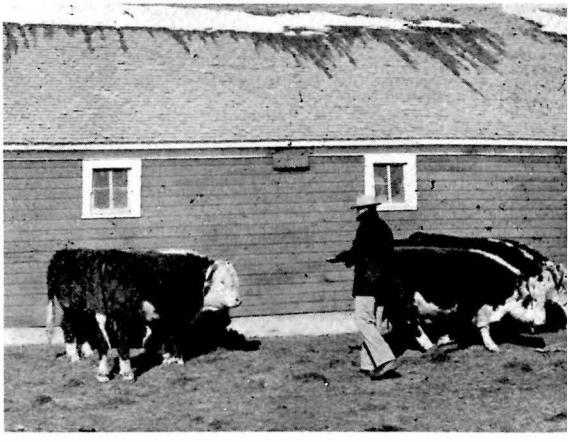
Results of several of these tests will allow evaluation of the inbred lines being developed and will also furnish information relative to the performance of the Experiment Station herd in comparison to the cattle population in South Dakota. In addition, this work will serve as demonstration projects for county agents and other Extension personnel cooperating in the program.

Direct comparisons will be available of performance tested bulls versus nontested bulls. Further, the producers cooperating in this work will receive complete records and will be able to practice selection on the basis of these records. The performance tested bulls are not expected to be superior in every case since they will be compared to a whole population of bulls, some of which should be high in performance characteristics, some low, and probably most of them medium. It is expected that in the tests, the breeder's bull would in some cases do better, in other cases not as well, but in the majority of cases about the same as the Experiment Station cattle.

Procedure

Selected bulls from the Experiment Station's test group are leased or sold to interested breeders who agree to separate their cows into two breeding herds. One herd, taken by gate cut, is bred to the Experiment Station bull and the other herd to the bulls owned by the breeder. The breeder eartags the calves at birth and records birth date and sire of the calf. At weaning time, Experiment Station personnel in cooperation with the county agent and Extension specialist weigh the calves and score them for conformation. The weights are adjusted for age, sex, and differences in age of dam, and a copy of the summary is furnished to the breeder. In all cases, where possible, further weight and conformation records are obtained during post-weaning growth of the calves. This varies with the breeder's usual method of handling his cattle.

This farmer cooperator is selecting an Experiment Station bull he will use and test on his farm.



Data at weaning have been collected on calves from four of the bulls on farm test in 1954. Post-weaning data will be collected on three of the four groups. These data are not presented because many more such comparisons are needed before the results will be reliable. In general, the calves from the tested bulls averaged from 6 to 17 pounds heavier and were either equal or slightly better in conformation than the calves from the cooperators' bulls.

Only a few bulls are available for this field test each year. The available bulls will be placed through county Extension agents and Extension animal husbandmen. An effort is being made to obtain statewide distribution of the bulls insofar as the limited number will permit.

Breeding for Resistance to Selenium Poisoning

Reed Ranch is in the selenium area and a number of difficulties have been encountered with selenium poisoning. Previous efforts to control selenium poisoning have been directed at finding a substance which when fed to cattle will prevent the symptoms. Up to now no satisfactory method for preventing selenium poisoning in cattle has been found.

One of the symptoms of an advanced stage of selenium poisoning.

Observations on the cattle at the Reed Ranch have indicated that animals may have the same level of selenium in the blood and hair but vary considerably in symptoms of poisoning. Some individuals are not visibly affected. This has also been true in laboratory work with rats. Experimental evidence is needed to determine whether or not these large individual differences are in part due to heredity.

Observations taken in swine experiments with selenium poisoning indicate breed differences in resistance to selenium poisoning. Other observations indicate that grade animals might be more resistant than purebred. Two breeds of cattle are now being carried on Reed Ranch. Crosses between the two breeds will be made in an effort to study possible breed differences and the effects of crossbreeding in relation to selenium poisoning.

Plans for the Future

Some of the areas covered in this publication are long-time projects and will require several years for completion. Among these are the selection - inbreeding studies, the testing of inbred lines in crosses with other lines, and in crosses with commercial cattle. The selenium resistance phase will also be a long-time project.

Selection Index

At present selection of replacements is made on the basis of equal attention to conformation, rate of gain, and weaning weight. While this method is recommended for general use, it is not absolutely certain that this is the selection procedure which will mean the most dollars in the pocket for the breeder.

Better recommendations could be made in this regard if it were known how much selection on one characteristic affected improvement in another characteristic. For example, does selection on rate of gain automatically improve or impair conformation? The limited data obtained thus far indicate that there is no correlation between type and rate of gain. Consequently one can produce good type animals that are fast gainers or one can produce poor type animals that are fast gainers. This means that faster gains can be achieved without resort to tall, leggy, or so-called "horsy" cattle. More data are needed to establish definitely the interrelationships between all of the characteristics and also to establish the degree to which the characteristics are transmitted from parent to offspring (heritability).

When this information is available it will be possible to estimate the dollar return expected under different methods of selection, that is, by placing varying amounts of emphasis on the different characteristics. For example, present data indicate that the heritability of rate of gain is 32 percent while that of type score at the end of the performance test is 9 percent. Say a unit change in rate of gain was of equal dollar value to a unit change in type score and the two characteristics are not correlated; a selection index would then give more emphasis to rate of gain than type score because more would be passed on to the offspring. If a unit change in type score was worth approximately three times the value of a unit change in rate of gain, then the two would receive equal emphasis in the selection index.

