EFFECT OF VARIED GROWTH FROM BIRTH THROUGH THIRTY MONTHS OF AGE ON THE PERFORMANCE OF BEEF HEIFERS

by

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INTRODUCTION

A major part of the maintenance of a cow-calf herd involves the development of replacement heifers. A replacement heifer represents a considerable investment in labor, feed, and operating costs before any return on this investment is realized. Improper management of a heifer from weaning to when she is pregnant with her second calf is also costly. Income is lost due to low calf weaning weights when heifers fail to breed early in the breeding season. Herd replacements are lost when heifers fail to conceive as yearlings or as first-calf heifers following parturition, due to improper prebreeding nutrition. Difficult parturitions, due to mismanagement is costly in terms of additional labor, medication and losses of cows, salable calves and herd replacements.

Numerous researchers have studied various levels of nutrition in the heifer 5 to 7 months prebreeding. Others have studied the effect of various levels of nutrition during late gestation in the bred yearling; however, few studies have related different nutritional management the first year as weanling heifers with management the second year as gestating yearlings.

Information is needed to determine: 1. The optimum nutritional level for replacement heifers; and 2. when the nutritional level can be reduced and not interfere with critical growth periods that damage subsequent performance. The objective of this study was to determine the effect of periodic growth from birth through 30 months of age on production and reproduction in the beef cow. In addition, a trial was conducted to study the effect of feeding varying levels of energy to bred yearling heifers in mid- and late-gestation on heifer performance.

REVIEW OF LITERATURE

Age at puberty becomes more critical under current management systems where heifers are expected to calve at approximately two years of age. Age at puberty is influenced by sire within breed (Laster et al., 1976), level of nutrition (Joubert, 1963; Bellows et al., 1965; Arije and Wiltbank, 1971; Laster et al., 1976) and growth rate (Reynolds et al., 1963; Wiltbank et al., 1966; Arije and Wiltbank, 1971). Laster et al. (1976) reported physiological maturity is influenced by genetic variation within a breed. Arije and Wiltbank (1974) found the average age at puberty for Angus, Hereford and Shorthorn heifers was 369, 433 and 372 days, respectively. These data are slightly higher than 337, 412 and 318 days for Angus, Hereford and Shorthorn heifers, respectively, reported by Wiltbank et al., (1966). The differences in the two sets are relative by breed, indicating the differences may be due to nutrition or other environmental factors. Blakely (1964) and Wiltbank et al. (1965) associated anestrus and delayed puberty with a low plane of nutrition. Smithson et al. (1964) found the main effect of a low level of nutrition the first winter is a delayed onset of puberty. Short and Bellows (1971) reported gain from 7 to 12 months of age produced unadjusted group average puberty ages of 433, 411 and 388 days for heifers receiving a low (fed to gain .23 kg/day), a medium (fed to gain .45 kg/day) and a high (fed to gain .68 kg/day) level of nutrition, respectively. Fewer of the low and medium heifers were in estrus before the breeding season and fewer of the low heifers were in estrus during the 60 day breeding season. Wiltbank et al. (1966) reported a negative regression of age at puberty on pre- and post-weaning average daily gain. Arije and Wiltbank (1971), in a study involving Hereford heifers, reported heifer weight had a greater influence on puberty than age. High preweaning average daily gain and heavy weaning weights were highly associated with early age and greater weight at puberty. The effect of preweaning growth rate and management on the age at puberty, was further pointed out by Varner et al., 1977. At weaning, heifers were divided into three groups. Group "R" were randomly selected from all heifers, group "H" were heifers with above average weaning weight, and group "L" were heifers with below average weaning weights. All groups were fed to reach the same prebreeding weight. Regardless of winter feeding system a higher percentage of the above average weaning weight heifers reached puberty by the beginning or during the breeding season. More of the "L" group reached puberty (79% vs 60%) than the below average heifers fed in the randomly selected group.

Reproductive efficiency can be defined as the percentage of cows which become pregnant in the breeding season and the length of calving interval. The advantages of having cows bred as early as possible in a breeding season were listed by Wiltbank (1970) as: 1. weaning calves from late conceiving cows are younger and consequently lighter than calves from cows that conceived early in the breeding season; 2. factors such as nutrition, losses at parturition and calfhood diseases can be more adequately controlled; and 3. opportunity for individual cows to have a calving interval within 12 months is greater in a shorter breeding period. Age at puberty and whether a heifer has her first calf early or late in the calving season are of prime importance in determining her lifetime production potential (Zimmerman et al., 1957; Lesmeister et al., 1973). Burgess et al. (1954), Nelmes and Bogart (1956), Morrow and Brinks (1968) and Lesmeister et al. (1973) reported calves born early in the calving season had faster preweaning average daily gain and therefore heavier weaning weights. This may be due to older calves being able to utilize grass to a greater advantage as well as being able to consume a larger portion of the dams milk as she approaches peak lactation. Lesmeister et al. (1973) and Sprott and Wiltbank (1978a) unpublished, reported heifers calving early in the calving season with their first calf tend to calve early in the calving season throughout their productive lives. Lesmeister et al. (1973) also reported early calving heifers had higher average annual lifetime calf production than late calving heifers.

