EFFECT OF DIFFERENT LEVELS OF WINTERING AND DIFFERENT AGES AT FIRST CALVING UPON PERFORMANCE OF BEEF COWS

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Bachelor of Science

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Manhattan, Kansas

1953

Submitted to the faculty of the Graduate School of the
Oklahoma State University of Agriculture and
Applied Science in partial fulfillment
of the requirements for the degree of
MASTER OF SCIENCE
May, 1958

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ACKNOWLEDGMENT

The author wishes to express his appreciation to Dr. L. S. Pope of the Animal Husbandry Department for his guidance during the course of this study and in the preparation of this thesis.

He also wishes to thank D. F. Stephens, Supt. of the Fort Reno Experiment Station and Marvin Wilson, herdsman for their help in caring for the experimental cattle and in maintaining necessary records.

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INTRODUCTION

The most common system of cow herd management in the Southwest is to graze year long on native grass pasture, with such supplemental feed as may be required. Native grass pastures usually furnish an adequate plane of nutrition during the summer months, except possibly during periods of extreme drouth. Some supplemental feed is usually provided during the winter to compensate for the low level of protein in the dry, weathered grass. The amount of winter supplement required is dependent upon many factors, including the length of the lactation period before spring grass appears, the type and amount of forage available, the quality of supplemental feed provided, and weather conditions.

Since winter supplemental feed represents one of the largest cash costs in the operation of a commercial cow herd, it is of great concern to the producer to feed the most economical quality and quantity of supplement in terms of the number, size and quality of calves at weaning time and the condition, thriftiness and longevity of the cows.

Thirty months is usually considered to be an ideal age for heifers to produce their first calves. However, in the usual systems of production followed in commercial herds it is desirable to have all calves dropped within a three or four month period. This necessitates calving heifers at two years of age, or waiting until they are

three years of age. Calving at two years of age has become more common in recent years and has been used quite extensively with liberally fed heifers. Previous tests have indicated that considerable difficulty can be expected in calving heifers at two years of age. However, if heifers do not calve until they are three years of age they must be maintained for a longer time before any returns are realized.

Levels of supplemental feeding and age at first calving have been extensively studied under many systems of management with both beef and dairy cattle. However, few of these studies have been continued for more than two or three years. Little is known of the long-time effects on productivity of two-year-old vs. three-year-old calving with different levels of winter supplement.

The project reported in this thesis was initiated in 1948 at the Oklahoma Agricultural Experiment Station. One hundred and twenty weanling Hereford heifer calves were divided into three groups and were wintered at one of three levels of winter supplement in each subsequent year. One-half of the heifers on each nutritional treatment calved first at two years of age, with the rest calving first at three years of age. These cows were nine years of age in the spring of 1957. Observations of weight changes and productivity were made on each cow during the course of the experiment with the intent of determining the effect of level of winter supplementation and age at first calving on the lifetime production of range beef cows.

REVIEW OF LITERATURE

Literature pertaining to this study has previously been reviewed by Thomas (1952) and Shroder(1954). This review will include only a few of the pioneer studies with beef cattle, and some of the more recent studies with cattle and other species on the effects of different levels of nutrition and different ages at first parturition on growth, mature size, reproductive performance and longevity.

McCampbell (1920) divided 80 Hereford heifer calves into two groups. One group was bred to calve at two years of age, while the other calved first at three years of age. One-half of the heifers in each group were wintered on a liberal grain ration and roughage, while the other half were wintered on roughage alone. The different winter treatments were continued until the cows were 4 years old. The results indicated that the first calf crop was reduced about 30 percent and that 30 percent of the cows became nonbreeders if they calved at two years of age without a liberal feeding of grain during the winter. He concluded that a cow never fully recovers from the shock of calving as a two-year-old, regardless of the method of feeding. The author suggested that development of heifers without grain and calving first at three years of age was the most practical method under range and semi-range conditions.

Withycombe et al. (1930) allotted 100 Hereford heifers to ten groups of ten heifers each and fed five different rations each winter,

ranging from wheat straw with a light feed of alfalfa hay to a full feed of alfalfa supplemented with barley. One lot of cows on each nutritional treatment calved first at two years of age and the other at three years of age. Calving at two years of age reduced the percent calf crop produced at the ages of three and four years. However, at five and six years of age, cows calving first at two years of age produced as large a calf crop as those calving first at three years of age. The lower percent calf crop produced at three and four years of age was more than offset by the value of the calf crop produced at two years of age. At the age of six and one-half years, cows which had produced their first calves at two years of age had produced an average of 0.7 more calves than the cows which calved first at three years of age. The first calves from cows calving first at two years of age were smaller at birth and gained slower from birth to weaning than the first calves from cows calving first at three years of age. However, when the cows were compared in the same years and at the same ages, there was little or no difference in weaning weight of their calves. Two-year-old heifers suckling calves weighed 200 pounds less than dry two-year-olds, but this difference was reduced to less than 100 pounds by the time the heifers were four years old. The effects of early breeding were not changed by light or heavy winter feeding. Cows wintered at the higher levels remained in a fleshier condition throughout the year and their calves gained at a slightly faster rate. However, the extra gain by the calves did not offset the cost of the extra feed, and the lower levels of wintering were distinctly more profitable. These workers concluded that little was

to be gained from having cows in a fleshy condition as long as they were strong and vigorous.

Reid et al. (1957) reared Holstein heifers from birth on three planes of nutrition supplying 65, 100 and 140 percent of Morrison's recommended total digestible nutrient allowances. These treatments were continued until first calving, after which all cows were fed according to milk production at 100 percent of Morrison's standards. The low level of nutrition delayed the first heat period by an average of thirteen months, but did not seem to adversely effect the conception rate. The first heat period seemed to be more closely related to body size than to age. Low level heifers weighed about 400 pounds less at first calving than heifers on the high level. This difference was reduced to about 100 pounds by the start of the fifth lactation. Little difference was noted in the productivity of the heifers reared on the three planes of nutrition. There was a slight trend for the low level cows to produce a little less milk than the high level cows during the first lactation, but slightly more in later lactations. The low level cows produced lighter calves at birth the first two years, but this difference disappeared at later calvings. A greater amount of calving difficulty was apparent at the first calving of low level heifers, but little or no difference was noted at later calvings.

