

FEEDING MANAGEMENT OF THE BEEF COW

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## INTRODUCTION

The feeding management of the beef cowherd must necessarily be based on economy of production. A sufficient return must be obtained to offset any added input. Generally there is a relatively small increment of variation in productive performance when feeding levels are varied from sub-optimum to optimum to super-optimum levels. This does not imply that there are no significant differences in performance at different nutritional levels, however, the level of performance and the level of nutrition are not in exact relative proportions.

The beef cow has the ability to adapt to widely variable feeding regimes. This ability is probably the reason such variations exist throughout the industry. It is not uncommon for two different cowherds to have similar production performance while maintained at considerably different nutritional levels. Some cowherds are maintained on high quality forage and considerable concentrate supplementation at maximum daily consumption during the wintering phase. The other extreme is that of cows receiving minimal amounts of poor quality forage as the only source of winter nutrients.

There is as much variation in cowherd management as there is in feeding management. For instance, there are fall-calving and spring-calving cowherds. There are cows grazing rangeland requiring 10 - 20 or more acres per cow and calf while there are other cowherds on tame pasture, with intensive management, requiring very few acres per cow and calf. The non-uniformity in cowherd management precludes the feasibility of an attempt to summarize all the recent research which has been conducted in the feeding management of beef cows.

A majority of the beef cows in the United States are on a spring-calving

program and are maintained throughout the year on native rangeland at the allocation of 10 to 25 acres per cow and calf. These cows usually have only natural occurring protection from climatic conditions for most of the year. Since this type of cowherd operation is the most common, particularly in the cow-country of the true prairie and great plains, it will be the primary subject of this report. However, brief mention will be made concerning some feeding management aspects of other common cowherd management practices.

#### The Basic Ration of the Beef Cow

The beef cow is primarily a forage consumer. She can utilize forage of practically any quality in producing animal protein, in the form of a calf, and at the same time maintain her own body in a functionally reproductive state.

This ability is the direct result of micro-organismic action in the cows rumen whereby cellulose and other carbohydrates are broken down to short chain or volatile fatty acids (VFA's). These VFA's are then used by the microbes, in combination with nitrogen from either a protein or non-protein source, to synthesis their own protein.

As the ingesta passes from the rumen to the omasum and abomasum some of the micro-organisms are carried with it. The micro-organisms are digested by the cow and yield high quality protein for the cow's assimilation. The quality of the microbial protein is such that no response to date has been obtained by the addition of essential amino acids to the ruminant diet.

According to Annison and Lewis (1959), the VFA's produced by the microbes in cellulose digestion are the main energy source for the cow. This assumption is based on the fact that the less complex carbohydrates, as well as cellulose, are readily attacked by the rumen micro-organisms.

Realizing that the diet of the beef cow is predominantly forage and that most of this consists of native grasses, it is appropriate to point out that the quality and quantity of the forage varies considerably due to seasonal changes. Forage quality and quantity varies from year to year depending on prevailing climatic conditions.

During part of the year, specifically late spring and the first three-fourths of summer, the available forage is usually all the cow needs to meet her nutritional requirements. However, at other times there must be adequate supplementation to insure a ration adequate for her requirements. During years of below average rainfall, the volume of forage may be deficient throughout the year.

In a New Mexico study it was found that the calf crop was reduced by 15 percent in a drouth year compared to years of average rainfall (Knox and Watkins, 1958). Calf crop was reduced 14 percent by heavy grazing as compared to light grazing in a Montana investigation (Marsh et al, 1959). In a trial with steers on native pasture, Kansas workers noted that late summer gains were depressed and that energy supplementation was beneficial in maintaining gains (Smith and Cox, 1953).

When beef cows received sufficient amounts of dry-cured native grass in an Oklahoma trial, it was found that they did not respond significantly to added energy during the wintering period (Zimmerman et al, 1959). It was also pointed out by these workers that the cost of winter supplemental feed is usually the largest cash out-lay in a cow-calf enterprise.

Effects of different levels of winter feeding of a spring-calving cow-herd can best be measured by variations in percent calf crop, regularity of breeding, longevity of the cow, calving date, birth weight of calves, weaning

weight of calves and calf survival rate from birth to weaning. These performance traits can logically be separated into reproduction traits and production traits. The reproduction traits would include; percent calf crop, regularity of breeding, calving date (influenced by the interval length from calving to rebreeding), and longevity or productive lifetime of the cow. The production traits include; birth weight, weaning weight and survival rate of the calves and mature cow weight.