The affect of proper nutrition on reproduction has been realized for many years. Johnson (1930) reported animals gaining in flesh during the breeding season, due to good nutrition, produce a higher percentage of calves. Since that time studies by Pinney et al. (1960, 1962b and 1972), Smithson et al. (1964), Dunn et al. (1965), Hill and Godley (1974) and Turman et al. (1965) reported the level of nutrition markedly effects average conception date and conception rate. Average calving dates (Turman et al., 1965) were reported as 3-24, 3-17 and 3-6 for heifers receiving a low (fed to make no gain during the winter period), a medium (fed to gain .5 lbs/hd/day) and a high (fed to gain 1 lb/hd/day) level of winter nutrition, respectively. Pinney et al. (1960) reported similar data where average calving dates were 3-23, 3-15, 3-4 and 2-26 for heifers fed a low, moderate, high and very high level of winter nutrition, respectively. All heifers conceived in all groups during a 105 day breeding season. Short and Bellows (1971) studied growth and reproduction using three groups of heifers fed to gain .23, .45 and .68 kg/day from 7 to 12 months of age. Pregnancy rates for a sixty day breeding season were 60%, 90% and 90% for the low, medium and high nutrition levels, respectively. The high level of nutrition significantly increased body weight and condition score by the end of the winter as compared with the medium and low levels. The heifers on the low nutrition level, gained more the following summer on grass, but still weighed less at the end of the summer, than heifers on the high level of nutrition. The average conception date was also delayed in heifers receiving the low level of nutrition prebreeding. These studies suggest conception date is affected more than conception rate by improper winter nutrition as weanling heifers.

The affect of nutrition on weight and condition change of gestating yearling heifers is important due to its subsequent effect on performance. Corah (1974) reported average weight changes of 36.1 kg and -5.8 kg when feeding bred yearling heifers 100% NCR recommended level of TDN and 65% of NRC, respectively, during the last trimester of gestation. Pinney et al. (1972) reported average winter weight changes during the supplemental feeding period of -38, -21 and -23 kg when gestating yearling heifers were fed a low (60% of NRC), a medium (120% of NRC) and a high (200% of NRC) level of protein, respectively. Bond et al. (1964) and Bond and Wiltbank (1970) reported heifers on a low level of energy or protein weighed less at parturition than heifers on higher levels, with energy having a greater effect. Bond and Wiltbank (1970) reported weights at the end of the feeding period of 397, 321 and 212 kg for high, medium and low levels of energy, respectively, while weights of 348, 325 and 258 were reported for high, medium and low levels of protein, respectively. Pinney et al. (1962b) fed three groups of gestating heifers to lose 20% of their fall body weight, 10% of the fall body weight and to maintain their fall body weight through the winter feeding period. Five times more feed was required to maintain the fall body weight than to lose 20% of their fall body weight.

Calving difficulty is a commonly experienced problem in first calf heifers. With more emphasis on growthier calves and heavier weaning weights, larger calves at birth and more calving problems can be expected. Bond et al. (1964) and Bond and Wiltbank (1970) reported heavier calf birth weight from gestating yearling heifers fed a high level of energy, while the level of protein fed had no effect on birth weight. Turman et al. (1964) reported calves 6.3 kg heavier at birth when their dams were fed a high vs low level of energy and protein. Less drastic differences (2 kg lighter) in calf birth weights were reported by Corah (1974), when yearling heifers in late gestation were fed 65% NRC recommended allowance for TDN as compared to 100% NRC, with protein held constant. Similar results have been reported by Young (1970), Tudor (1972) and Early et al. (1977). Mean calf birth weights born to Angus and Hereford cows of 26.3, 27.9 and 29.0 were reported by Laster (1974) when fed 4.9, 6.2 and 7.7 kg TDN/hd/day, respectively, for 90 days precalving. These results explain the positive correlations found between calf birth weight and precalving condition of the dam, reported by Bellows et al. (1971a) and Deutscher (1978). Knapp et al. (1940 and 1942), Dawson et al. (1947), Woolfolk and Knapp (1949), Gregory et al. (1950), Burris and Blunn (1952), Sagebiel et al. (1969), Rice and Wiltbank (1970) and Laster et al. (1973) reported male beef calves range from 4.2 to 5.8 lbs heavier at birth than females. Burris and Blunn (1952), Koone and Dillard (1967), Bellows et al. (1971a) and Smith et al. (1976) reported 1.3 to 1.9 days longer gestation period for males. Smith et al. (1976) reported a regression of calf birth weight on gestation length of .25