Swanson (1957) conducted a study with eight pairs of identical twin dairy heifers, in which one heifer of each pair was fed in a "normal, practical manner" and the other was fed a fattening ration from four months of age until the first calving. After calving, concentrates were fed to both twins on the basis of the milk production

of the higher producer and roughage was fed ad libitum. In all except one pair, the "normally" fed heifer was the higher milk producer, with the average production about 20 percent greater than for the fattened heifers. Three of the pairs were milked during the second lactation and in each pair the fattened heifer was the inferior producer. Udders taken from the heifers at the end of their second lactations revealed incomplete development of the lobule-alveolar system in the fat heifers.

Patterson (1953) wintered beef cows each winter for six winters on five different rations. The wintering period was from December 1 to March 15. All of the rations except one provided for body weight maintenance and the average loss for the six winters was only 19 pounds per cow for the poorest ration (pasture clippings). Without exception, milder winters that caused some green forage to be available on permanent pastures resulted in a higher conception rate during the following breeding season. The weaning weights of the calves seemed to be rather strongly related to the winter weight gain or loss of the cows. Cows receiving the poorest ration weaned calves that were significantly lighter than calves produced by cows on the other treatments.

Wallace (1948a, 1948b) found that the birth weight of twin lambs could be approximately halved, and the birth weight of single lambs significantly decreased by an extremely low plane of nutrition of the dam during the last two months of fetal life. The fetal tissues and anatomical areas which had the highest growth rate at the time of restricted nutrition were more greatly effected than the more slowly growing parts.

Wallace (1948c) subjected pregnant ewes to extremes of nutrition soon after conception. He found no significant differences in fetal development at the end of the third month of pregnancy. At the end of the third month, certain high plane ewes were reverted to a low plane and part of the low plane ewes were switched to a high plane. He reported that the development of the fetus after the third month was much more dependent upon the level of nutrition of the dam during the period of maximum fetal growth (last two months) than upon the state of body reserves of the dam.

Joubert (1954) observed that a low plane of nutrition could greatly delay the occurrence of estrus, but did not adversely effect the conception rate. This study was conducted with 14 pairs of dizygotic twins, or half sisters of the same age, which were placed on their respective high or low planes of nutrition at weaning. First estrus was delayed by six months or more in the low level heifers, but they required fewer services per conception.

Many studies have been conducted which illustrate the strong tendency for animals to compensate for periods of restricted growth by growing at a faster rate, or for a longer period of time, when adequate nutrients again become available. One of the most thorough studies on this subject was conducted with swine by McMeekan (1940a, 1940b, 1940c). He found that a restricted level of energy intake most severely retarded the later maturing parts or tissues of the body. Among the tissues, bone was least effected by restricted nutrition, followed by muscle and then fat. The anterior parts of the body were generally least effected by restricted nutrition, with the loin being most effected. All parts and tissues showed marked

recuperative capacity upon provision of ample nutrients following undernourishment. The recuperative power was relatively greater with respect to late developing tissues or parts as compared to the early maturing ones. This experiment was terminated before the effect of retarded growth on mature size could be determined.

Palsson and Verges (1952a, 1952b) conducted an experiment with sheep very similar in design to McMeekan's swine experiment. They concluded that at any stage, an organ, part or tissue of high natural growth intensity at that stage was proportionately more retarded in development by restricted nutrition than an organ, part or tissue of lower growth intensity at that age. The later developing parts or tissues were proportionately more effected than the earlier developing ones.

Winchester et al. (1957) allotted twelve pairs of identical twin calves to 8 treatments in a factorial design experiment. Three energy levels were fed, providing for maintenance, one pound potential gain and two pounds potential gain. Digestible protein levels of 2.4, 6.5 and 12.4 percent at the low energy level; 6.7, 10.4 and 13.7 percent at the medium energy level; and 6.5 and 11.4 percent at the high energy level were fed. These rations were fed between the ages of six and twelve months, after which each animal was given a good growing-fattening ration ad libitum. Twin pairs were slaughtered when they reached the same carcass grade. The feed efficiency during the entire feeding period was very similar for twin pairs, despite the wide difference in treatment within some pairs. With one exception, the within pair difference in feed efficiency was only 2 to 6 percent. Twin pairs reached the same slaughter grade at about

the same weight, although those on the more restricted ration took longer to reach slaughter grade.

EXPERIMENTAL

This study was initiated in October, 1948, with 120 choice Hereford weanling heifers. One hundred five of the heifers were purchased from the Moon Ranch, Mill Creek, Oklahoma, and the remainder were obtained from the experiment station herd. The heifers were divided on the basis of weight into 8 lots of 15 head each. These 8 lots were assigned at random to the different treatments. The heifers were started on experiment at the Lake Carl Blackwell Experimental Range near Stillwater. In June, 1949, they were moved to the Fort Reno Experiment Station.

Throughout the experiment, all lots were allowed to graze comparable native grass pastures (principally bluestem, Indian and switch grass) and had access to a mineral mix consisting of two parts ground rock salt and one part steamed bone meal. During the winter feeding period, extending from early November to mid- April, the cows were fed the following supplemental feeds per head daily in addition to the dry native grass:

Lots 1 and 2 (low level) - 1.0 pound of cottonseed cake

Lots 3 and 4 (medium level) - 2.5 pounds of cottonseed cake

Lots 5 and 6 (high level) - 2.5 pounds of cottonseed cake and 3.0 pounds of oats

The cows were fed twice the above amounts of feed every other day. Lots 7 and 8 were wintered at the medium level and were used

to test the value of late summer supplementation and also to test the value of thyroprotein as a stimulant to milk production. Thomas (1952) and Shroder (1954) reported the results of these tests. In this thesis, lots 7 and 8 will be considered only when discussing the effects of age at first calving.

