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REPRODUCTION DIFFICULTIES IN RANGE BEEF CATTLE

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Mortalities caused by reproduction difficulties result in heavy financial losses in the range cattle industry, and therefore data are needed on the amount and cause of different types of such deaths. This publication summarizes data on reproductive losses gathered from 22 years of observation of several experimental cattle herds exposed to different management methods. The study suggests probable causes of some losses, describes factors that may be involved in others, and discusses some which are unexplained.

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Reproduction Difficulties In Range Beef Cattle[1]

INTRODUCTION

For years many California stockmen have had excessive calf losses from unknown causes. This report discusses calf losses observed while engaged in other range cattle management studies, but it is the authors' hope that data presented here will encourage stockmen to study their reproduction losses more closely in order to help solve some of the problems involved.

During earlier studies of range cattle management at the U. S. Forest Service-maintained San Joaquin Experimental Range in Madera County, it was noted that a large percentage of calf losses were due to abortions and stillbirths not associated with dystocia (Wagnon, *et al.*, 1959).[2] The cows had not been tested for pregnancy and it is likely that some reported as "dry" had actually aborted. Very few aborted fetuses were found, but the majority of the stillbirths were; most of these appeared normal and apparently were dropped at term. A few were small or had deformities characteristic of acorn calves (Hart *et al.*, 1947). The foundation heifers were tested for Bang's disease and found negative, and no other reproduction diseases were found in the herds. Vitamin A deficiency was not found.

Similar losses were reported in neighboring commercial herds and occurred mostly during the dry-forage period. Most abortions occurred after midsummer, during the sixth or seventh month of gestation (these were called "dry feed" abortions by some stockmen).

Woodward and Clark (1959) reported a 3.6 per cent stillbirth loss (from 8,857 births) in Hereford cattle from 1936 to 1957 at the U. S. Range Livestock Experiment Station, Miles City, Montana. They were unable to discover any causative factor, but they noted that more males than females were stillborn, that live-born calves were heavier at birth, and that there was a significantly higher number of stillborn calves in the inbred populations. A significantly higher number of stillbirths were recorded in first calvings, and posterior presentations and twinning resulted in a higher-than-average number of stillbirths. Wiltbank *et al.* (1961), studying beef cattle in Virginia and Louisiana, found that total losses at calving time were larger than those reported by Woodward and Clark (1959). They reported that the largest losses in potential calf crops were the result of failure to conceive, early embryonic death, and death of calf at, or shortly after, birth. Donald (1963), studying perinatal deaths among calves in a crossbred dairy in Great Britain, found a 14.7 per cent loss in purebred heifers and 6.4 per cent in crossbred heifers; corresponding losses for older cows were 2.4 per cent and 3.6 per cent, respectively.

Our experiments with breeding herds at the San Joaquin Experimental Range were directed principally toward determining the effects of unimproved range and management practices upon the number of calves produced, weight of calves at weaning, and weight of breeding animals. The management practices studied were mainly (1) feeding cows on range forage alone *versus* supplemental feeding designed to compensate for seasonal nutritional deficiencies in natural forage; (2) heavy *versus* moderate and light stocking; (3) determining how much the breeding herd, originally of ordinary range quality, could be improved by the use of purebred bulls; and (4) rotational *versus* yearlong grazing (Bentley and Talbot, 1951; Wagnon *et al.*, 1959).

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[1] Submitted for publication January 19, 1965.

[2] See "Literature Cited" for publications referred to in text by author and date.

Ascribing different types of calf losses to positive causative factors was difficult as it was not known what normal losses would be under operating conditions set up in the experiments. Various types of such losses have been summarized here for each group of cattle studied, and in studies conducted after 1948 attempts were made to find causative factors responsible for reproduction losses.

PROCEDURE

The cows used were grade Herefords bred to purebred Hereford bulls from the University herd at Davis. Breeding commenced annually about December 28 and terminated May 1 with one bull used per pasture; to equalize differences in breeding effects, bulls were rotated annually between major breeding groups. Unless otherwise stated, cows were culled for poor health, poor conformation, or barrenness; all were culled after they were 10 years old. Calves were weaned about July 1 each year, and cull cows were removed and replacement heifers added.

The operational year was approximately July 1 to July 1 and consisted of dry-forage, winter, and green-forage periods. Dry-forage and winter periods were combined to form a "supplemental period" (about July 1 to February 1) during which most of the experimental groups received supplements on the range. The green-forage period was called the "grazing period" (about February 1 to July 1) and during it the cows subsisted entirely on natural forage. Seasonal variations in forage conditions resulted in some variation in the lengths of the two major periods. Unless otherwise stated, pasture stocking was at a moderate rate.

GENERAL SUPPLEMENTAL FEEDING

This consisted of 1 pound of cottonseed cake, pellets or meal (43 to 41 per cent protein), per cow daily from the start of the supplemental period until calving commenced (about October 1); protein supplement was then increased to 2 pounds per head daily. Following the first autumnal rainfall that initiated new forage growth, 1 pound of rolled barley per head daily was added to the ration. Occasionally, cottonseed pellets were replaced by linseed pellets, and rolled barley by ground milo. Some groups were self-fed by mixing the supplements with salt to regulate daily intake. During some droughty periods when there was a shortage of forage the above supplements were added to, or replaced with, alfalfa hay.

MANAGEMENT OF COWS

From 1936 to the close of the grazing period in 1948 the major studies involved two breeding herds, A and B. Herd A was hand-fed supplements, while herd B received no supplements except for one severe winter when a few deaths from malnutrition and exposure occurred. Replacement heifers for each herd originated within their respective herd. During supplemental periods the A herd was in pasture 11 in 1936 and 1937, pasture 13 from 1938 through 1941, and pasture 12 from 1942 through 1947. The B herd was in pasture 12 in 1936 and 1937, and in pasture 14 from 1938 through 1947. During the 1936–1948 grazing periods, cows in the two herds were divided equally among pastures 1 to 6, with each pasture grazed at a different intensity, varying from heavy to light use. The same cows were returned to the same pasture each year until culled or dead.

In 1941 a third breeding herd, C, was established to provide needed additional weaner calves. This herd, which was maintained year-around in one pasture and which received hand-fed supplements, was formed in July 1941 with cows culled from the A and B herds. The herd was in pasture 12 until July 1942, and then continuously in pasture 13 until the start of the 1948 grazing period, when it was moved to pasture 14. During this latter period a creep was provided for the calves

PASTURE ROUTINE, 1936–1958

Period	Herd	Routine
July, 1936 to July, 1948	A	Regular pasture rotation
July, 1936 to July, 1948	B*	Regular pasture rotation
July, 1941 to July, 1948	C	Year-around in one pasture
February, 1948 to July, 1957	F	Year-around in one pasture
July, 1948 to July, 1950	Provisional D	Changing routine
July, 1948 to July, 1950	Provisional E	Changing routine
July, 1950 to July, 1953	D	Regular pasture rotation; poor reproduction record
July, 1950 to July, 1953	E	Regular pasture rotation; good reproduction record
July, 1953 to July, 1958	Breeding Group I	Regular pasture rotation; contains D and E herd cows
July, 1953 to July, 1958	Breeding Group II	Regular pasture rotation; contains D and E herd cows; pastures fertilized with sulfur

* This herd did not receive supplements on the range.

and the self-feeder was charged with a mixture of 400 pounds rolled barley, 50 pounds beet pulp and 50 pounds cottonseed meal. Breeding in 1948 was by a purebred Angus bull until March 12, after which a Hereford bull was used for the remainder of the breeding season.

The studies of the A, B and C herds terminated at the close of the 1948 grazing period, and the herds were then disbanded. Major findings resulting from the use of these herds have been reported by Hutchison and Kotok (1942); Bentley and Talbot (1951); and Wagnon *et al.* (1959).

To further study possible ill-effects on reproduction from year-around grazing in one pasture, 12 dry cows were selected from the B herd on February 10, 1948. The cows were designated the F herd and placed in pasture 4 (fig. 1), where they remained continuously until the close of the 1957 grazing period. Supplements were hand-fed through the 1953 supplemental period and self-fed thereafter. Agricultural gypsum was used to regulate daily supplement intake in 1954 and through the 1955 dry-forage period until illness was encountered. The supplement was then mixed with salt (Wagnon, 1960). A calf creep, charged with the same feed mixture as for C herd calves, was placed in the pasture for the droughty 1949 grazing period.