## EFFECTS OF WINTER FEEDING LEVEL ON REPRODUCTION TRAITS

The immature beef female, up to about four years of age, has nutritional requirements for growth. This requirement is in addition to the requirements for maintenance and reproduction. Winter nutrition of the young beef cow deserves separate consideration because of this additional requirement.

Pinney et al (1960), investigated the effects of different levels of winter supplementation on reproductive performance for; first, second, and third calving cows. Three levels of feeding were used to establish predetermined body weight changes. The period of supplementation was from November 1, to April 18, and included parturition with its accompanying weight loss.

The feeding levels were designated as; low, medium and high. The body weight losses desired were; 20 percent, 10 percent and none, for the low, medium, and high levels respectively. In all cases the losses were slightly greater than anticipated. Changes in body weights were calculated, using November and April weights.

In this study it was found that young beef cows on the low level had; longer calving intervals, lower conception rates, and later average calving dates than the medium or high level cows. This difference was most pronounced in first calf heifers and diminished as the cows approached maturity. The nutritional requirements for growth of the first-calf heifers was undoubtedly responsible for this trend.

The cows on the high level tended to encounter more calving difficulties, especially the two-year-olds calving for the first time. As the cows approached maturity and by the time of third calf the variation between groups in percent calf crop declined considerably. The low level cows continued to have the lowest percent calf crop and the longest interval between

calving and rebreeding.

The period between weaning and first breeding, at about 13 months of age for heifers calving at two years of age, is critical to the growing and developing beef heifer. Not only must nutritive demands for growth be met, but the heifer must reach puberty and start cycling regularly before the start of the breeding season.

In order to determine the effects of varying levels of nutrition during the two winters between weaning and first-calving on reproduction traits, an experiment was conducted by Smithson et al (1964) at the Oklahoma Station. Three levels of winter nutrition based on desired body weight changes were used. The feeding levels were designated as low, moderate and high. Desired weight changes during the first winter as weaner heifers were; no gain, approximately 100 pounds gain and approximately 168 pounds gain for the low, moderate and high groups respectively. During the second winter, after a summer of grazing good pasture, the desired weight changes were; 150-175 pounds loss, 50 pounds loss, and no weight change for the low, moderate and high groups respectively.

Following the first two winters all heifers were maintained on the moderate level. The data concerning body weight changes are presented in Table 1. When all of the heifers received the moderate level, the winter weight losses were inversely proportional to previous weight losses. This suggested that if heifers are given the opportunity, compensatory growth can practically offset early growth repression.

The results of the experiment were somewhat inconclusive since no large variations in traits measured occurred. However, it appeared that the average calving date and percent calf crop were improved as the winter nutritional



level was increased. Birth weights and weaning weights for the first calf crop were also improved by additional winter nutrition.

Table 1. Effect of Winter Feed Level for Beef Females on Weight Change.\*

Feed Level	Low	Moderate	High
Av. Wt. Change, lbs.			
Initial Weight	438	438	438
8 to 18 Months of age			
Winter gains	-26	97	147
Summer gains	355	314	277
Net yearly change	329	411	424
19 to 30 Months of age			
Winter gains	-193	-128	-67
Summer gains	237	187	141
Net yearly change	44	59	74
31 to 43 Months of age			
Winter gains	-120	-166	-207
Summer gains	205	251	257
Net yearly change	85	85	50
Fall weight			
43 Months of age	991	1000	1022

\*Smithson et al (1964)

The second calf crop followed the winter of all moderate level feeding. The calves from the original low level cows had the heaviest birth and weaning weights, indicating again compensatory effects. Table 2 includes the summary of the reproduction data from this trial.

Probably the main effect of the first winter at a low level of nutrition is to delay the onset of puberty and, as a result, delay conception and average calving date as two-year-olds. Compensatory gains on good summer pasture

can offset the winter losses. The summer gains are usually inversely related to preceding winter gains.

Table 2. Effect of Winter Feed Level on Reproductive Performance.\*

Feed Level	Low	Moderate	High
Average calving date			
First calf	4/3	3/19	3/12
Second calf	4/6	3/26	3/1
Percent calf crop			
First calf	65	70	72
Second calf	73	76	62
Average birth weight (lbs.)			
First calf	65	71	72
Second calf	81	79	76
Average weaning weight (lbs.)			
First calf	388	408	412
Second calf	444	424	425

\*Smithson et al (1964)

Bedrak et al (1969) observed an emaciated condition and low reproductive performance in beef cows grazing pastures low in protein during the winter in Florida. A supplement of cottonseed meal improved the condition and reproductive performance in these cows. An experiment was designed to investigate the effect of varying levels of supplemental protein on performance of beef cows.