Some heifers were found to be pregnant at the start of the experiment and were removed from the test during the first winter. One heifer from each of lots 1 and 5, two heifers from each of lots 6 and 8, and three heifers from each of lots 4 and 7 were removed. These heifers were replaced with heifers from the experiment station herd which were of the same age. During the summer of 1949, one heifer in lot 3 was removed after foot rot developed to the extent that one toe had to be removed. She was replaced with a heifer of comparable age and breeding from the experiment station herd.

Since the summer of 1949, a total of 20 cows have been removed from the experiment. No attempt was made to replace them. Only those cows that had to be removed because of illness or that failed to wean a calf two years in a row have been removed from the experiment.

The heifers in lots 1, 3, 5 and 7 were bred in the summer of 1949 to calve first at two years of age. The heifers in lots 2, 4, 6 and 8 were bred in 1950 to calve first at three years of age. The cows were pasture mated to purebred Hereford bulls from May 1 to late August each year. In 1952 and thereafter, the cows were divided into breeding groups on the basis of their previous productivity within each nutritional treatment. Bulls were assigned to the breeding

groups at random. All cows have been pasture mated, except in 1956 when a hand mating system was used.

The management followed in regard to the calves was essentially the same throughout the experiment. Bull calves were castrated at 6 to 8 weeks of age, and all calves were dehorned and vaccinated for blackleg and malignant edema at approximately 3 months of age. All calves were weaned in early October.

Throughout the experiment the following records were maintained:

1. Feed consumption data and yearly feed costs, including pasture, supplemental feed and mineral.
2. Weights of all cows at approximately monthly intervals.
3. Calving dates.
4. Birth and weaning weights of all calves. Birth weights were adjusted to a bull equivalent and weaning weights to a 210 day steer equivalent using the factors calculated by Botkin (1952).

The data were analyzed statistically according to the methods of Snedecor (1956).

RESULTS AND DISCUSSION

The results obtained from the start of the experiment until August, 1951, were reported by Thomas (1952), and those obtained from 1951 until November, 1953, were summarized by Shroder (1954). This thesis includes the results for the period from November, 1953, to June 1, 1957, as well as a summary of the entire project up to 1957.

In discussing the effects of the level of winter feeding, the age at first calving will be disregarded; when discussing the effects of the age at first calving, all lots which calved at the same age will be considered together regardless of the level of winter feeding. This method of comparison is valid if there is no interaction between the level of winter feeding and age at first calving. Withycombe *et al.* (1930) stated that the effects of two-year-old calving were not changed by light or heavy winter feeding. However, McCampbell (1920) found some evidence of interaction between the two factors. In this study the weights of the cows indicated that there might be a slight interaction. However, this interaction was not apparent in the productivity data of the cows.

Effects of Level of Wintering

1953-1954

Table I contains a summary of weight data and calf production records for the period from November 3, 1953, to October 29, 1954.

TABLE I WEIGHT DATA, FEED COSTS AND CALF PRODUCTION RECORDS OF COWS WINTERED AT DIFFERENT LEVELS, 1953-1954

Age at first calving	Two-year-old				Three-year-old			
Lot number	1	3	5	7	2	4	6	8
Level of winter supplement	Low	Med.	High		Low	Med.	High	
No. of cows per lot Nov. 1953[1]	14	14	12	14	14	14	14	14
Average cow weights (lbs.)								
Fall 11/3/53	1078	1149	1162	1220	1170	1171	1198	1207
Spring 4/13/54	939	1006	1040	1051	1050	1029	1086	1029
Fall 10/29/54	1061	1125	1103	1130	1139	1122	1198	1168
Winter gain	-139	-143	-122	-169	-120	-142	-112	-178
Summer gain	122	119	63	79	89	93	112	139
Feed costs per cow ($)[2]								
Winter	6.46	15.49	29.46	15.49	6.46	15.49	29.46	15.49
Summer	17.72	17.72	17.72	17.72	17.72	17.72	17.72	17.72
Total yearly feed cost	24.18	33.21	47.18	33.21	24.18	33.21	47.18	33.21
Calf production records								
No. of calves born	14	13	12	14	14	13	13	14
No. of calves weaned[3]	14	13	11	14	14	11	10	12
Average calving date	3/2	2/25	2/26	3/5	3/16	2/25	2/27	2/24
Average calf weights (lbs.)								
At birth (corrected for sex)	82.0	84.2	82.8	82.9	81.2	81.9	86.8	84.9
At weaning (corrected for age and sex)	514	508	498	507	510	490	517	507

[1] This project was initiated in 1948 with 15 heifers per lot. As of November, 1953, a total of 10 cows had been removed. In May, 1954, one cow was removed from lot 4 and one from lot 5. Both had failed to wean a calf in 1953 and 1954.

[2] Feed prices quoted in the Okla. Agr. Expt. Sta. Misc. Pub. MP-34 were used in computing feed costs.

[3] One calf in lot 4, one in lot 5, two in lot 6 and two in lot 8 were stillborn or died within a few hours after birth. One calf in lot 4 died of blackleg, and one in lot 6 bled to death after dehorning.

The winter of 1953-1954 was mild and open with about average rainfall. The cows on all levels of supplement wintered satisfactorily, with little difference among the lots in weight loss. The average weight losses for the low (lots 1 and 2), medium (lots 3 and 4) and high (lots 5 and 6) level lots were 130, 142 and 116 pounds, respectively.