After July 8, 1948, all cows in the A, B and C herds were placed in provisional D and E herds, and these two provisional groups were maintained through 1948–49 and 1949–50 only. Provisional D herd was in pasture 13 for the supplemental period, and in pasture 14 for the grazing period. The provisional E herd was in pasture 1 and pasture 2 for the first portion of the supplemental period, and in pasture 11 for the remainder of the period. This herd was in pasture 12 for all but about the last 6 weeks of the grazing period, when it was moved to pastures 1 and 2. Both herds were hand-fed supplements. Because 1949 was a poor forage year, the bred cows of both herds were moved to the University of California at

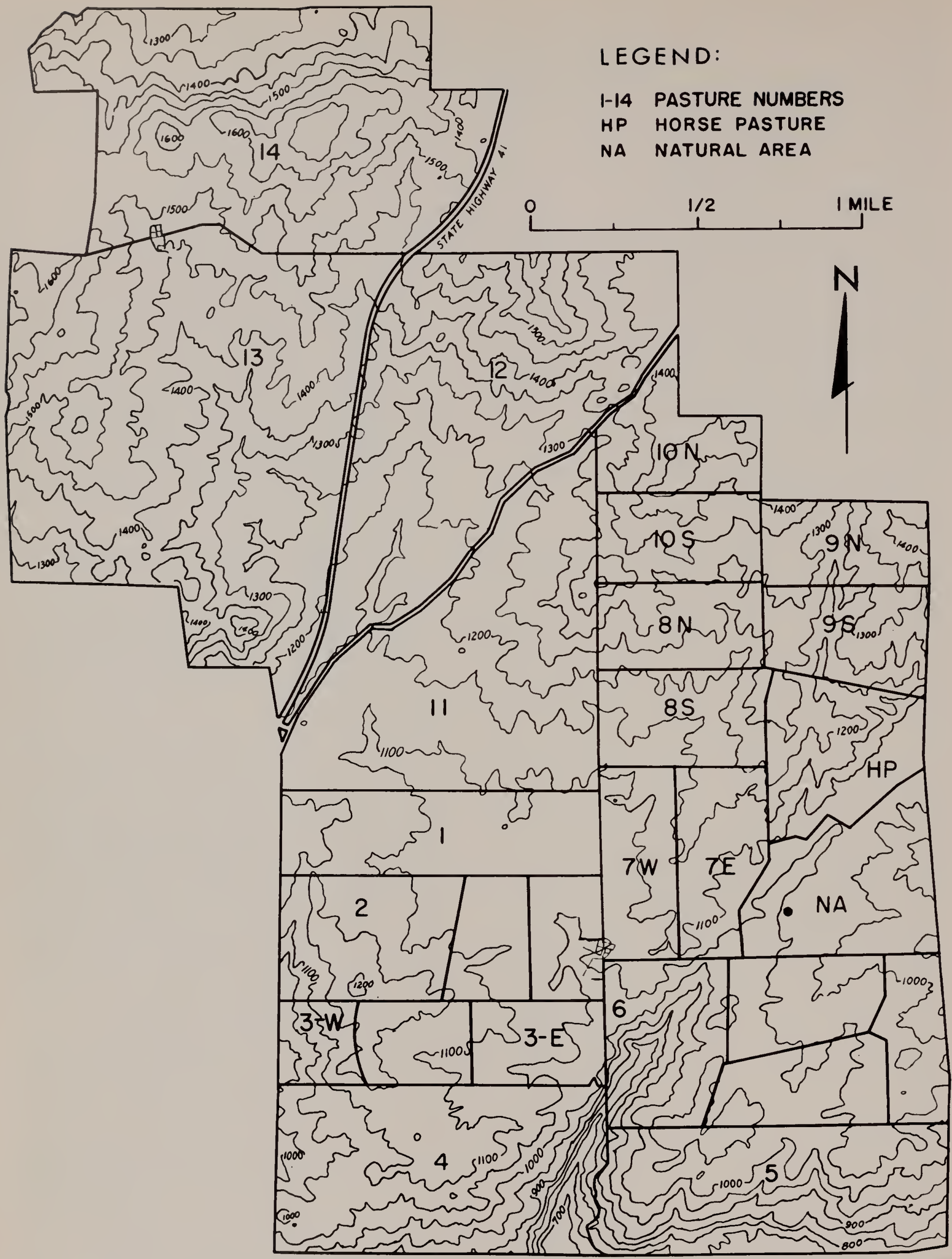


Fig. 1. Pasture diagram of the San Joaquin Experimental Range, 1948–1958.

Davis from July 7 to September 26, 1949. The first-bred heifers remained at the range.

Meanwhile, plans were being considered to remove brush and excess trees from pastures 1, 2, 11 and 12 and to treat the pastures with fertilization, rodent control and, possibly, reseeding. Pastures 1 and 2 contained large swale areas and were to be reserved until the last few weeks of the grazing period so that calves pastured in them would have green forage until nearer weaning. The herd in these pastures was to be culled for poor reproduction. Pastures 13 and 14 would be controls, and the pastures and their herd would be managed as in the past.

In the fall of 1951 enough pit gypsum was applied to pastures 1 and 2 to supply about 60 pounds of sulfur per acre; in the spring of 1952 soil sulfur was applied to pasture 11 at the rate of 60 pounds per acre; in the summer of 1953 pit gypsum, at the same rate as in pastures 1 and 2, was applied to pasture 12; and in 1954 pit gypsum was again applied to pastures 1 and 2.

After the cows were returned from Davis to the range those having a poor reproduction record, or descended from dams with a poor reproduction history, were placed in herd D and rotated between pastures 13 and 14. Cows with a good reproduction history were placed in herd E, which was rotated among pastures 1, 2, 11 and 12. These herds became officially operative in 1950–51 and were continued through 1952–53.

Cows in E herd losing a calf from abortion, stillbirth, or early death were culled or transferred to the D herd. Replacement heifers originated from their respective herds, but were reared together in other pastures until they were bred; they became replacements at the start of the supplemental period during which they would first calve. Supplements given to the D herd were self-fed, while those to the E herd were hand-fed. To determine if a copper deficiency could be demonstrated by a change in hair-coat color in late fall and winter, the D herd also received ½ gram of $CuSO_4$ per pound of supplement fed and 500 grams of $CuSO_4$ per 50 pounds of salt during the grazing period.

In mid-1953, following abandonment of the proposed improved practices demonstration, the D and E herds were randomly divided. Half of the D herd was placed with half of the E herd to form Breeding Group I and the other halves of the two herds were combined to form Breeding Group II. Both groups were maintained until mid-1958. Breeding Group I was rotated in pastures 13 and 14, and Breeding Group II was rotated in pastures 1, 2, 11 and 12. E herd cows losing a calf were not transferred to the D herd when culled. An Angus bull was also turned into pasture 14 at the start of each grazing period to see if pasture size and topography had been affecting per cent pregnancy when the services of just one bull were available. Replacement heifers continued to be selected and reared as previously described for the D and E herds. During the last 4 years of this 5-year period these heifers were used in a study of the effects of a high-protein diet on pregnant heifers; they became replacements after calving.

Because of insufficient water in pasture 13, Breeding Group I was hand-fed supplements; Breeding Group II was self-fed. Breeding Group I was given a minor-mineral mix to see if the reproduction rate and weaning weights of the calves in the pasture 13 and 14 routine could be improved. This mixture was fed at the rate of ½ pound per 50 pounds of salt and consisted of the following: $CaHPO_4$, 1014 grams; K_2HPO_4, 773 grams; $CaCO_3$, 686 grams; $MgSO_4$, 106 grams; Fe citrate, 58 grams; $MnSO_4$, 3 grams; KI, 1.7 grams; CaFe, 1 gram; $CuSO_4$, 0.6 grams; ZnO_2, 0.5 grams; and CoCl, 0.2 grams.

Heavy reproduction losses in first-calving heifers in parts of California led to a request for information on the effects of feeding a high-protein diet during late gestation. For 4 years, starting in 1954, bred replacement heifers were randomly divided at the start of the supplemental period. A control group was given the usual supplement diet, but protein supplement to the other group was gradually increased until 8 pounds of cottonseed pellets per head was fed daily. This rate was continued until each heifer had calved.

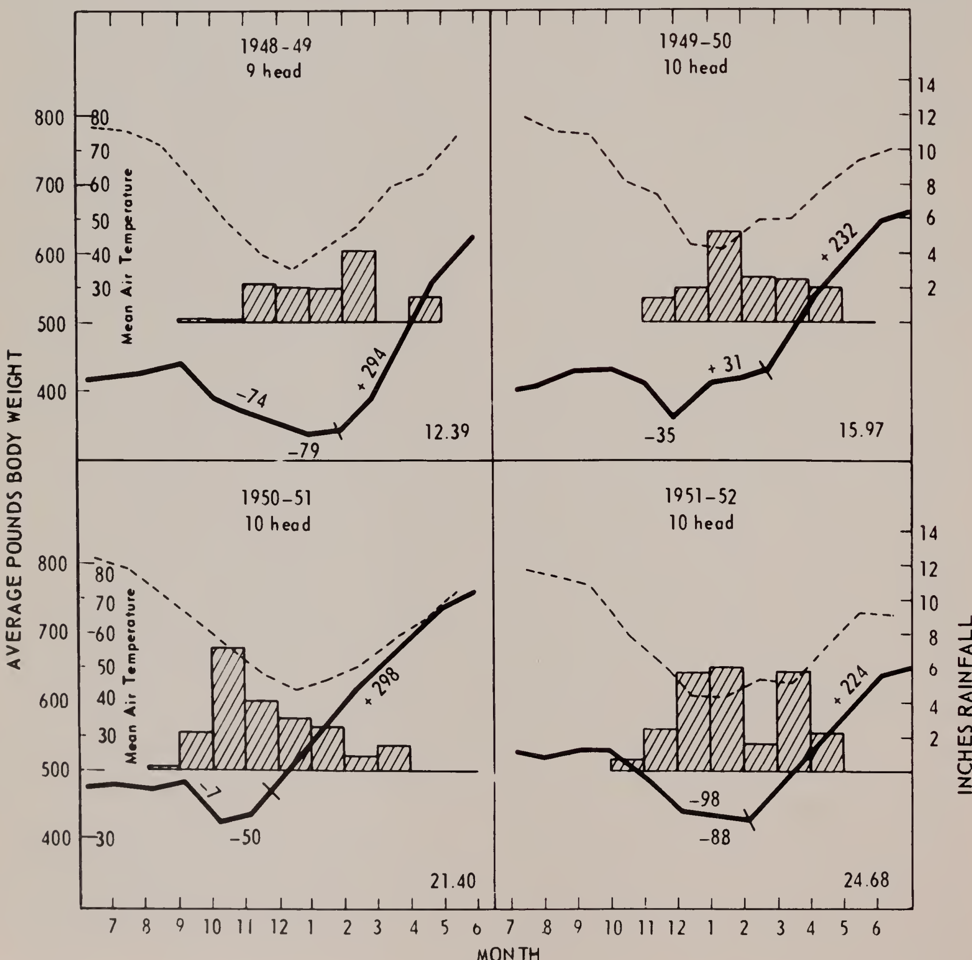
All weights (except for suckling calves) were taken after an all-night stand in a corral lot without food and water (Wagnon and Rollins, 1962). A detailed description of the experimental area is given by Hutchison and Kotok (1942).