Four groups of cows were fed rations having the crude protein content as the only variable. All other nutrients were estimated to be adequate for a daily gain of 0.75 to 1.00 pound. The cows were two-year-old heifers being bred to calve at three years of age. The rations supplied the following

pounds of crude protein per cow daily; 1.34, 1.06, 0.71 and 0.62 for groups 1, 2, 3 and 4, respectively. Groups 1 and 2 gained 0.75 and 0.52 pound and group 3 and 4 lost 0.07 and 0.23 pound per day respectively.

Prior to the experiments, the heifers were on feeding trials where they were offered adequate levels of protein and energy over periods of 90 to 120 days and checked for estrus twice daily. During the breeding period, which began on the 113th day of the experiment, all heifers were bred at next estrus. Heifers which did not return in estrus were slaughtered 44 days following breeding. Those which returned in estrus following the first mating were rebred a second time and slaughtered after 44 days if they did not return in estrus. Heifers bred at the third estrus period were killed three days following the last breeding. Heifers which did not show estrus were slaughtered at random times with other experimental animals.

Reproductive performance for groups 1, 2 and 3 were not significantly different. However, group 4 appeared to have a depressed reproductive performance as indicated by a longer interval to first estrus and fewer estrus cycles.

Rumen filtrate was sampled at slaughter and it appeared that the level of protein intake had a direct effect on cellulose digestion. Those cows consuming higher levels of protein had increased feed utilization as compared to those on low protein intake.

From the results of this trial it appears that supplemental protein will help maintain gain and condition. However, it is doubtful if any reproductive response was exhibited in this experiment to added protein in the diet of these cows. A summary of the daily gain data is presented in Table 3.

Mature cows do not have the growth requirements for nutrients of young

beef females. Growth has essentially been completed by four or five years of age in the beef cow.

Table 3. Effect of Protein Intake on Average Daily Gain of Two-Year-Old Beef Heifers.\*

Group No.	Daily Crude Protein Intake (lb.)	Average Initial Weight (lb.)	Average Final Weight (lb.)	Average Daily Gain for 168 Days (lb.)
1	1.34	654	793	0.75
2	1.06	660	750	0.52
3	0.71	686	674	-0.07
4	0.62	697	640	-0.23

\*Bedrak et al (1969)

Wiltbank et al (1962) studied the importance of energy in reproduction of mature cows. An experiment was designed to test the effect of feeding two levels of energy either before or after calving on reproductive performance. Protein, calcium, phosphorous, and vitamin A were supplied in excess of the National Research Council (1963) recommendations. The cows were placed on experiment approximately 140 days prior to calving.

The cows were divided into four groups referred to as; high-high, high-low, low-high and low-low. The first designation refers to the relative amount of feed provided before calving and second to the feeding level after calving. The high level ration before calving contained approximately 9.0 pounds of T.D.N. and 1.43 pounds of digestible protein, while the low level contained 4.5 pounds of T.D.N. and 0.93 pounds of digestible protein. After

calving the high ration had 16.0 pounds of T.D.N. and 1.90 pounds of digestible protein and the low had 8.0 pounds of T.D.N. and 1.76 pounds of digestible protein.

The level of energy intake both before and after calving had significant effect on reproduction. The reproductive traits noted as being affected were; interval between calving and first estrus, conception rate, number of services per conception, and number of cows bred which did not conceive.

As shown in Table 4, the cows on the high-high regime had the fewest number of services per conception and a larger percent of cows conceiving on first and second service. The low-high group was next in reproductive performance, the high-low group was third and the low-low group had the poorest reproductive performance. There were significantly more of the "low-low" cows that failed to exhibit estrus and they had the largest number of services per conception.

Table 4. Effect of Energy on Occurrence of Estrus and Conception Rate.\*

Feeding Level	Interval Calving to First Estrus (days)	Not Showing Estrus (%)	Bred Not Conceiving (%)	Conceived (%)		
				(service) 1st	2nd	3rd
High-high	48	0	5	67	95	95
High-low	43	14	10	42	74	84
Low-high	65	5	0	65	75	100
Low-low	52	78	33	33	50	67

\*Wiltbank et al (1962)

With the results of all possible combinations of these various energy levels, it appears that energy supplementation is more critical than protein for mature cows. The period after calving, until ample grass is available, is the most critical. Heaviest supplementation should occur after calving for best reproductive performance. Flushing cows (cows gaining weight) after calving improved reproductive performance.