The birth weights of all calves were about 5 pounds heavier than in the previous year, and averaged 81.6, 83.1 and 84.7 pounds for the low, medium and high level lots, respectively. The trend observed in earlier years for the low level cows to calve somewhat later than the medium and high level cows was continued. The medium level cows calved earliest with an average calving date of February 25, followed by the high level cows on February 27, and the low level cows on March 10.

The summer of 1954 was very hot and dry. Temperatures averaged 5 degrees above normal and rainfall was only one-third of normal from May to October. The summer weight gains of the cows were somewhat less than in previous years. The fall weights in 1954 averaged 28 pounds less than in 1953. Since the stocking rate was light (10-12 acres per cow), there was adequate grass available throughout the summer.

The average weaning weights (corrected for age and sex) were 512, 500 and 507 pounds for the low, medium and high level lots, respectively. The average weaning weight for all lots was 11 pounds lighter than in 1953, but was heavier than in any year prior to 1953.

1954-1955

Table II contains a summary of weight data and calf production records for the period from October 29, 1954 to November 4, 1955. The winter of 1954-1955 was mild with rainfall about two-thirds of

TABLE II WEIGHT DATA, FEED COSTS AND CALF PRODUCTION RECORDS OF COWS WINTERED AT DIFFERENT LEVELS, 1954-1955

Age at first calving	Two-year-old				Three-year-old			
Lot number	1	3	5	7	2	4	6	8
Level of winter supplement	Low	Med.	High		Low	Med.	High	
No. of cows per lot Nov. 1954[1]	14	14	11	14	14	13	14	14
Average cow weights (lbs.)								
Fall 10/29/54	1061	1125	1103	1130	1139	1122	1198	1168
Spring 4/11/55	1001	1054	1114	1073	1115	1056	1143	1082
Fall 11/4/55	1144	1190	1240	1168	1225	1220	1263	1227
Winter gain	-60	-71	11	-57	-24	-66	-55	-86
Summer gain	143	136	126	95	110	164	120	145
Feed costs per cow ($)[2]								
Winter	10.37	17.11	28.18	17.11	10.37	17.11	28.18	17.11
Summer	17.71	17.71	17.71	17.71	17.71	17.71	17.71	17.71
Total yearly feed cost	28.08	34.82	45.89	34.82	28.08	34.82	45.89	34.82
Calf production records								
No. of calves born	14	14	9	13	14	11	14	11
No. of calves weaned[3]	13	14	9	13	14	11	12	10
Average calving date	3/9	3/5	3/5	3/18	3/22	3/7	3/3	3/1
Average calf weights (lbs.)								
At birth (corrected for sex)	77.0	81.0	79.3	78.4	74.3	78.6	78.4	76.8
At weaning (corrected for age and sex)	487	500	494	478	481	488	500	492

[1] One cow from lot 5 died during October, 1955, of hardware disease. One cow was removed from lot 8 in October, 1955. She was open in 1955 and a pregnancy examination revealed that she had failed to re-breed.

[2] Feed prices quoted in the Okla. Agr. Expt. Sta. Misc. Pub. MP-43 were used in computing feed costs.

[3] One calf in lot 1 was stillborn; one in lot 6 died soon after birth; and one in lot 6 died of unknown causes after dehorning.

normal. The weight losses of the cows were much less than in any previous year, with 42 pounds average loss for cows on the low level, 69 pounds for the medium level cows and 26 pounds for the high level cows. As in the previous winter, the medium level lots lost more weight than the low level lots. In the spring of 1955, the low level lots averaged 3 pounds heavier than the medium level lots and 72 pounds lighter than the high level lots.

The birth weights were lighter than in 1954, with the average weights (corrected for sex) being 75.6, 79.9 and 78.7 pounds for the low, medium and high level lots, respectively. The average calving dates were about a week later than in 1954. The high level lots calved earliest with an average calving date of March 4, followed by the medium level lots on March 6, and the low level lots on March 16.

Weather conditions during the summer of 1955 were favorable with temperature and rainfall near normal. Summer weight gains of the cows more than compensated for the losses the previous winter. The medium level lots, which lost the most the previous winter, made the greatest summer gain. Weaning weights (corrected for age and sex) of the calves were somewhat lighter than in 1953 and 1954, averaging 484, 495 and 498 pounds for the low, medium and high level lots, respectively.

1955-1956

Table III contains a summary of weight data and calf production records for the period from November 4, 1955, to October 30, 1956. The winter of 1955-1956 was very dry. Rainfall was only one-third of normal from November through April. Winter weight losses of the

TABLE III WEIGHT DATA, FEED COSTS AND CALF PRODUCTION RECORDS OF COWS WINTERED AT DIFFERENT LEVELS, 1955-1956

Age at first calving	Two-year-old				Three-year-old			
Lot number	1	3	5	7	2	4	6	8
Level of winter supplement	Low	Med.	High		Low	Med.	High	
No. of cows per lot Nov. 1955[1]	14	14	10	14	14	13	14	13
Average cow weights (lbs.)								
Fall 11/4/55	1144	1190	1240	1168	1225	1220	1263	1227
Spring 4/20/56	1025	1081	1152	1071	1135	1069	1191	1143
Fall 10/30/56	1103	1165	1164	1160	1182	1128	1223	1180
Winter gain	-119	-109	-88	-97	-90	-151	-72	-84
Summer gain	78	84	12	89	47	59	32	37
Feed costs per cow ($)[2]								
Winter	10.39	17.87	28.75	17.87	10.39	17.87	28.75	17.87
Summer	17.79	17.79	17.79	17.79	17.79	17.79	17.79	17.79
Total yearly feed cost	28.28	35.66	46.54	35.66	28.28	35.66	46.54	35.66
Calf production records								
No. of calves born	14	13	10	13	13	13	13	13
No. of calves weaned[3]	12	12	10	13	13	12	12	13
Average calving date	3/22	3/22	3/26	3/21	4/1	3/16	3/21	4/4
Average calf weights (lbs.)								
At birth (corrected for sex)	78.4	77.4	81.5	81.2	80.8	81.5	80.8	79.2
At weaning (corrected for age and sex)	508	502	509	524	514	503	515	512

[1] One cow was removed from lot 4 in February, 1956, because of a severe infection that developed at calving time. One cow was removed from lot 4 in October, 1956, because of a cancerous growth on her nose. One cow was removed from lot 6 in October, 1956, for failure to conceive two years in a row.