EFFECTS FROM SEASONAL CHANGES IN CLIMATE

Variations in monthly distribution of rainfall, the amounts received, and the mean air temperatures have marked effects on seed germination, subsequent plant growth and per cent of the various species comprising the dominantly annual-type forage cover. Thus, these factors affect cattle subsisting on the forage (Bentley and Talbot, 1951; Wagnon *et al.*, 1959; Wagnon, 1963).

For six of the years 1948–58, annual rainfall was below the longtime average of 17 to 18 inches. In midwinter of each year mean monthly temperatures dropped below 50° F and retarded forage growth, the degree of retardation being dependent on the degree of cold.

Figure 2 below shows some possible effects of climatic fluctuations on cattle growth as indicated by variations in average weight losses and the gains of the unsupplemented weaner heifers for the annual supplemental and grazing periods. These weight changes were a reflection of the changing nutritive values of available forage and not its abundance (except in



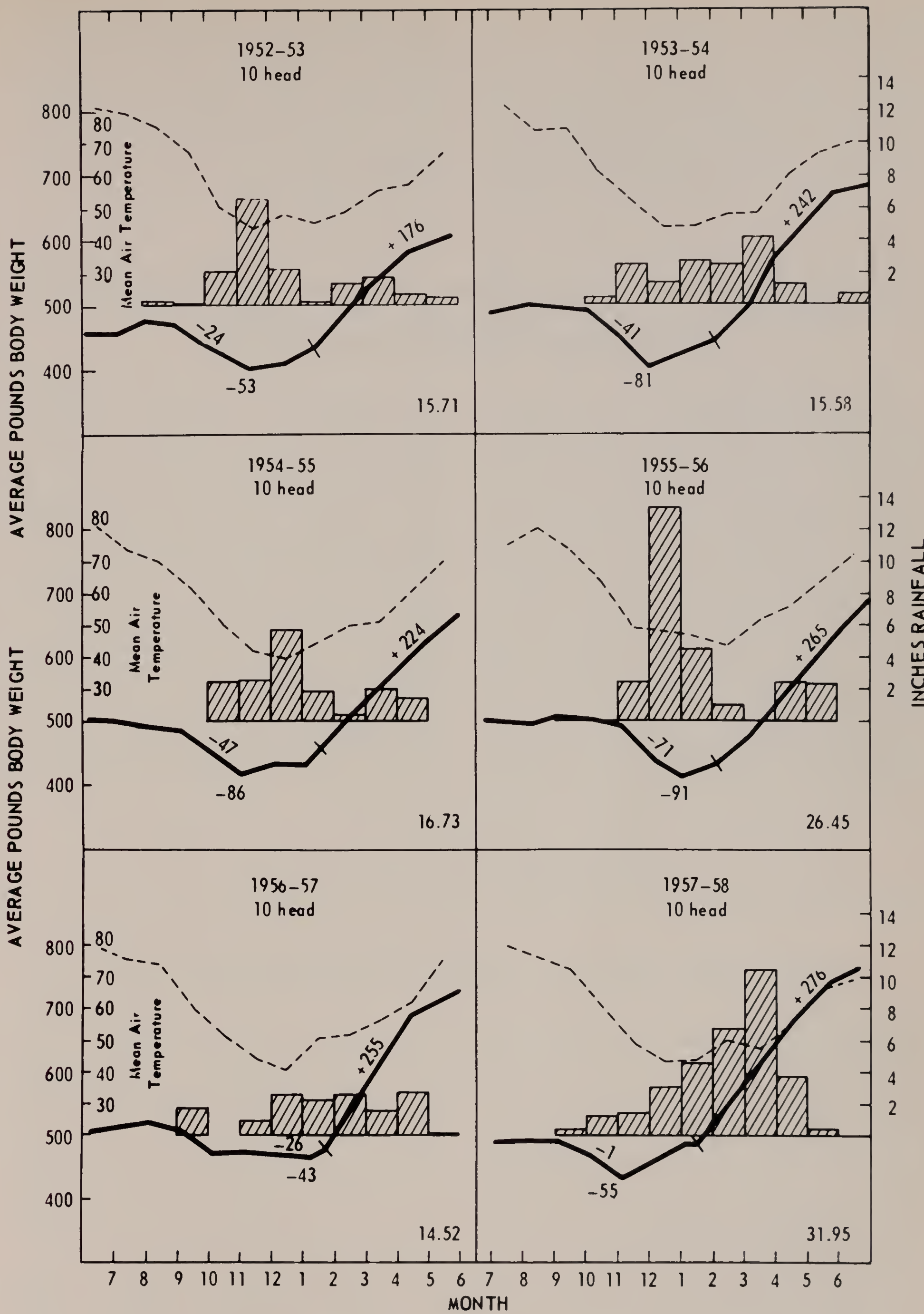


Fig. 2. Average weight curves (solid line) for unsupplemented weaner heifers with monthly rainfall totals (bars) and the monthly mean temperature (dotted line), 1948–1958. Total annual rainfall is given in the lower right corner of each graph. Average weight gains and losses for the supplemental and grazing periods are given above weight curves; maximum average weight loss during supplemental period only is given below the line.

midwinter), as a light stocking rate was used.

Although breeding cows used in this study received supplements calculated to meet their minimal nutritive requirements, it should be reemphasized that the breeding season commenced about January 1 when range forage conditions were often poorest. The study shows that natural conditions in these poor years did not adversely affect per cent pregnancy obtained. Thus, the supplemental feeding program was evidently fulfilling its objectives.

REPRODUCTION COMPARISONS OF SUPPLEMENTED AND UNSUPPLEMENTED COWS

Table 1 shows that supplemented herd A had a larger percentage of cows conceiving, and that they weaned more pounds of weaner calf per cow than did unsupplemented herd B or supplemented herd C cows. Since one-third of the cows in herds A and B had to close-graze during grazing periods, some decrease in conceptions could be expected. In the B herd, lack of supplemental feeding was the major cause of the marked reduction in conception rate. The 17.6 per cent of dry cows in herd C—a herd maintained year-around in one pasture at a moderate stocking rate—is excessive, and causative factors remain unknown. The greater age at weaning of the A herd calves indicates that their dams were able to conceive earlier than the cows of the other two herds, which had identical breeding seasons. Although weaning weights of calves from supplemented herds exceeded those of the unsupplemented herd, the actual difference noted between calves from the two supplemented herds was not expected; in fact, differences could be expected to be opposite from those actually obtained, because none of the C herd cows was subjected to close grazing.

It is possible that heredity might be in-

Table 1

REPRODUCTIVE DATA ON SUPPLEMENTED A AND C HERDS AND UNSUPPLEMENTED B HERD, 1936–1948

Item	1936–48		1941–48		
	A Herd	B Herd	A Herd	B Herd	C Herd
Total possible matings	448	456	267	270	148
Per cent cows dry	10.5	25.0	7.9	23.3	17.6
Per cent cows pregnant	89.5*a*‡	75.0*b*	92.1*a*	76.7*b*	82.4*b*
Calves weaned	367	302	225	179	100
Per cent calf crop	81.9*a*	66.2*b*	84.3*a*	66.3*b*	67.6*b*
Calves lost prior to weaning	37	41	22	29	22
Per cent calves lost	9.2	12.0	8.9*a*	14.0*a,b*	18.0*b*
Abortions	10	7	6	5	2
Stillbirths	14	11	8*a*	11*a*	14*b*
Per cent abortions and stillbirths	6.0	5.3	5.7*a*	7.7*a*	13.1*b*
Losses from dystocia	3	5	2	2	2
Losses due to death of dam	3	8	1	3	1
Losses from other causes*	7	10	5	8	3
Average calf weaning age (days)	238*c*§	228*d*	238*c*	227*d*	224*d*
Average calf weaning weight (lbs.)†	462*c*	407*d*	449*c*	394*a,d*	418*b,d*
Pounds weaner calf produced per cow	378	269	378	261	283

* Illness, accidents, etc.
† Adjusted to 240 days of age.
‡ Mean values in the same line and same time period but having different letters *a* or *b* differ significantly ($P < 0.05$).
§ Mean values in the same line and same time period but having different letters *c* or *d* differ significantly ($P <$ p.01).

volved in some of the abortions and stillbirths shown in table 1, because in some instances these losses occurred in several successive generations. Early calf deaths which were also observed could be related to losses from abortions and stillbirths; some of the early deaths occurred shortly after birth, while others occurred in a few weeks. In many instances the calves appeared to be of normal size and health prior to death.