These are only theoretical examples used to demonstrate the utility of a selection index and should not be used as a basis for a selection program. The correlations mentioned here are not the usual correlations since they also include environmental effects. The correlations needed are those based only on heredity and not the usual ones based on heredity plus environment. These hereditary or genetic correlations require large amounts of data before the estimates can be considered reliable. This is only one

of several areas where the regional nature of the work will hasten the acquiring of needed information. A good selection index will be one of the most valuable benefits a breeder can realize from research of this type.

Breeding progress in cattle has always been relatively slow and, in spite of fairly large estimates of heritability for some characteristics, it no doubt will continue to be slow. In cattle breeding thus far there is nothing that produces results comparable to stilbesterol or antibiotics in livestock feeding. Possibly crosses of inbred lines will produce such an effect, but this remains to be seen. The process of selection, while not producing overnight results, can build a herd by accumulating small increases until worthwhile results are obtained. Once these gains are made they are a permanent part of the herd and need not be purchased anew each year or season.

Performance Testing Procedures

The collection of 28-day weight and feed records to the end of the 196-day performance test will enable an analysis to be made of the effectiveness of 140- and 168-day data as compared to the longer period. The shorter periods appear to better fit management practices and most breeders are presently using one of them. Analysis of the Experiment Station data will indicate whether or not the longer test is more effective in finding the better performing bulls.

A study is also needed to determine at what stage of development the performance test should be conducted. Most tests are conducted during the first winter in a similar manner to the procedure outlined for the Experiment Station project. However, it may be that a test at a later age would be more effective. If the herd of grade cows mentioned earlier were available for testing lines, the calves produced could be used in a study of this question.

Why Inbreed?

At this point one might ask why do you study inbreeding when you are recommending selection? The answer, of course, lies in the fact that part of the function of research is to be several years ahead of industry in order that when problems arise, answers will be on hand.

It is also typical of research that several methods must be attempted before the best recommendation can be made. In this case selection is recommended because it appears from the estimates of heritability there is opportunity for improvement through this method. If and when the point is reached where selection has done all it can in improving the various desired characteristics, some other method for improvement will be needed. Whether or not inbreeding is the answer cannot be said at this time, but information must be on hand by the time it is needed.

Research Goal

The cattle in the beef breeding project were acquired largely through a lease agreement with purebred breeders in the state. They

gave a percentage of the calf crop to the Experiment Station in exchange for the maintenance of the cow herd. Some cows were purchased outright, but they form a minority of the herd.

The cattle acquired were not a select group. In fact, the majority would be the offspring of cows from which the owners were willing to sacrifice half the calf crop.

This beef breeding project has been developed to find methods of improving breeding stock rather than to produce superior stock. Once new methods are established, breeders can use them to produce the superior stock. In many cases the breeders may be starting with cattle already superior to the Experiment Station herds. The purebred cattle industry has the acreage, the breeding stock, and the herdsmanship necessary to apply the findings of the researcher.

In other fields of genetic research, where under certain conditions as many as three generations per year can be obtained, where self-fertilization can be accomplished, where the initial cost of parent stock is low, and where the number of offspring of a single mating is relatively large, the increase and distribution of improved strains can be made statewide in a short time. This procedure cannot be applied to cattle breeding research at present.

What Is Available Now?

At present a dozen or more South Dakota cattle breeders are performance testing their bull calves. This represents a source where producers may purchase performance tested bulls. A few cautions in this regard are in order. Just because a bull is performance tested does not mean that he is good.

In selecting a bull, find out what his performance was with respect to the rest of the calves in that herd, and always try to buy individuals above-average in all characteristics.

Another thing to keep in mind in buying performance tested bulls is that environmental differences are so large between ranches that comparisons of gains in one herd cannot be made with gains made in another herd. A bull gaining 2½ pounds a day under one breeder's feeding and management might only have gained 2 pounds in another herd or 3 pounds in a third.

While this situation prevents the most accurate selections on rate of gain and weaning weight, producers have been faced with this same situation in selections on conformation for many years. A breeder with excellent abilities in fitting an animal can make its conformation appear better than a bull with equal breeding value in the hands of a poor fitter. This is by no means a condemnation of the fitting procedure but simply points out that these environmental effects have been present in selections on conformation in the past and will continue to be in effect on selections on conformation, rate of gain, and weaning weight in the future.

About the best one can do is always strive to obtain bulls well above average for the herd in all characteristics. Just as in the past, producers have found that some bulls breed poorer than they look while others breed better than they look. They will also find some bulls will produce slower gaining calves than they expected and others will produce faster gaining calves than they expected.

In addition to the purebred breeders who are performance testing their bulls, there is an increasing number of commercial producers who are eartagging their calves at birth and weighing their calves at weaning time in an effort to find their poor producing cows. Both of these programs, the one for purebred breeders and the one for commercial producers, are carried on in cooperation with the Extension Service. Anyone wishing more information relative to either of these programs should contact his county agent.