[2] Feed prices quoted in the Okla. Agr. Expt. Sta. Misc. Pub. MP-45 were used in computing feed costs.

[3] Two calves in lot 1 and one in lot 4 were stillborn; one in lot 3 died at 2 months of age of unknown causes; and one in lot 6 died at 2 weeks of age of an infection.

cows were greater than in the previous winter, with an average weight loss of 105, 128 and 79 pounds for the low, medium and high level lots, respectively. The trend for the medium level lots to lose the most weight was continued.

There was very little difference in the birth weights (corrected for sex) of the calves produced by cows on the three levels of winter supplement. The average birth weights were 79.6, 79.4 and 81.1 pounds for the low, medium and high level lots, respectively. The average calving dates were about two weeks later than in 1955. The hand mating system used in the summer of 1955, instead of the pasture mating system used in all previous years, may have been responsible for the later calving dates. The average calving dates for the low, medium and high level lots were March 27, March 19 and March 23, respectively.

Very dry conditions prevailed during the summer of 1956, with temperatures above normal. The weight gains of the cows were much less than in any previous summer, averaging 62 pounds for the low level lots, 72 pounds for the medium level lots and 24 pounds for the high level lots. The fall weights were about 50 pounds lighter than in 1955.

The hot, dry weather did not seem to effect the calf weights as greatly as it did the weights of the cows. The weaning weights (corrected for age and sex) averaged 512, 502 and 512 pounds for the low, medium and high level lots, respectively.

1956-1957

Table IV contains a summary of weight data and calf production records for the period from October 30, 1956, to June 1, 1957. The

TABLE IV WEIGHT DATA, FEED COSTS AND CALF PRODUCTION RECORDS OF COWS WINTERED AT DIFFERENT LEVELS, 1956-1957

Age at first calving								
Lot number	1	3	5	7	2	4	6	8
Level of winter supplement	Low	Med.	High		Low	Med.	High	
No. of cows per lot Nov. 1956[1]	14	14	10	14	14	11	13	13
Average cow weights (lbs.)								
Fall 10/30/56	1103	1165	1164	1160	1182	1128	1223	1180
Spring 4/9/56	1075	976	1042	1052	1148	981	1214	1100
Winter gain	-28	-189	-110	-118	-34	-147	-9	-80
Feed costs per cow ($)[2]								
Winter	12.58	20.09	33.51	20.09	12.58	20.09	33.51	20.09
Calf production records								
No. of calves born[3]	14	15	10	14	13	11	12	13
No. of calves living 6/1/57[4]	13	13	10	14	13	10	11	12
Average calving date	3/22	3/7	3/8	3/28	3/20	3/15	3/8	4/1
Average calf weights (lbs.)								
At birth (corrected for sex)	85.1	81.6	87.3	81.1	82.8	81.9	80.0	84.0

[1] One cow was removed from lot 2 and one from lot 6 in May, 1957, after both failed to wean a calf two years in a row. One cow in lot 8 died in April, 1957, of unknown causes.

[2] Feed prices quoted in the Okla. Agr. Expt. Sta. Misc. Pub. MP-48 were used in computing feed costs.

[3] One set of twins in lot 3.

[4] One calf in each of lots 1, 3, 4, 6 and 8 was stillborn and one calf in lot 3 died at two weeks of age of an acute virus infection.

weather during the winter of 1956-1957 was mild with above average rainfall. The low and high level lots wintered in excellent condition losing an average of only 31 and 60 pounds, respectively. However, the medium level cows lost an average of 170 pounds. The trend for the medium level lots to lose the most weight was noted in the three previous winters, but the differences in weight loss were much greater during the winter of 1956-1957. The greater loss of the medium level lots may have been partly due to pasture differences. In previous winters the different lots were rotated among the different pastures at regular intervals. On the basis of previous response it was decided that the pastures being used contained approximately equal quantity and quality of forage and the lots were not rotated among pastures during the winter of 1956-1957.

The average birth weights (corrected for sex) were heavier than in any previous year except 1954, with the low, medium and high level lots averaging 84.0, 81.8 and 83.3 pounds, respectively. The average calving dates were March 21, March 10 and March 8.

1948-1957

The entire nine years of this experiment must be considered in determining the effect of the level of wintering. Results of any one year can be misleading when compared to the long-time results. A summary of body weight changes of the cows and calf productivity data is presented in Table V. Table VI contains average weight changes of the cows and calf production data for each year.

The levels of winter feeding seemed to have slight effect on the body weight of the cows, with the greatest difference being found, as might be expected, at the end of the winter period. The greatest

TABLE V SUMMARY OF WEIGHT DATA AND CALF PRODUCTION RECORDS OF COWS WINTERED AT THREE LEVELS AND CALVING FIRST AT TWO DIFFERENT AGES, 1948-1957

Age at first calving	Two-year-old				Three-year-old			
Lot number	1	3	5	7	2	4	6	8
Level of winter supplement	Low	Med.	High		Low	Med.	High	
No. of cows at start of experiment	15	15	15	15	15	15	15	15
No. of cows remaining on test 6/1/57	14	14	10	14	13	11	12	12
Average weight changes of cows (lbs.)								
Initial weight 10/29/48	473	476	476	481	476	461	470	478
Ave. winter weight gain	-98	-108	-64	-108	-101	-98	-60	-103
Ave. summer weight gain	186	184	144	191	197	176	160	194
Mature weight 11/2/56[1]	1103	1165	1164	1160	1182	1128	1223	1180
Calf production records								
No. of calves born (1950-1957)	109	110	91	107	97	88	94	92
Ave. calving date	3/15	3/8	3/9	3/12	3/16	3/6	3/5	3/8
Ave. birth weight (sex corrected)	76.8	76.5	78.4	77.1	77.0	77.8	78.3	76.7
No. of calves weaned (1950-1956)	91	93	75	91	82	71	73	72
Percent calf crop weaned[2]	91.0	93.9	86.2	91.9	96.5	85.5	85.9	84.7
Ave. weaning weight (age and sex corrected)	480	472	477	481	494	474	492	487

[1] The fall weight in 1956 was selected as the mature weight because fewer cows failed to wean calves than in any previous year.