As culling was based on poor conformation, poor health, barrenness, and age, and not on calf-loss or failure to conceive in one season, many of the losses encountered may be representative of a herd where poor production or reproduction failure of a cow were disregarded when selecting her daughters as replacements.

To study possible effects from culling cows that failed to wean a calf each year, an analysis was made of A and C herd data. From 1935 to 1947–48, 215 cows received supplements. They had 1,213 possible pregnancies (5.6 per cow) and weaned an 80.4 per cent calf crop. Sixty-eight cows (31.2 per cent) weaned a calf each possible pregnancy; they averaged 5.5 pregnancies per cow and weaned a 100.3 per cent calf crop (1 pair twins). Each of the remaining 147 cows failed to wean one or more possible calves; if failure to do so had been been the criterion for culling, these cows would have been culled after an average 2.7 possible pregnancies per cow. Per cent calf crop, including their first loss, was 64.0 (including 3 pair of twins). Of the 147 cows, 121 were retained for an additional average 3.6 possible pregnancies, and during this latter period they weaned a 78.2 per cent calf crop. Thus this group, which could have been culled for first failure to wean calves, produced a higher percentage calf crop after first-calving failure. Of total cows, 29 heifers failed to wean a calf following their first breeding. These animals were maintained in the herd through an average 5.3 possible pregnancies, and during this period they weaned only a 61.7 per cent calf crop.

The above summation is not indicative of results obtained when cows are culled for failure to wean a calf, and when replacements are from cows able to reproduce regularly under existing range conditions. It is quite possible that the excessive number of reproduction losses in the C herd were due to unknown environmental factors that could be corrected by proper managerial treatment.

YEAR-AROUND GRAZING IN ONE PASTURE

Observations of the F herd in pasture 4 year-around extended through nine calf crops (table 2), and failure to wean a calf was not a criterion for culling. The results show a higher average per cent pregnancy and calf crop, and higher average calf-weaning weight and age than had been obtained with A and C herds.

Pasture 4 contained a higher percentage of area having steeper southern exposures than did the other herd's pastures. Pasture 4 evidently was warmer in winter and grew more early forage than did other pastures; F herd cows and calves pastured there gained weight sooner and faster than did animals in other pastures.

The average reproduction efficiency of the F herd was higher than that of the A and C herds, but this was at least partly due to the marked decrease in per cent of dry cows (table 3). Average F herd calf losses after conception were similar to those of the A herd (table 1) and losses from abortion, stillbirths and early deaths were lower than those of the C herd.

These results indicate that year-around grazing in one pasture is not necessarily the cause of slower rebreeding, lower conception, higher reproduction losses, and lighter calf-weaning weights. Further, data show that increased production may be obtained by making better use of favorable natural features, such as those which existed in pasture 4.

TABLE 2

WEIGHT CHANGES, SUPPLEMENTATION DATA, AND WEANER CALF PRODUCTION OF THE F HERD, YEAR-AROUND GRAZING IN ONE FIELD, 1948–1957

Item	1948 to 1949	1949 to 1950	1950 to 1951	1951 to 1952	1952 to 1953	1953 to 1954	1954 to 1955	1955 to 1956	1956 to 1957	1948 to 1957
Number of cows*	12	10	11	10	11	12	11	11	9	97
Start supplemental period, average weight (lbs.)	1,061	958	1,076	1,111	1,155	1,089	1,116	1,139	1,095	1.090
End supplemental period, average weight (lbs.)	841	907	978	873	999	997	908	894	954	928
Average weight loss (lbs.)	220	51	98	238	156	92	208	245	41	162
Length supplemental period (days)	232	233	175	224	196	199	220	196	228	211
End grazing period, average weight (lbs.)	944	1,099	1,157	1,107	1,100	1,096	1,139	1,118	1,138	1,104
Average weight gain (lbs.)	103	192	179	234	101	99	231	224	184	176
Average weight gain or loss for year (lbs.)†	−117	+141	+81	−4	−55	+7	+23	−21	+43	+14
Per cent cows pregnant‡	100.0	90.0	100.0	90.9	100.0	100.0	92.3	100.0	100.0	97.1
Retained placentas	2	1	0	3	1	3	1	0	3	14
Per cent calf crop	83.3	70.0	100.0	63.6	91.7	100.0	84.6	91.7	91.7	86.7
Average weaning age calves (days)	244	219	243	260	231	239	246	244	252	242
Average weaning weight calves (lbs.)	480	456	545	522	513	498	524	530	498	507
Average pounds calf produced per cow	400	319	545	332	470	498	443	486	457	440
Average total supplements per cow (lbs.)	569	548	322	495	375	599	456	429	531	...
Linseed pellets (lbs.)	464	548	322	168	...	...	...	...	...	...
Cottonseed pellets (lbs.)	45	...	...	297	338	260	...	...	...	...
Cottonseed meal (lbs.)	...	...	...	...	...	...	400	400	406	...
Rolled barley (lbs.)	60	...	...	30	37	41	56	29	125	...
Gypsum (lbs.)	...	...	...	...	...	...	205	143	...	...
Hay salt (lbs.)	...	...	...	...	...	...	...	61	213	...
Alfalfa hay (lbs.)	...	...	...	...	...	298	...	...	...	...

* Weight data based on cows present at all three annual weighings.
† Periods extended from weaning to weaning, which was usually first week in July. Thus, each period was about 12 months.
‡ Reproduction data based on all cows—a total of 105 for the 9-year period.

Table 3
REPRODUCTIVE DATA FOR D, E, AND F HERDS IN A PASTURE-ROTATION SYSTEM, 1950–1957*

Item	D Herd	E Herd	F Herd
	1950–53	1950–53	1948–57
Total cows possibly bred	171	122	105
Per cent cows dry	18.7	2.5	2.9
Per cent cows pregnant	81.3	97.5	97.1
Total calves weaned	130	108	91
Per cent calf crop	76.5‡	88.5‡	86.7
Total calves lost prior to weaning	11	12	11
Per cent calves lost	7.9	10.1	10.8
Abortions	1	3	1
Stillbirths	3	3	4
Early deaths	1	0	2
Per cent abortions, stillbirths, and early deaths	3.6	5.0	6.9
Losses from dystocia	1	2	1
Losses due to death of dam	1	4	1
Losses from other causes†	4	0	2
Average calf weaning age (days)	238	245	242
Average calf weaning weight (lbs.)	454	504	509
Average pounds weaner calf produced per cow	347	446	441

* F herd year-around in one pasture.
† Illness, accidents etc.
‡ Difference of these means significant ($P < .05$).

EFFECTS OF CULLING ON REPRODUCTION LOSSES, 1950–1958

The D herd cows having poor reproduction histories (their own or their dams), and cows with a good reproduction history (herd E), provided data on the effects of culling for reproduction failure (table 3). From 1950–51 through 1952–53, D and E herds were in a separate pasture-rotation system, with pastures of the E herd providing more nutritious forage for about 6 weeks prior to calf weaning than did those of herd D. In addition, some E herd pastures had been improved with sulfur fertilization (Bentley *et al.*, 1958; Wagnon *et al.*, 1958; Green *et al.*, 1958). These advantages were expected to produce heavier cows, heavier calf-weaning weights, and greater carrying capacities for the pastures. Table 4 gives data on supplements fed, seasonal weight changes of the cows, and calf weaning.

The average reproduction efficiency of herd E was higher than that of herd D, but this was due to a significant difference in per cent of dry cows—that of herd E being the lowest obtained in these studies and that of herd D the highest. Calf losses following conception were highest for herd E, but not significantly so, with these losses in both herds similar to those previously reported for A and F herds. The excessive per cent of dry cows in herd D was close to that previously found in herd C, and causative factors remained unknown.

Breeding D and E herd replacement heifers, and some of the E herd cows, for the 1951–52 calf crop involved the use of a bull apparently responsible for a more-than-average number of breech presentations. Three cows died from this cause, with a calf lost from dystocia in herd D. In 1952–53 two dystocia losses and two stillbirths were from breedings to this bull.