In a subsequent trial, Wiltbank et al (mimeo) studied the effect of level of energy intake after calving on reproductive performance. The rations used in this experiment were calculated to equal; 0.75 the N.R.C. maintenance requirements, total N.R.C. maintenance requirements, and full feeding. It was found that cows receiving higher levels of nutrition gained body weight faster and had improved reproductive performance. The reproductive traits showing improvement were; conception rate, interval from first calving to estrus and occurrence of estrus. A summary of the reproductive performance data from this experiment is presented in Table 5.

Table 5. Influence of Postpartum Energy Intake on Reproductive Performance of Hereford Cows.\*

Ration	Showing Estrus Days After Calving				Not Showing Estrus (%)	Cows Diagnosed Pregnant (%)	Cows Not Pregnant	
	50 (%)	70 (%)	90 (%)	110 (%)			No Estrus (%)	Bred (%)
3/4 Main.	7	43	64	71	21	72	21	7
Main.	57	78	93	93	7	79	7	14
Full-fed	15	46	77	92	8	92	8	0

\*Wiltbank (Mimeo)

The results indicate a close correlation between body weight gain and reproductive efficiency in beef cows. In the Year Book of Agriculture (1939) Friedman and Turner state that reproductive performance appears to be closely related with adequate nutrition for good growth in the young and general good health in mature animals. Any nutrient deficiency which causes reduced growth or poor general health will cause reproduction problems.

In a beef breeding herd where less than one calf is marketed per cow each year a large portion of the feed intake goes for maintenance of the cow and calf and is not returned in product. Through research it has been shown that the maintenance requirements for an animal is related to its size. Also, it has been shown that the effect of winter body weight change on reproductive performance depends to a degree on the condition or fatness of the cow going into the winter. The National Research Council (1963) has expressed the nutrient requirements of mature, pregnant cows on the basis of an average weight of 477 kg. for the major beef breeds.

Research was conducted by Klosterman et al (1968) and Kress et al (1969) to determine the effect of cow size and condition upon maintenance requirements and efficiency. It was found that a direct relationship exists between a weight-height ratio (W/H ratio) and the degree of fatness in beef cows. When this W/H ratio principle was applied to the feeding management of winter supplemental feed it was found that some adjustment might be necessary in N.R.C. recommendations according to the condition of the cow.

Cows that had a high degree of finish tended to gain weight while thin cows lost weight when the amount of energy fed was based on their metabolic body size. These experiments indicate that an accurate description of the amount of feed needed for the maintenance of an individual mature beef cow

should be based on a measure of condition in addition to body weight. The concept of a simple ratio of weight to height would appear to be a relatively accurate method for determining the degree of condition in beef cows.

Kiracofe et al (1969) at the Kansas station designed an experiment to determine the effect of varying levels of winter nutrition on the reproductive traits of beef cows. The cows were maintained year-round on native bluestem pasture with three pounds of alfalfa per day from November 1, to May 1, as the basic ration. They were divided into four groups according to treatment. Rations consisting of; three pounds cracked milo and 1.5 pounds of soybean oil meal, or three pounds of cracked milo, or 1.5 pounds of soybean oil meal for groups 1, 2, and 3 respectively. Group 4 served as the control and received no supplementation in addition to the alfalfa hay.

The winter rations were formulated so group 1, the high energy and high protein ration, would approximately maintain the cows weight from November 1, to May 1. All other rations were designed to cause varying amounts of weight loss. As would be expected, the low energy and low protein content of the basal ration caused group 4 to encounter the greatest weight losses. No attempt was made to estimate the amount of winter pasture consumed.

The results of the trial indicate that conception rate was lowered and the interval from calving to conception was lengthened by low energy and low protein during the wintering phase. Table 6 shows the effect of the winter feeding levels on postpartum conception. Conception rate was highest for group 2. The interval between calving and conception was shortest for group 1 with group 2 and 3 intermediate and group 4 the longest.

It was noted in this trial that late calving cows having access to early growth of forage were less likely to exhibit differences in the reproductive traits. This may be a reason that Oklahoma and Nebraska work mentioned



earlier in this report had some contradiction. The growing season in Oklahoma starts earlier in the spring and extends later into the fall than in Nebraska.