[2] Based on the number of cows bred to calve in each year.

TABLE VI WEIGHT DATA AND CALF PRODUCTION RECORDS OF COWS WINTERED AT DIFFERENT LEVELS
1948-1957

Year	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Average fall weight (lbs.)										
Lots 1 & 2 (low level)	474	786	1013	1017	1039	1124	1100	1185	1142	
Lots 3 & 4 (medium level)	470	784	1011	1041	1064	1160	1124	1204	1148	
Lots 5 & 6 (high level)	473	820	1053	1084	1100	1181	1156	1254	1199	
Average spring weight (lbs.)										
Lots 1 & 2		497	748	754	863	878	994	1058	1080	1111
Lots 3 & 4		528	780	796	885	962	1018	1055	1076	978
Lots 5 & 6		561	816	881	975	1016	1065	1130	1175	1139
Average winter gain (lbs.)										
Lots 1 & 2		23	-38	-259	-154	-161	-130	-42	-105	-31
Lots 3 & 4		58	-4	-215	-156	-102	-142	-69	-128	-170
Lots 5 & 6		88	-4	-172	-109	-84	-116	-26	-79	-60
Average summer gain (lbs.)										
Lots 1 & 2		289	265	263	176	246	106	127	62	
Lots 3 & 4		256	231	245	179	198	106	149	72	
Lots 5 & 6		259	237	203	125	165	91	124	24	
No. of cows bred to calve										
Lots 1 & 2			15	30	28	28	28	28	28	28
Lots 3 & 4			15	29	28	28	28	27	27	25
Lots 5 & 6			15	30	26	26	26	25	24	24
No. of cows that calved										
Lots 1 & 2			14	29	26	27	28	28	27	27
Lots 3 & 4			15	28	26	27	26	25	26	25
Lots 5 & 6			13	27	26	26	25	23	23	22

(continued)

TABLE VI (continued)

Year	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
No. of calves weaned										
Lots 1 & 2			13	29	25	26	28	27	25	
Lots 3 & 4			14	27	26	24	24	25	24	
Lots 5 & 6			11	25	24	24	21	21	22	
Average calving date										
Lots 1 & 2			3/21	3/9	3/11	3/13	3/9	3/16	3/27	3/21
Lots 3 & 4			3/14	3/6	3/4	3/4	2/25	3/6	3/19	3/10
Lots 5 & 6			3/15	3/3	3/3	3/2	2/27	3/4	3/23	3/8
Average birth weight (sex corrected, lbs.)										
Lots 1 & 2			71.7	70.1	73.7	76.5	81.6	75.6	79.6	84.0
Lots 3 & 4			67.9	70.1	73.0	75.1	83.1	79.9	79.4	81.8
Lots 5 & 6			72.6	72.8	71.9	80.2	84.7	78.7	81.1	83.3
Average weaning weight (age and sex corrected, lbs.)										
Lots 1 & 2			427	450	467	529	512	484	512	
Lots 3 & 4			413	443	436	503	500	495	502	
Lots 5 & 6			404	453	444	519	507	498	512	

difference was in the spring of 1953 when the high level cows were 138 pounds heavier than the low level cows, while the difference was only 28 pounds in favor of the high level cows in the spring of 1957. The spring weights of the medium level cows were generally about half way between the high and low level average weights until the spring of 1955. In 1955 and 1956 they averaged 3 and 4 pounds lighter than the low level cows and in 1957 they were 133 pounds lighter. The great loss of weight of the medium level cows during the winter of 1956-1957, as has been mentioned previously, may have been due to pasture differences. No explanation can be found for the lighter weights in 1955 and 1956.

The difference in average fall weight between the low and medium level lots was about 60 pounds in most years. This difference was generally somewhat less than the difference in spring weights. A trend was noted in 1955 and 1956 for the medium level lots to be much closer in average weight to the low level lots than to the high level lots, although they maintained an advantage of 19 and 6 pounds for the two years.

It must be remembered in considering the small differences in average weight between the lots that adequate grass was available throughout the experiment. During the winters of 1955-1956 and 1956-1957 heavy growths of annual "winter grass" (primarily Bromus catharticus, Bromus tectorum and Bromus commutatus) furnished some green feed throughout the winter. There was an unusual supply of green feed available late in the winter of 1956-1957. It was also noted that the cows receiving the low level of winter supplement were more vigorous grazers than the cows on the medium and high level. The

actual difference in nutrients consumed by the cows may not have been as great as the difference in amount of supplemental feed would indicate.

The most consistent difference noted between the cows on the different levels of winter supplement was in average calving date. The overall average calving dates were March 16, March 7 and March 7 for the low, medium and high level lots, respectively. The low level cows consistently calved 7 to 12 days later than the cows in the other lots. This difference was not great, and was not statistically significant, but could be of some economic importance.