It would seem logical for Herd E to

TABLE 4

WEIGHT CHANGES, SUPPLEMENTATION DATA, AND WEANER CALF PRODUCTION FOR D AND E HERDS, 1950–1953

Item	D Herd‡				E Herd			
	1950 to 1951	1951 to 1952	1952 to 1953	1950 to 1953	1950 to 1951	1951 to 1952	1952 to 1953	1950 to 1953
Total number cows*	56	60	54	170	38	39	45	122
Average weight start supplemental period (lbs.)	1,087	1,083	1,038	1,070	1,076	1,142	1,077	1,097
Average weight end supplemental period (lbs.)	945	835	872	883	984	859	918	921
Average weight loss (lbs.)	142	248	166	187	92	283	159	176
Average weight end grazing period (lbs.)	1,109	1,045	1,066	1,073	1,164	1,118	1,091	1,123
Average weight gain (lbs.)	164	210	194	190	180	259	173	202
Average weight gain or loss for entire year (lbs.)	+22	−38	+28	+3	+88	−24	+14	+26
Per cent cows pregnant	85.7	86.7	70.4	81.2	97.4	97.4	97.8	97.5
Retained placentas	0	8	5	13	0	6	6	12
Per cent calf crop	76.8	83.3	68.5	76.5	97.4	84.6	84.4	88.5
Average weaning age calves (days)	247	236§	231	238§	239	252	245	245
Average weaning weight calves (lbs.)	491	432§	440	454§	511	503	497	504
Average pounds calf produced per cow	377	360	301	347	498	425	420	446
Length of supplemental period (days)	181	223	205	203	168	224	199	197
Total supplements fed per cow (lbs.)	262	405	316	...	263	459	365	...
Cottonseed pellets (lbs.)	...	...	...	...	214	345	331	...
Cottonseed meal (lbs.)	228	312	277	...	...	...	...	...
Rolled barley (lbs.)	34	93	39	...	49	114	34	...
Alfalfa hay (lbs.)	...	...	...	...	...	...	...	...
Hay salt (lbs.)†	106	161	135	...	...	...	...	...

* Total number cows used for reproduction data. Weight data based on number of cows present at all three weighings annually; total numbers slightly less than indicated here.
† Hay salt used to regulate feed intake in self-feeding supplements.
‡ D herd received $CuSO_4$ for suspected copper deficiency.
§ A calf from a cow that died prior to calf weaning not included.

have heavier calf-weaning weights and a higher per cent pregnancy and calf crop than herd D because of better pasture conditions. However, Herd E data for these three items were actually little different from those obtained for the F herd (table 3), in which failure to wean a calf was not a criterion for culling.

REVERSING PASTURE ROTATION ROUTINES

In 1953, Breeding Group I was put in the former D herd's pasture-rotation system, and Breeding Group II in the former E herd's system. All of Group II's pastures were sulfur fertilized, and because of resultant increased forage production it was possible to increase the number of cows to approximately that held in pastures 13 and 14. Table 5 gives data on supplements fed, seasonal weight changes of the cows, and weaner calf production. Calf production of E herd cows placed in the former D herd pasture routine dropped markedly as compared with production of cows remaining in their former pasture routine, while D herd cows placed in the former E herd pasture routine showed a marked improvement in calf production over those remaining in their former pasture routine.

Data in table 6 do not show significant differences in average per cent of dry cows and average per cent of calf losses from combined abortions, stillbirths, and early deaths, and from combined dystocia, death of dam, and other causes between the D and E herds within Breeding Groups I and II. In most instances however, herd E losses were lowest.

The per cent of dry cows in Breeding Group I was substantially lower than that previuosly obtained in herd D (table 3) or in the C herd (table 1) formerly in pasture 13. Just how effective the addition of a second bull was in increasing the conception rate is questionable, as only seven of the 225 Breeding Group I cows calving had been bred by an Angus bull.

EFFECTS OF HIGH PROTEIN DIET ON FIRST-CALVING HEIFERS

Heifers receiving the high-protein diet gained an average of 77 pounds more than did controls during the pre-calving period. Since calving usually continued into November, the actual spread in weight gain exceeds that shown in table 7. Average birth weights of calves from the two groups of heifers were almost identical, and differences in calf losses were not significant even though losses were somewhat higher for the control group. Thus, this study did not show that there were greater calf losses due to feeding an excessively high-protein diet through late gestation.

The weaning weight of the calves from heifers fed the high-protein diet averaged 12 pounds less than that of the control group calves, but the difference was not significant after adjustments for differences in sex and age had been made. Thus, there was no evidence that the high-protein-fed heifers milked less than did the controls.

EFFECTS OF CHANGED ROUTINE AND ENVIRONMENT

When range cattle are moved from a familiar environment or a well-established routine they often fare worse until they adjust to the new surroundings, and if the two environments are markedly different the animals may never fare equally well in both. This may be due to different climates, strange pastures or forage, different associates, change in social status, disease, parasites, or a combination of these factors.

Cows moved from a group having a long-established routine to a different group and routine within the same ranching unit sometimes walk the pasture fence for several days in an apparent attempt to return to their former home. Newly moved animals are sometimes so afraid of the strange cattle that they do not eat normally until placed with a more compatible group. Replacement heifers reared as a single-aged group until placed in a mixed-aged breeding herd did not get their share of range supplements under some management systems because the older cows butted them away from the feed troughs (Wagnon, 1965). In some instances this resulted in excessive weight losses, lighter weaning-weight of their calves, and, possibly, slowness or failure of the animals to rebreed that season.

Because the causes of excessive reproduction losses were unknown, possible effects from changing routine were examined in herds C, provisional herds D and E, F herd, and Breeding Groups I and II (see also Farnsworth, 1962). In the second year of the C herd it received

TABLE 5

WEIGHT CHANGES, SUPPLEMENTATION DATA, AND WEANER CALF PRODUCTION FOR BREEDING GROUPS I AND II, 1953–1958 (herd E culled for poor reproducers)

Item	Group I											
	1953–54		1954–55		1955–56		1956–57		1957–58		1953–58	
	D	E	D	E	D	E	D	E	D	E	D	E
Total number cows*	29	23	31	19	28	23	27	22	23	24	138	111
Average weight start of supplement period (lbs.)	1,010	1,035	1,046	999	1,020	998	1,047	997	1,062	1,062	1,034	1,021
Average weight end of supplement period (lbs.)	913	873	880	862	905	873	937	880	991	958	919	890
Average weight loss (lbs.)	97	162	166	137	115	125	110	117	71	104	115	131
Average weight end of grazing period (lbs.)	1,044	1,002	1,019	1,050	1,045	1,052	1,097	1,077	1,177	1,092	1,066	1,052
Average weight gain (lbs.)	131	129	139	188	140	179	160	197	186	134	147	162
Average weight gain or loss entire year (lbs.)	+34	−33	−27	+51	+25	+54	+50	+80	+115	+30	+32	+31
Per cent cows pregnant	89.7	100.0	100.0	94.7	85.7	87.0	88.9	90.9	78.3	95.8	89.1	93.7
Retained placentas	4	0	5	2	0	0	7	5	1	2	17	9
Per cent calf crop	72.4	91.3	87.1	73.7	85.7	69.6	77.8	81.8	73.9	100.0	79.7	83.8
Average weaning age of calves (days)	238	251	238	246	241	249	228	253	221	224	234	243
Average weaning weight of calves (lbs.)	442	432	439	438	433	429	455	491	444	477	442	455
Average pounds calf produced per cow	320	395	382	323	371	299	354	402	328	477	352	381
Length supplement period (days)	211		223		195		228		189		209	
Total supplement fed per cow (lbs.)†	564		679		267		777		341		...	
Cottonseed pellets (lbs.)	228		240		244		212		329		...	
Cottonseed meal (lbs.)	...		...		...		...		...		...	
Rolled barley (lbs.)	41		40		23		49		12		...	
Alfalfa hay (lbs.)	295		399		...		516		...		...	
Hay salt (lbs.)	...		...		...		...		...		...	

	Group II											
Total number cows*	26	21	26	26	28	26	28	24	24	29	132	126
Average weight start of supplement period (lbs.)	1,070	1,057	1,149	1,096	1,183	1,150	1,135	1,134	1,118	1,108	1,130	1,111
Average weight end of supplement period (lbs.)	989	930	973	925	929	918	958	967	969	983	964	944
Average weight loss (lbs.)	81	127	176	171	254	232	177	167	149	125	166	167
Average weight end of grazing period (lbs.)	1,155	1,099	1,182	1,137	1,176	1,173	1,115	1,134	1,113	1,129	1,149	1,136
Average weight gain (lbs.)	166	169	209	212	247	255	157	167	144	146	185	192
Average weight gain or loss entire year (lbs.)	+85	+42	+33	+41	−7	+23	+20	0	−5	+21	+19	+25
Per cent cows pregnant	92.3	100.0	96.2	100.0	96.4	96.2	96.4	91.7	95.8	96.6	95.5	96.8
Retained placentas	2	1	0	0	1	0	0	0	1	5	4	6
Per cent calf crop	84.6	100.0	92.3	96.2	92.9	88.5	85.7	87.5	87.5	86.2	88.6	91.3
Average weaning age of calves (days)	231	254	237	250	246	244	236	236	215	222	230	241
Average weaning weight of calves (lbs.)	491	523	515	517	518	502	488	476	471	468	489	497
Average pound calf produced per cow	415	523	475	497	481	444	418	417	412	403	433	454
Length supplement period (days)	209		224		196		227		191		209	
Total supplement fed per cow (lbs.)†	603		634		237		518		333		...	
Cottonseed pellets (lbs.)	...		...		...		...		...		...	
Cottonseed meal (lbs.)	272		271		212		406		322		...	
Rolled barley (lbs.)	41		11		25		112		11		...	
Alfalfa hay (lbs.)	290		352		...		...		...		...	
Hay salt (lbs.)	131		133		119		206		139		...	