Table 6. Effect of Wintering Level on Reproductive Performance of Beef Cows.\*

Winter Ration	Conception Rate (%)	Days from Calving to Conception
3.0 lb. Milo and 1.5 lb. SOM	92	52.0
3.0 lb. Milo	100	58.0
1.5 lb. SOM	91	59.2
Control	73	69.2

\*Kiracofe et al (1969)

Theoretically, the maintenance of beef cows on native range during the entire year should be considered the natural environment. Even if this is true, it is not unreasonable to assume that sub-optimum range conditions could develop in years when climatic conditions are other than normal. Rainfall is a climatic factor that varies considerably and has much influence over quantity and quality of forage produced in a given year.

In addition to energy and protein, the amount of carotene (vitamin A precursor) in range forage is affected by drouth. Pope et al (1958) in Oklahoma found no advantage in favor of vitamin A supplementation. However, even though there was no response in reproductive performance, it was noted that the blood and liver stores of vitamin A in the calves was drastically low at the end of three months. It was felt by these workers that extremely

high levels of vitamin A had to be fed to the cow for any of it to pass to the calf via the milk.

Above average rainfall after the forage has matured in the fall tends to leach nutrients, especially minerals, from the winter feed supply. However, when Tillman et al (1959) fed weathered range grass to cows in dry lot for 172 days no benefit was found with mineral supplementation. Their speculation was that when energy and protein were adequate, using grain as a source of the supplemental nutrients, the mineral requirements were met.

## EFFECT OF WINTER FEEDING LEVEL ON PRODUCTION TRAITS

The amount of feed required for maintenance of the cow and calf results in a relatively small return in product (pounds of calf weaned) from the annual feed consumed. The cow-calf operation is probably the least efficient of all livestock enterprises. Any practice which will result in returns above the cost of implementing the practice should be given a due amount of consideration by the producer.

The production traits which have been shown to be affected by wintering level are; calf birth weight, calf weaning weight, longevity of the cow and mature cow weight. All of these traits have a direct influence on the profit realized from a cow-calf operation. "Efficiency" seems to be the key word in industry today and the cow-calf operation is no exception.

The work of Kress et al (1969) at Wisconsin showed that the estimates of production efficiency used in the trial were negatively related to the ratio of weight to height at the withers, an estimate of fatness. The estimates of efficiency of production used here were the units of weaning weight equivalent per unit of TDN consumed by the cow and calf and units of actual weaning weight produced per unit of TDN.

If a portion of the variation in efficiency due to differences in fatness could be controlled by feeding practices, economy of production should be improved with less intense feeding of fleshy cows. Indications were that skeletally large and small cows are approximately equal in efficiency, provided they have equal weight to height ratios, with a possible advantage for the large cow. The fact was also pointed out that the calf from the larger cow has the genetic potential for more efficient post-weaning gains.

Ludwig et al (1967) reported a summary of performance of spring-calving

cows wintered at different levels from weaning through seven calf crops. The experimental treatments employed were designed to result in selected winter weight change patterns as follows:

Low - No gain the first winter as calves, with a loss of approximately 20 percent of fall weight during subsequent winters as bred females.

Moderate - Gain of 0.5 lbs. per head daily the first winter as calves, with a loss of 10 percent of fall weight during subsequent winters as bred females.

High - Gain of 1.0 lb. per head daily the first winter as calves, with less than 10 percent loss of fall weight during subsequent winters as bred females.

Very High - Self-fed a 50 percent concentrate mixture during the first winter as calves and during subsequent winters as bred females.

It should be noted that these weight change patterns were changes from November to mid-April and included weight loss at calving and post-calving loss until green grass is ample in the spring.

As shown in Table 7, these workers found that cows on the low level produced calves with lighter birth and weaning weights than those on the medium or high levels. The very high regime resulted in birth weights lower than the moderate or high levels and equal to the low level. However, due to a shorter longevity and lower percent calf crop, the very high level caused a drastic reduction in total pounds of calf weaned for the seven calf crops.

It was also noted in this study, that even though the low level cows lost more weight during the winters, the compensatory gain during the summers resulted in similar mature weights between the low, moderate and high groups. The lower weaning weights in the very high group were probably due

to a depression in milk production caused by fat deposition in the mammary glands.