The lots receiving the higher levels of winter supplement generally produced calves weighing more at birth, but the differences were not great and were not consistent from year to year. The high level cows produced the heaviest calves in 1950, 1951, 1953, 1954 and 1956. The low level cows produced the heaviest calves in 1952 and 1957, while the calves from the medium level lots were heaviest in 1955. The average birth weights (corrected for sex) were 76.9, 77.1 and 78.3 pounds for the low, medium and high level lots, respectively. Wallace (1948a, 1948b) reported that the birth weight of lambs could be significantly decreased by a low plane of nutrition of the dam. There is no indication in this study that the plane of nutrition had any significant effect on the birth weight of the calves even though the greatest restriction in nutrition was late in pregnancy when the fetus would be growing at a maximum rate. However, the low plane of wintering used in this study was not as severe as that imposed on ewes by Wallace. In his studies, ewes were made to lose about 20 percent of their body weight before lambing, while the

low level cows in this experiment usually lost very little weight and in some years gained a slight amount during the last three months of pregnancy.

The average weaning weights (corrected for age and sex) for the low, medium and high level lots were 487, 473 and 485 pounds, respectively, including all calves produced from 1950 through 1956. From these figures it cannot be logically assumed that the level of wintering had any effect on the productivity of the cows. The later calving would give some advantage to the low level cows, since they had suckled their calves for a shorter time each year before abundant green forage was available in the spring. However, the difference in average calving date was probably not great enough to have any significant effect on the corrected weaning weights. No logical explanation can be found for the low average weaning weights of the calves produced by the medium level cows. Patterson (1953) and Withycombe et al. (1930) both reported that higher levels of winter feed resulted in heavier calves at weaning time.

Another factor which must be considered in determining the effect of the different levels of winter supplement on productivity is the percent calf crop weaned. The percent calf crop weaned, based on the total number of cows exposed to the bulls in each year, was 93.5, 90.1 and 86.0 for the low, medium and high level lots, respectively. There was no great difference in the number of cows which failed to conceive, with six potential calves being lost in the low level lots and nine each in the medium and high level lots by cows being open. A total of six calves were lost from the low level lots, nine from the medium level lots and fourteen from the high level lots

between birth and weaning. Two-thirds of these losses were stillborn calves or calves which died within a few hours after birth. These losses accounted for 5, 5 and 10 calves lost from the low, medium and high level lots, respectively. The other losses were of such a miscellaneous nature that they could not be adequately classified. Some of these losses could not definitely be called an effect of the nutritional treatment, although it was usually possible that the nutritional treatment was a contributing cause. Thus, no calf losses were disregarded in calculating the percent calf crop weaned.

McCampbell (1920) and Patterson (1953) have both reported improved calving percent with higher levels of winter supplemental feed. Patterson reports that higher levels of winter feed are reflected in higher conception rates in the following breeding season. There was no indication that this was true in this study. The percent calf crop weaned in this experiment was as high or higher than those usually obtained in commercial herds in this area.

One of the objectives of this experiment was to determine the effect of the different levels of winter supplement on the longevity of the cows. On June 1, 1957, there were 27, 25 and 22 cows remaining on experiment in the low, medium and high level lots, respectively. The number of cows removed was smaller than was anticipated when the experiment was designed. Failure to conceive or to wean a calf for two years in a row accounted for more than half of the cows removed. Four were removed from the high level lots and two each from the low and medium level lots for failing to conceive two years in a row. One high level cow was removed after being open one year and producing a stillborn calf the following year, and another was removed

after producing stillborn calves in two consecutive years. One low level cow and two each from the medium and high level lots were removed because of miscellaneous diseases and infections. One medium level cow died in calving in 1950 as a two-year-old. As with the calf losses, it is hard to determine the extent to which these losses may be related to the level of winter supplement. However, the level of winter supplement cannot be definitely removed as a possible contributing factor in most cases. At nine years of age the higher levels of winter supplement definitely did not appear to have a beneficial effect on the longevity of the cows, and actually appeared to have been detrimental.

Effects of Age at First Calving

Since the yearly results from 1953 to 1957 were discussed previously in considering the effects of the level of winter feeding, no further discussion is deemed necessary. Tables I, II, III and IV contain summaries of cow weight data and calf production records for the individual years from 1953 to 1957.

Table VII contains average weight changes of the cows and calf productivity data for each year. The age at first calving seemed to have a more consistent effect upon the weight of the cows than upon their productivity. The cows which calved first at three years of age were 121 pounds heavier in the fall of 1950 when those that calved first at two years of age were weaning their first calves. This difference had decreased to 68 pounds by the spring of 1951 and was generally between 30 and 60 pounds in later years. This agrees with the results obtained by McCampbell (1920) and Withycombe et al. (1930)

TABLE VII WEIGHT DATA AND CALF PRODUCTION RECORDS OF COWS CALVING FIRST AT TWO AND AT THREE YEARS OF AGE, 1948-1957

Year	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Average fall weight (lbs.)										
Lots 1, 3, 5 & 7 (calved first at two years of age)	476	816	968	1008	1060	1152	1105	1181	1147	
Lots 2, 4, 6 & 8 (calved first at three years of age)	472	778	1089	1077	1101	1186	1156	1234	1180	
Average spring weight (lbs.)										
Lots 1, 3, 5 & 7		533	759	770	876	940	1008	1058	1077	1036
Lots 2, 4, 6 & 8		522	799	838	920	984	1048	1100	1137	1117
Average winter gain (lbs.)										
Lots 1, 3, 5 & 7		57	-57	-198	-132	-120	-144	-47	-104	-111
Lots 2, 4, 6 & 8		50	21	-251	-157	-117	-138	-56	-97	-63
Average summer gain (lbs.)										
Lots 1, 3, 5 & 7		283	209	238	184	212	97	123	70	
Lots 2, 4, 6 & 8		256	290	239	181	202	108	134	43	
No. of cows bred to calve										
Lots 1, 3, 5 & 7			60	58	54	54	54	53	52	52
Lots 2, 4, 6 & 8				60	56	56	56	55	55	52
No. of cows that calved										
Lots 1, 3, 5 & 7			56	55	50	51	53	50	51	52
Lots 2, 4, 6 & 8				58	54	54	54	50	52	49
No. of calves weaned										
Lots 1, 3, 5 & 7			50	54	48	50	52	49	47	
Lots 2, 4, 6 & 8				55	49	50	47	47	50	