* Reproduction data based on numbers given here. Weight data based on animals present at all three weighings annually, consequently numbers slightly lower.
† Breeding Group I received a minor-mineral mix fed in their salt during this period.

TABLE 6

REPRODUCTION DATA FOR BREEDING GROUPS I AND II, 1953–58

(D herd cows not culled for failure to wean a calf)

Item	Group I											
	1953–54		1954–55		1955–56		1956–57		1957–58		1953–58	
	D	E	D	E	D	E	D	E	D	E	D	E
Cows possibly bred	29	23	31	19	28	23	27	22	23	24	138	111
Per cent cows dry	10.3	0	0	5.3	14.3	13.0	11.1	9.1	21.7	4.2	10.9	6.3
Per cent cows pregnant	89.7	100.0	100.0	94.7	85.7	87.0	88.9	90.9	78.3	95.8	89.1	93.7
Calves weaned	21	21	27	14	24	16	21	18	17‡	24‡	110	93
Per cent calf crop	72.4	91.3	87.1	73.7	85.7	69.6	77.8	81.8	73.9	100.0	79.7	83.8
Calves lost prior to weaning	5	2	4	4	1†	4	3	2	2	0	15	12
Per cent calves lost prior to weaning	19.2	8.7	12.9	22.2	7.1	20.0	12.5	10.0	11.1	0	12.2	11.5
Abortions	1	0	0	1	0	0	0	0	0	0	1	1
Stillbirths	2	0	0	2	1†	1	0	1	2	0	5	4
Early deaths	2	1	0	0	0	1	0	0	0	0	2	2
Per cent abortions, stillbirths, and early deaths	19.2	4.3	0	16.7	4.2	10.0	0	5.0	11.1	0	6.5	6.7
Losses from dystocia	0	0	1	0	0	1	1	0	0	0	2	1
Losses due to death of dam	0	0	0	0	0	0	2	0	0	0	2	0
Losses from other causes	0	1	3*	1*	0	1	0	1	0	0	3	4
Average calf weaning age (days)	238	251	238	246	241	249	228	253	221	224	233	245
Average calf weaining weight (lbs.)	442	432	439	438	433	429	455	491	444	477	443	453
Pounds weaner calf produced per cow	320	395	382	323	371	299	354	402	328	477	353	380

	Group II											
Cows possibly bred	26	21	26	26	28	26	28	24	24	29	132	126
Per cent cows dry	7.7	0	3.8	0	3.6	3.8	3.6	8.3	4.2	3.4	4.5	3.2
Per cent cows pregnant	92.3	100.0	96.2	100.0	96.4	96.2	96.4	91.7	95.8	96.6	95.5	96.8
Calves weaned	22	21	24	25	26	23	24	21	21	25	117	115
Per cent calf crop	84.6	100.0	92.3	96.2	92.9	88.5	85.7	87.5	87.5	86.2	88.6	91.3
Calves lost prior to weaning	2	0	1	2†	1	2	4†	1	2	4¶	10	9
Per cent calves lost prior to weaning	8.3	0	4.0	7.7	3.7	8.0	14.8	4.5	8.7	14.3	7.9	7.4
Abortions	1	0	0	0	0	0	0	0	0	0	1	0
Stillbirths	1	0	0	2†	1	1	3†	1	1	2	6	6
Early deaths	0	0	1	0	0	0	1	0	0	0	2	0
Per cent abortions, stillbirths, and early deaths	8.3	0	4.0	7.7	3.8	4.3	14.8	4.5	4.3	7.1	7.1	4.9
Losses from dystocia	0	0	0	0	0	1	0	0	0	0	0	1
Losses due to death of dam	0	0	0	0	0	0	0	0	1	1	1	1
Losses from other causes	0	0	0	0	0	0	0	0	0	1¶	0	1
Average calf weaning age (days)	231	254	237§	250	246	244	236	236	215	222	233	241
Average calf weaning weight (lbs.)	491	523	515§	517	518	502	488	476	471	468	497	497
Pounds weaner calf produced per cow	415	523	475	497	481	444	418	417	412	403	440	454

* Calves died about same time.
† One stillbirth in pair twins; cow not culled for this.
‡ Includes one pair of twins.
§ Does not include a steer bitten by a rattlesnake, nor a sick heifer.
¶ One of two twins.

Table 7

REPRODUCTION DATA FOR FIRST-CALVING GROUP I HEIFERS SUPPLEMENTED IN USUAL MANNER, AND SIMILAR GROUP II HEIFERS SUPPLEMENTED WITH A HIGH-PROTEIN DIET PRIOR TO CALVING, 1954–1958

Item	1954–55		1955–56		1956–57		1957–58		1954–58	
	I	II	I	II	I	II	I	II	I	II
Number of heifers	9	10	9	9	10	10	10	10	38	39
Average intial weight (lbs.)	1,108	1,065	1,006	1,018	1,011	1,000	989	1,003	1,027	1,022
Average pre-calving weight (lbs.)	1,130	1,195	1,095	1,172	1,057	1,115	1,035	1,121	1,078	1,150
Average weight gain (lbs.)	22	130	89	154	46	154	46	118	51	128
Number calves weaned	9	10	7†	8†	8	10	7‡	8	31‡	36
Average calf birth weight (lbs.)*	68	70	73	76	72	68	65	70	70	71
Average calf weaning weight (lbs.)*	500	475	476	481	510	474	449	435	479	467
Calves lost	0	0	2	1	2	0	2	2	6	3
Abortions	0	0	0	0	0	0	0	0	0	0
Stillbirths	0	0	1	1	0	0	1	0	2	1
Early deaths	0	0	1	0	1	0	0	0	2	0
Per cent abortions, stillbirths and early deaths	0	0	22.2	11.1	10.0	0	11.1	0	10.8	2.6
Losses from dystocia	0	0	0	0	1	0	1	2	2	2
Losses due to death of dam	0	0	0	0	0	0	0	0	0	0
Losses from other causes	0	0	0	0	0	0	0	0	0	0

* Based on original weight data.
† One death from dystocia in each group.
‡ One heifer in this group failed to conceive.

additions of pregnant A and B herd cows which had become well accustomed to an established routine. It should also be noted that cows from the unsupplemented B herd received better treatment after entering the supplemented C herd.

Table 1 shows that the C herd had an average 17.6 per cent of dry cows, 13.1 per cent of abortions and stillbirths, and that its cows were slow in rebreeding. Abortions and stillbirths in this herd were rather uniformly distributed over the 7-