Table 7. Performance of Beef Cows Wintered at Different Levels Through Seven Calf Crops.\*

Treatment	Low	Moderate	High	Very High
Cows remaining after seven calf crops (%)	83.4	86.7	80.0	73.3
Percent calf crop weaned per treatment	86.3	88.3	85.9	83.7
Average birth weight (lbs.)	75	77	79	75
Total pounds of calf weaned	69,546	79,410	73,616	33,461

\*Ludwig et al (1967)

Young cows appeared to show more pronounced response to the different levels of winter nutrition than mature cows. However, for the duration of the life-time study it seemed that the moderate level was most desirable under the conditions existing in Oklahoma.

In several trials conducted by Wiltbank, in Nebraska, to determine the effect of varying levels of winter nutrition on reproductive performance it was noted that low energy and low protein intake was accompanied by lighter birth and weaning weights. This feeding regime also caused greater winter weight losses in the cows but was compensated for by greater summer gains.

In the winter and during drouth years, forage intake is limited. Even when adequate quantity of forage is available, the quality is often low.

A study was conducted by Speth et al (1962) in southern Nevada to determine if dietary supplements could increase productivity of cows under adverse seasonal and climatic conditions. The cows in this experiment grazed semi-desert range during the entire year. The supplements were fed from November to May and the trial was of five year duration.

The treatments consisted of the following supplements: None (control), 1 pound of barley daily, 1 pound of either soybean or cottonseed oil meal daily, or 3 pounds of alfalfa. All supplements were pelleted. All cows were exposed to the same bull or bulls for any given year.

The cows receiving the control diet lost considerably more weight during the winters, had a much lower percentage of calves produced and lower calf weaning weights than cows in any of the other treatment groups. However, the cows receiving the commercial protein had a much higher incidence of calves born dead. Knox and Watkins (1958) reported calf losses at birth were increased when cows were fed a commercial protein supplement on range. Neither of these investigators attempted possible explanations for this phenomenon.

Cows receiving 3 pounds of alfalfa or 1 pound of barley had greater production per cow in pounds of calf weaned than either the control or protein supplemented groups. Annual weight changes of the cows due to treatment were not significant because cows having lost the most weight during the winter gained the most the following summer. A summary of this study is presented in Table 8.

Conner (1962) observed, by sampling range forage with rumen fistulated steers, that cattle change the relative amounts of grass and browse in the diet late in the summer. The browse tends to be higher in protein at this time. This may partially explain the lowered response to protein supplementation in favor of energy supplementation that has been noted by several

researchers.

Table 8. The Effect of Dietary Supplements on Mature Cows and Weaning Weights of Their Calves.\*

Supplement	None	Barley 1 lb.	Commercial Protein, 1 lb.	Alfalfa 3 lb.
Cows per treatment	60	58	61	59
Daily weight changes				
Winter (171 days)	-.21	0.03	0.14	0.09
Summer (184 days)	0.54	0.25	0.01	0.13
Yearly (355 days)	0.18	0.12	0.07	0.11
Cows calving, %	48.2	72.5	63.9	66.7
Calves born dead, %	3.3	0.0	16.7	1.7
Weaning weights, 6 mo.	264	298	289	288
Production per cow, lbs.	119	216	136	187

\*Speth et al (1962)

Lighter weaning weights (caused by reduced milk flow), shorter productive life, and a reduction in pounds of calf weaned during a cows lifetime have been shown to accompany very high nutritional levels during development of beef heifers.

Pope (1965), noted an inverse relationship between very high nutrition during heifer development and longevity in the cowherd. On the other hand, it has been shown that a most critical period in the cows productive life is at time of first-calving. This is particularly true when first-calving occurs at two years of age. Limiting energy at this time has caused lighter birth weights, reduced milk production and lighter weaning weights, as well

as delaying rebreeding. Also, since first estrus occurs at about 600 pounds of body weight, sufficient nutrition during the heifers first winter is mandatory if breeding for two-year-old calving is desired.

As cows mature the response to supplementation, on range providing adequate forage intake, is less pronounced. However, the quality of weathered forage is usually reduced to the point where at least a low to moderate level of supplementation would be desirable.

Supplementation of minerals or vitamins for beef cows under range was not considered in any of the experiments reviewed by the author. Calcium, phosphorous and vitamin A have been included in several dietary studies with no consistent or significant responses being observed. Tillman (1959) observed that cows on weathered range forage appeared to have glossier hair-coats when supplemented with steam-bone meal but found no other measurable response.