(continued)

TABLE VII (continued)

Year	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Average calving date										
Lots 1, 3, 5 & 7			3/14	3/10	3/7	3/7	3/1	3/10	3/22	3/17
Lots 2, 4, 6 & 8				2/28	3/1	3/5	3/2	3/9	3/26	3/19
Average birth weight (sex corrected, lbs.)										
Lots 1, 3, 5 & 7			69.8	71.7	72.9	76.9	83.0	80.5	79.5	83.5
Lots 2, 4, 6 & 8				71.1	71.8	76.6	83.6	76.9	80.6	82.2
Average weaning weight (age and sex corrected, lbs.)										
Lots 1, 3, 5 & 7			415	460	447	514	507	490	511	
Lots 2, 4, 6 & 8				447	452	523	506	490	511	

who reported that heifers which calve at two years of age tend to catch up with those that calve first at three years of age, but never quite attain the same mature size. The difference between the two groups in this study was somewhat less than reported by Withycombe et al. (1930), but the trend was the same.

As of June 1, 1957, a total of 52 cows remained in the two-year-old calving group and 48 remained in the three-year-old calving group. There were no apparent differences between the two groups in reasons for removal of the cows. Failure to conceive or to wean a calf two years in a row accounted for 11 of the 20 cows removed. Four of these were from the two-year-old calving group and seven from the three-year-old calving group. One cow which calved first at two years of age died at parturition in 1950. The remaining eight cows were removed for miscellaneous reasons which were usually associated with some infection or disease.

The percent calf crop weaned from 1950 to 1956 was 90.9 percent for the two-year-old calving group and 88.2 percent for the three-year-old calving group. These figures were based on the total number of cows bred to calve each year. There was no evidence of the trend reported by Withycombe et al. (1930) for cows calving first at two years of age to raise a lower percent calf crop at three or four years of age than cows which calved first at three years of age. The difference in calving percentage was rather consistent with the two-year-old calving group producing the higher percent calf crop in every year except 1956. If the calf crop produced at two years of age is disregarded and the cows are compared in the same years and at the same age, the difference in percent calf crop becomes

greater. This method of calculation would increase the percent calf crop to 92.3 percent for the two-year-old calving group. The cows which calved first at two years of age had produced 1.07 more calves per cow by the fall of 1956 than the cows which calved first at three years of age. This is much greater than the difference of 0.7 calf at the age of six and one-half years reported by Withycombe et al. (1930).

The cows which calved first at three years of age calved an average of two days earlier than those which calved first at two years of age. The average calving dates were March 9 and March 11. The differences in calving dates were not consistent, but there was a slight trend for the three-year-old calving group to calve earlier for the first three calf crops, and for the two-year-old calving group to calve as early or earlier in subsequent years.

As was noted by Withycombe et al. (1930), the first calves produced by heifers calving at two years of age were lighter at birth and gained slower from birth to weaning than the first calves produced by heifers which did not calve until they were three years of age. However, when the cows were compared on an equal age basis there was little or no difference in productivity. The average birth weights (corrected for sex) were 77.1 and 77.4 pounds for the two-year-old and three-year-old calving groups, respectively. The average weaning weights (corrected for age and sex) were 478 and 487 pounds. If the calves produced by the two-year-old calving group at two years of age are disregarded, then the average birth weight becomes 78.3 pounds and the average weaning weight becomes 488 pounds for this group.

Under the conditions of this experiment calving heifers at two years of age had no adverse effect on their subsequent productivity. There was no indication of the large decline in breeding efficiency reported by McCampbell (1920). The percent calf crop weaned would tend to indicate that calving at two years of age may have improved the reproductive ability of the cows. However, in deciding whether or not to breed heifers to calve at two years of age several factors must be kept in mind. Considerable difficulty can be expected in calving two-year-old heifers. In this study about 50 percent of the heifers which calved first at two years of age required assistance in giving birth to their first calf and one heifer died following a very difficult delivery. With heifers less well developed than these, an even greater amount of difficulty might be expected.

SUMMARY

An experiment was initiated in 1948 with 8 lots of 15 Hereford heifers per lot to study the effects of level of winter supplementation and age at first calving upon life-time production of range beef cows. Results to June 1, 1957, are reported. All lots grazed native grass year-long and during each winter (early November to mid-April) received the following amounts of cottonseed cake per day: Lots 1 and 2 (low level), 1.0 pound; Lots 3 and 4 (medium level), 2.5 pounds; and Lots 5 and 6 (high level) 2.5 pounds plus 3.0 pounds of oats. Lots 7 and 8 were wintered at the medium level and received additional late summer supplementation. They were considered only in the comparison of two-year-old vs. three-year-old calving. Lots 1, 3, 5 and 7 calved first at two years of age, while lots 2, 4, 6 and 8 calved first at three years of age. Calves were dropped in February, March and April and weaned in early October each year.

Low levels of wintering and early calving both adversely affected the body weight of the cows, but the differences were small and tended to become less as the cows grew older. Neither level of wintering or age at first calving seemed to have much effect on birth or weaning weights of the calves. Cows on the low level of winter supplement consistently calved 7 to 12 days later than those on the medium and high levels. The percent calf crop weaned was inversely related to the level of winter supplement. Cows calving first at two years of

age weaned a larger percent calf crop than those calving first at three years of age. The number of cows remaining on test at nine years of age was also inversely related to the level of winter supplement.

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The content and form have been checked and approved by the author and thesis adviser. The Graduate School Office assumes no responsibility for errors either in form or content. The copies are sent to the bindery just as they are approved by the author and faculty adviser.

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