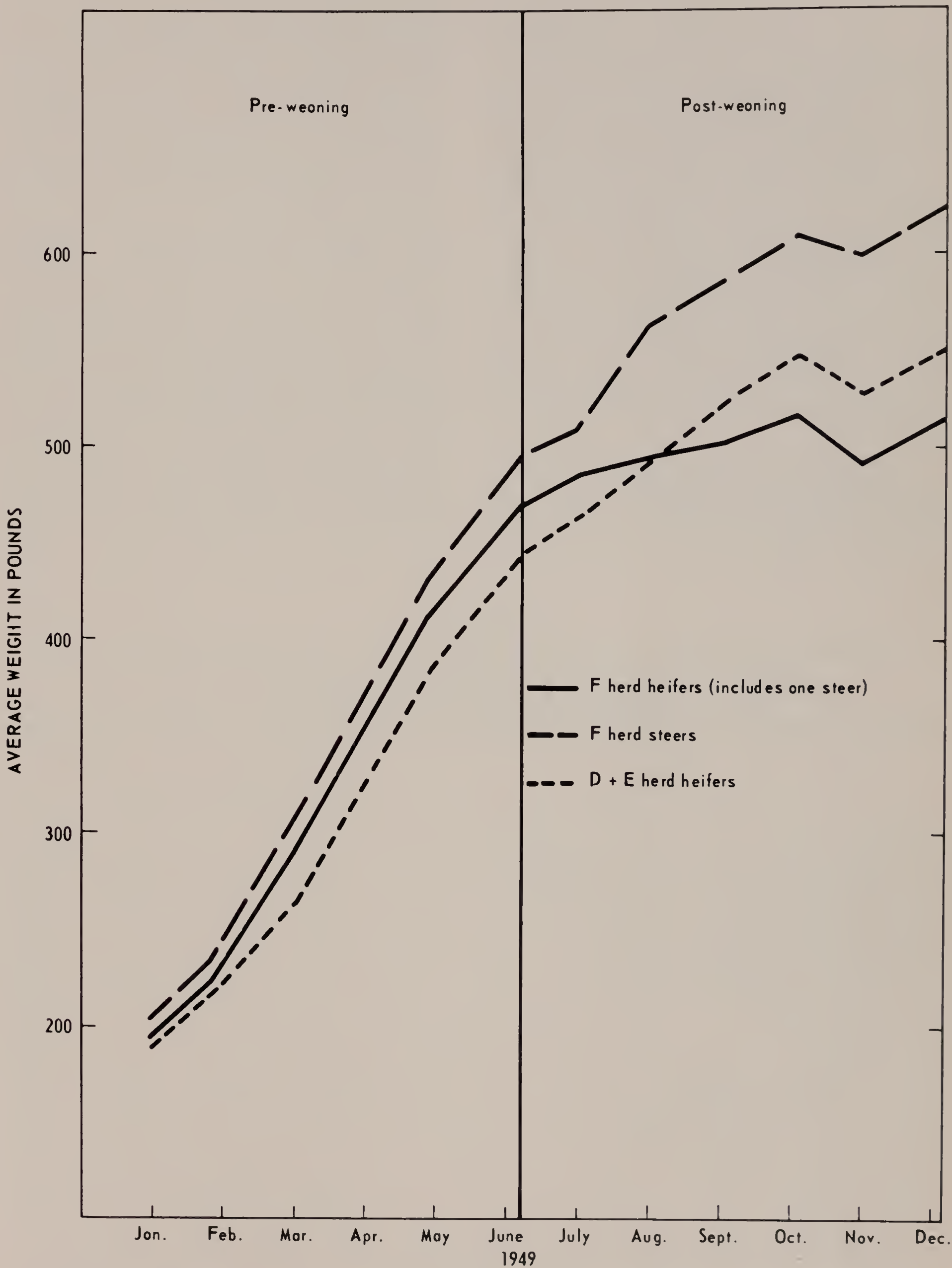


Fig. 3. Average weight curves of F herd calves, and D and E herd heifers, showing decreased growth after weaning.

year period, while a large number of dry cows and a marked retardation in rebreeding was noted during the fifth and sixth years after the cows had become well-accustomed to their routine. Thus, these reproduction losses do not appear to be the result of changing routine.

In the F herd, formed with 12 dry B herd cows in the middle of the 1948 breeding season, most of the cows had conceived just prior to their change of routine. The high average production of this herd is shown in tables 2 and 3; however, these cows showed an average weight loss of 220 pounds during their first supplemental period in the new environment, and completed the 1948–49 period weighing an average 117 pounds less than at the start. Their first rebreeding in this pasture was markedly below that of subsequent years, as shown by the average 219 days calf weaning age for 1949–50.

During studies of the A, B and C herds an occasional calf apparently grew normally through the suckling period but after weaning would not gain weight as did similarly treated calves. Some of these calves went into a slow decline and died from what was subsequently termed "decline disease." These calves were not identified prior to weaning; they occurred in all three herds, but appeared more frequently in the early years of the C herd. Six (5 heifers and 1 steer) of the 10 calves weaned in the first calf crop (1948–49) of the F herd were found to be afflicted with decline (fig. 3), but retardation was mild and the calves apparently performed normally after the onset of winter. Causes of the condition remained unknown.

In 1948–49, provisional D herd (formed with 2 A herd cows, 24 C herd cows and 23 bred replacement heifers) was rotated between pastures 13 and 14, and 49 per cent of the herd continued to be supplemented in a pasture in which they were formerly maintained year around. At the same time, provisional E herd (formed with 26 A herd and 18 B herd cows) was rotated

TABLE 8

WEIGHT CHANGES, SUPPLEMENTATION DATA, AND WEANER-CALF PRODUCTION FOR PROVISIONAL D AND E HERDS, 1948–50 TRANSITIONAL PERIOD

Item	1948–49		1949–50	
	D Herd	E Herd	D Herd	E Herd
Total number cows	49	44	54	37
Start of supplemental period, average weight (lbs.)*	1,039	1,032	1,007	1,036
End of supplemental period, average weight (lbs.)	918	929	947	910
Average weight loss (lbs.)	121	103	60	126
End of grazing period, average weight (lbs.)	993	1,095	1,119	1,099
Average weight gain (lbs.)	75	166	172	189
Average weight gain or loss for year (lbs.)	−46	+63	+112	+63
Per cent cows pregnant	100.0	70.5	94.4	94.6
Retained placentas	8	2	5	6
Per cent calf crop	79.6	59.1	63.0	75.7
Average calf-weaning age (days)	241	229	240	247
Average calf-weaning weight (lbs.)	391	430	483	492
Average pounds of weaner calf produced per cow	311	254	304	372
Length of supplemental period (days)	230	232	229‡	231‡
Total supplements fed per cow:				
Cottonseed pellets (lbs.)	251	270	84	84
Rolled barley (lbs.)	55	58	..	..
Alfalfa hay (lbs.)	1,050†	1,103†	1,022§	670§

* Weight data based on cows present at all three weighings annually.
† Poor quality hay due to rain damage.
‡ Cows on pasture at Davis the first 84 days (includes travel).
§ Used as supplement after 11/10/49 because of shortage of range forage.

between pastures 1, 2, 11 and 12, and the pasture routine was new except for the fact A herd was formerly in pasture 12 for its supplemental period. Table 8 gives supplementation, seasonal weight changes of the cows, and weaner calf production during this time; table 9 gives reproduction data. As the cows had been bred prior to being placed in these provisional herds, the marked difference in per cent of dry cows in 1948–49 is happenstance. The high average calf-weaning ages in 1949–50 show that the cows rebred early. The data show a marked increase in calf losses from abortions, stillbirths and early deaths in both herds, but losses from dystocia, death of dam, and other causes were low.

In 1949–50, 77 head of provisional D and E herd cows were moved to Davis, California, on July 11 and returned to the range on September 26. At Davis the cows were placed on barley stubble until August 1, when they were moved to Sudan grass pasture. One cow aborted on August 8, four on August 13, three on August 14, and one on September 9; the cause was not determined and all cows were found negative to the *Brucella abortus* agglutation test. There had been reports of heavy abortion losses from disease in some herds that had been moved into adjacent foothills for the first time; later this disease was diagnosed as epizootic bovine abortion (Howarth *et al.*, 1956), and it became known as "foothill abortion."

When provisional D and E herd cows were returned to the range just prior to the start of their regular calving period, 17 head of provisional D herd cows were transferred to the new E herd; the remainder were kept in the new D herd. At the same time, 17 provisional E herd cows were transferred to the new D herd and the others remained in the new E herd. These new herds did not become operative until mid-1950 after they had dropped the calves they were carrying and had been rebred. Table 9 shows that there were more losses from stillbirths and early deaths.

If there were effects from changing routine in late 1949 at the establishment of the new D and E herds, they are shown in the 1949–50 data (tables 8 and 9),

Table 9

REPRODUCTION DATA FOR PROVISIONAL D AND E HERDS, 1948–50 TRANSITIONAL PERIOD

Item	1948–49		1949–50	
	D Herd	E Herd	D Herd	E Herd
Cows possibly bred	49	44	54	37
Per cent cows dry	0	29.5	5.6	5.4
Per cent cows pregnant	100.0	70.5	94.4	94.6
Calves weaned	39	26	34	28
Per cent calf crop	79.6	59.1	63.0	75.7
Calves lost prior weaning	10	5	17	7†
Per cent calves lost	20.4	16.1	33.3	20.0
Abortions	2	1	9*	4*
Stillbirths	5	2	5	0
Early deaths	1	2	1	2
Per cent abortions, stillbirths and early deaths	16.3	16.1	29.4	17.1
Losses from dystocia	0	0	0	2†
Losses from death of dam	1	0	1	0
Losses from other causes	1	0	1	0
Average calf weaning age (days)	241	229	240	247
Average calf weaning weight (lbs.)	391	430	483	492
Average pounds weaner calf produced per cow	311	254	304	372

* Of nine cows aborting at Davis, three were not identified by individual number. Two were assigned to D herd and one to the E herd.

† A pair of twins counted as one in total calves lost.

as the cows had quite likely adjusted to their new groupings by the time they were rebred for the 1950–51 calving. There was no evidence of effects from routine changes at the formation of Breeding Groups I and II in mid-1953. Calf losses for herds D and E following conception were quite similar to those previously reported for the A, B and F herds (tables 1 and 3).

CREEP FEEDING

The routine of the C herd was changed at completion of calving the last year of its existence when the herd was moved to pasture 14 for the 1948 grazing period. Due to droughty conditions a creep was established for the calves. Average daily consumption of supplements per calf was 1.2 pounds the first 60 days when forage was in early growth stages, 2.1 pounds the next 49 days while forage was maturing and drying, and 4 pounds the remainder of the period when forage was dry. Average total consumption of concentrates per calf was 232 pounds. During the feeding period these calves made an average total gain of 221 pounds, as compared with 257 and 260 pounds, respectively, for calves of the A and B herds that were not creep fed. The differences were significant: ($P < .01$). Although supplement consumption of the C herd calves was lower than expected (possibly affected by pasture size and topography) it seemed strange that their weight gains would be less than those of the A and B herds.