kg/day calculated on a within breed basis. This was in close agreement with .30 and .20 for Hereford and Angus breeds, respectively, reported by Bellows et al. (1971a). Sire within breed was reported to effect calf birth weight (Koch and Clark, 1955 and Lasley et al. 1961). Koch and Clark (1955) and Lasley et al. (1961) reported heritabilities for birth weight of 42% and 67%, respectively.

Studies by Anderson and Bellows (1967) showed dystocia, defined as a delayed or difficult parturition, to be the most common cause of perinatal calf death. Bellows et al. (1969), Rice and Wiltbank (1970) and Bellows et al. (1971b) when separating dystocia causative factors into those attributed to the dam and those attributed to the calf, found pelvic area of the dam at a constant weight and calf birth weight to be the two most important. After taking precalfing measurements on ninety 2-year-old first-calf Hereford heifers, Rice and Wiltbank (1970) reported dystocia rates of 68.8% in cows with pelvic areas less than 200 cm^2 and 28% for cows with pelvic areas of over 200 cm^2. Corah (1974) reported assistance in parturition was required for 37.5% of the heifers with pelvic areas below 220 cm^2, 29.4% of the heifers with pelvic areas from 220 to 240 cm^2, and no assistance for heifers with pelvic areas over 240 cm^2. Ward (1971) reported 38% of the herd had precalving pelvic areas of less than 225 cm^2 and half of them experienced calving difficulty. In contrast, Laster (1974) found the most important factor associated with pelvic area was cow weight, but was unable to associate pelvic area to dystocia at a constant cow weight. When looking for linear and quadratic effects of pelvic area on dystocia, Laster (1974) wasn't able to find any threshold points for the influence of pelvic area on dystocia either within or across breed groups. He concluded the heavier 2-year-old dams had larger pelvic openings but had proportionally even larger calves. Sagebiel et al. (1969), Nelson and Huber (1971), Laster et al. (1973) and Laster (1974) reported higher incidences of dystocia in heifers giving birth to calves with above average birth weights. Increased incidences of dystocia have been reported in male calves (Nelson and Huber, 1971; Laster et al., 1973; Laster, 1974; Brinks et al., 1973; Fredeen et al., 1974) which may be due to the heavier birth weight of males. Smith et al. (1976) reported dystocia level increased linearly with birth weight both across and within breed groups when analyzing 2,368 births from Hereford and Angus cows bred to Hereford, Angus, Jersey, South Devon, Limousin, Charolais and Simmental sires. The Charolais and Simmental sires had faster preweaning average daily gain, larger birth weights and more dystocia. South Devon and Limousin crosses were intermediate in birth weight and slightly below Charolais and Simmental in dystocia level. Jersey crosses had lighter birth weights and experienced significantly less dystocia. When averaged over all dams, a 1 kg increase in birth weight within a breed group results in 1.63±.20% increase in dystocia rate. Breed of sire, breed of dam and sire within breed have all been shown to influence dystocia level (Brinks et al., 1973; Laster et al., 1973); Laster, 1974; Sagebiel et al., 1969; Monteiro, 1969). Brinks et al. (1973) reported the heritability for calving difficulty to be very low. He found heifers that were 31 to 46% inbred had significantly higher incidences of calving difficulty. In a winter nutrition trial reported by Pinney et al. (1960) four groups of gestating yearling heifers were fed a low, medium, high and very high level of nutrition. Five of the fourteen calves born in the very high nutrition group died at birth. At least two of the deaths were reported to be directly due to difficult parturition. The low and medium groups showed a definite advantage over the high and very high groups in ease of calving. Nelson and Huber (1971) scoring the flesh condition of first calf heifers at precalving, found the percent of cows requiring assistance at calving was 8%, 19% and 28% for cows classified as below average, average and above average flesh condition, respectively. Young (1970), Tudor (1972), Corah (1974) and Laster (1974) reported differences in calf birth weight but no effect on percent calving difficulties when various levels of energy were fed the last trimester of gestation.