To further observe results obtained with the creep, it was moved to pasture 4 for the first calf crop of the F herd during the droughty 1949 grazing period. (The F herd had been moved to this pasture during their breeding for this calf crop.) Average daily consumption of supplements per head, for forage periods similar to those for the C herd calves, was 1.1 pounds the first 70 days, 4.2 pounds the next 48 days, and 6.1 pounds for the remainder of the period. Average total consumption of supplements per calf for the period was 475 pounds. During the feeding period these calves made an average total gain of 253 pounds as compared with 199 and 227 pounds, respectively for the provisional D and E herd calves (routines of whose dams had been changed in mid-pregnancy) that were not creep fed. These gains differed significantly: ($P < .01$). The smallest average gain of provisional D herd calves occurred in pasture 14, where C herd calves had been creep fed the previous year. Therefore, pasture 14 itself appeared to be the cause of the low calf-weaning weights.

EFFECT OF MINERAL SUPPLEMENTATION

Copper was fed to the D herd in 1950–53, but there was no discernible improvement in hair coats, reproduction, or calf-weaning weights (tables 3 and 4). Analysis of liver samples from cows culled at the close of this period showed 57 ppm of copper, as compared to 35 ppm in the livers of cows receiving no copper. Thus, a copper deficiency did not exist.

Feeding Breeding Group II a mix of minor minerals during 1953–58 produced little evidence that D herd cows of this group performed better than they did when in the 1950–53 D herd (tables 4 and 5). There was an improvement in per cent conception, but it is not known if this was because of the minerals—the per cent of dry cows was still excessive. There was no improvement in per cent of calves lost, in faster rebreeding, or in calf-weaning weights.

REGULATING SUPPLEMENT INTAKE WITH SALT

From the time we commenced mixing salt with concentrates to regulate the daily intake of these supplements by cattle, we received reports from the field

Table 10

REPRODUCTION DATA ON COWS LOSING A CALF, 1935–1958

Item	Age (years)									Total
	3	4	5	6	7	8	9	10	Over 10	
Total number of cows	185	170	147	120	100	79	62	46	4	913
Cows not with bull	1	1	0	1	0	0	0	0	0	3
Dry cows	2	24	26	15	8	7	7	7	0	96
Cows pregnant	182	145	121	104	92	72	55	39	4	814
Per cent pregnant	98.4	85.8	82.3	87.4	92.0	91.1	88.7	84.8	100.0	89.5
Abortions	11	14	7	6	1	3	2	0	1	45
Stillbirths	25	15*	12	14*	6*	11* †	8	3†	1	95
Early deaths	7	5	6	6	3	2	1	0	0	30
Per cent abortions, stillbirths, and early deaths	23.6	23.4	20.7	25.0	10.9	22.2	20.0	7.7	50.0	20.9
Calves dying from dystocia	8	7	6	3	3	1	2	0	0	30
Calves dying of other causes	14	4	4	1	5	3	1*	0	0	32
Per cent calves lost	35.7	31.0	28.9	28.8	19.6	27.8	25.5	7.7	50.0	28.5
Per cent calves weaned	63.0	60.4	58.5	63.9	76.0	68.4	67.7	80.4	50.0	64.9

* Includes one stillbirth in a pair of twins.
† Includes a stillborn pair of twins.

that the practice resulted in lowered breeding efficiency. The E herd was hand-fed supplements in 1950–53, and the E herd in Breeding Group II (same pasture routine) were self-fed supplements in 1953–58. The lack of significant differences in reproduction performance of these two groups (tables 4 and 5) indicates that the high salt consumption resulting from the use of salt to regulate daily intake of supplements does not lower reproduction efficiency.

ABORTIONS, STILLBIRTHS, AND EARLY-CALF-DEATH LOSSES

From 1938 to 1958, out of 185 cows losing calves prior to weaning 135 lost one or more calves from abortions, stillbirths and early deaths. Table 10 shows that the per cent losses from abortions, stillbirths and early deaths were similar for all age classes. Thus, it appears impossible to completely eliminate the types of calf losses noted in this report. However, culling the cows which had such losses increased the calf crop about 8 per cent, while in some instances changing an established routine during pregnancy appeared to increase these losses.

SUMMARY

In a 12-year study of effects of supplementing the diets of range cows, supplemented herds averaged 10.5 per cent dry cows, 6.0 per cent loss from abortions and stillbirths, and 3.2 per cent loss from dystocia, death of dam, and other causes; unsupplemented cows averaged 25.0, 5.0, and 7.0 per cent, respectively. The excessive numbers of dry cows in each group may largely be due to the effects of close grazing on one-third of the cows in each group, plus the lack of needed supplements in the unsupplemented group. In a 10-year investigative period which followed the first study, a study of the effects of climatic conditions on weight gains and losses indicated that the rates of protein and energy supplementation used in the program were adequate for good conception.

Another supplemented herd, maintained year-around in one pasture at a moderate stocking rate, averaged 17.6 per cent dry cows, 13.1 per cent abortions and stillbirths, and 4.9 per cent loss from dystocia, death of dam, and other causes over a 7-year period. Excessive losses from failure to conceive, abortions, and stillbirths were attributed to year-around grazing in one pasture. A second supplemented herd, maintained year-around in another pasture over a 9-year period, averaged 2.9 per cent dry cows, 6.9 per cent abortions, stillbirths and early calf deaths (now considered related to the abortion-stillbirth problem), and 3.9 per cent loss from dystocia, death of dam, and other causes; in addition, cows of this group bred more readily than those of the 7-year group. Thus, it appears that year-around grazing in one pasture is not necessarily the cause of a high per cent of dry cows and an increase in the abortion, stillbirth and early calf death rate.

Supplemented cows with poor reproduction histories and not culled for losing a calf had, in a two-pasture rotation system for 3 years, an average 18.7 per cent dry cows, 3.6 per cent abortions, stillbirths and early calf deaths, and 4.3 per cent loss from dystocia, death of dam, and other causes. Another supplemented group of cows having good reproduction histories and culled for losing a calf had, in a three-pasture rotation system for 3 years, an average 2.5 per cent dry cows, 5.0 per cent abortions, stillbirths and early calf deaths, and 5.1 per cent loss from dystocia, death of dam and other causes. Lack of sufficient bull power was

possibly in part to blame for the high per cent of dry cows in the first group.

After placing half the cows having good reproduction histories with half the cows having poor reproduction histories in the latter's two-pasture rotation system for a 5-year period, the latter group averaged 10.9 per cent dry cows, 6.5 per cent abortions, stillbirths and early calf deaths, and 5.7 per cent loss from dystocia, death of dam and other causes; the cows with good histories averaged 6.3, 6.7 and 4.8 per cent, respectively. When half the cows having poor reproduction histories were placed with half those having good reproduction histories in the latter's three-pasture rotation system for the 5-year period, the latter group averaged 3.2 per cent dry cows, 4.9 per cent abortions, stillbirths and early calf deaths, and 2.5 per cent loss from dystocia, death of dam and other causes; the group having poor histories averaged 4.5, 7.1 and 0.8 per cent respectively. Thus, cows having good reproduction histories had an increase in calf losses when placed in the two-pasture rotation system, but cows having poor reproduction histories had a decrease in calf losses when placed in the three-pasture rotation system.

The marked reduction in per cent dry cows between the groups in the two-pasture rotation system for the 3-year and 5-year period does not appear attributable to the addition of another bull during the second period, as the Angus bulls sired only 3.1 per cent of the calves. In the three-pasture rotation systems, sulfur fertilization and adjustment of the pasture rotation to take advantage of late-maturing forage in the few weeks prior to weaning increased pasture carrying capacity, weights of cows, and calf-weaning weights; all this was expected.

Feeding a high amount of protein to first-calving heifers through the last 3 or 4 months of gestation period did not cause them to have heavier calving losses or to differ in calf-weaning weights from heifers supplemented in the usual manner.

Changing the cattle's established routine or environment during late pregnancy appeared to increase calf losses during a 2-year period. In the first year, cows did not leave the range and there was a 16.2 per cent loss from abortions, stillbirths and early calf deaths. In the second year during which cows were moved off the range for 80 days prior to calving, these losses were 24.4 per cent—this includes an 11.7 per cent abortion loss while the cows were away; losses from dystocia, death of dam and other causes were only 2.5 and 3.5 per cent, respectively. Factors arising from changing routine may have also been involved in a decline condition of weaned calves: 60 per cent of the first calf crop of a herd whose routine was changed during the breeding season was afflicted, and creep-fed suckling calves from a herd whose routine was changed at the end of the calving period gained less weight than did similar calves not creep fed in two herds accustomed to a pasture change at that time of year.

There was no evidence that salt used to regulate daily consumption of self-fed supplements lowered breeding efficiency of cows.There were no apparent benefits from feeding copper or a minor-mineral mixture.

Reproduction records of all the cows receiving supplements over the 22-year period of study showed an average total loss of 20.9 per cent. Of this, 9.2 per cent were dry cows, 8.0 per cent abortions, stillbirths and early calf deaths, and 3.7 per cent were dystocia, death of dam and other causes. Losses from failure to conceive and from abortions, stillbirths and early calf deaths show the greatest variability between years and experimental herds. These losses probably have the greatest possibility of being reduced by proper management. However, most losses from dystocia, death of dam and other causes probably were unavoidable.

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