A major portion of calf deaths occur within 24 hours of birth (Wiltbank et al., 1961a). Wiltbank and Lefever (1961b), Anderson and Bellows (1967) and Brinks et al. (1973) reported calving difficulty was the major cause of calf deaths, with losses usually occurring at or near birth. In heifers on a very high level of nutrition, Pinney et al. (1960) reported a portion of the many calf losses seen were directly related to difficult births. Anderson and Bellows (1967) reported 79% of the calves lost at or near birth were anatomically normal, with the most common cause of death being attributed to injuries resulting from difficult delayed parturitions. Laster et al. (1973) reported death losses of 20% where difficult deliveries were experienced and 5% where little or no assistance at parturition was required. Smith et al. (1976) reported death losses of 11.5 and 3.1% for assisted and unassisted deliveries, respectively. Koger et al. (1967) reported a highly significant quadratic effect of birth weight on calf survival. After reporting a larger portion of small calves result in perinatal deaths because they are weak at birth, Monteiro (1969) suggested consideration be given to the degree of birth weight reduction. Corah (1974) reported a slightly higher death loss, due to weak calves, when heifers were fed a restricted diet (65% NRC for TDN) the last trimester of gestation.

The breeding season following a cows first parturition is the most difficult to obtain conception. Baker and Quesenberry (1944) found the lowest calving percentage to occur in cows four years of age. The lowest conception rates occurred at three years of age, following the first calf. Baker and Quesenberry (1944) reported calf crops were lowered 10 to 15%

the year following a drought year. When studying the effect of stocking rate on reproduction in beef cattle, Marsh et al. (1959) reported average calving percents of 92.5% on moderately and lightly stocked ranges and 77.5% on heavily stocked range. The cows on the heavily grazed pasture tended to skip a year between calvings. Supplementing cattle on pasture with silage and hay drastically improved conception rates (Lantow and Snell, 1924). Smithson et al. (1964) studying the effect of poor nutrition the first and second winters on the reproductive efficiency of beef heifers, felt poor management the second winter was more damaging since the heifer at this time must undergo the strain of calving and lactation while continuing to grow and develop. In the same study, the poor nutrition fed to bred yearlings resulted in delayed rebreeding and reduced conception rate. Sprott (1978, unpublished) reported beef heifers that are thin at calving have poor reproductive performance in the subsequent breeding season. Turman et al. (1964) reported precalving nutrition may have a greater influence on final conception rate, while postcalfing nutrition may have a greater effect on conception day. The importance of early conception has been previously reviewed. Turman et al. (1964 and 1965) and McCartor (1972) found the length of the interval from calving to conception depends largely on the level of nutrition provided during the previous wintering period. When feeding gestating heifers a high, medium and low level of nutrition precalving, Turman et al. (1965) reported the medium and low nutrition groups had average conception dates 3 and 5 weeks later, respectively, than the high level group. The days from calving to conception were reduced by 46 and 49 days as compared with controls when groups were fed 3 and 6 lbs of corn per head per day, respectively (Early et al., 1977). The effect of calving difficulty on subsequent reproduction is complex and poorly understood (Konermann et al., 1969). Brinks et al. (1973) reported heifers which had experienced difficult parturitions as two year olds had a longer production interval than heifers with no calving problems. In a study where 47 percent of the heifers required assistance at calving, Turman et al. (1965) found no significant association between calving difficulty and rebreeding performance. Instead, slightly shorter intervals from calving to conception were seen in heifers which had very difficult and cesarean deliveries. Laster et al. (1973) reported a 11.6% lower conception rate during a 45 day AI period and a 8.2% lower final conception rate in heifers that had experienced dystocia in their previous parturition, while the length of the interval from calving to conception differed by only 1.2 days.

Approximately 60% of the variation in calf preweaning performance is accounted for by milk production level of the dam (Neville et al., 1960; Hohenboken et al., 1973). Furr and Nelson (1964) found preweaning average daily gain and calf weaning weight were excellent criteria for selecting range cows for milk production. The level of milk production has been found to be a direct effect of the nutrition provided both pre- and post-calving (Neville et al., 1960; Nelson et al., 1962; Pinney et al., 1962b; Bond et al., 1964; Smithson et al., 1964; Turman et al., 1964). Neville et al. (1960) studied the effect of three levels of nutrition on milk production, when fed six weeks prior to calving to four months of lactation. Milk production levels at day 120 of lactation were 8.5, 10.2 and 11.5 lbs/day, and on day 240 of lactation the levels were 8.1, 9.6 and 10.5 lbs/day for a low, medium and high level of nutrition, respectively. The various levels of nutrition had an influence on the level of milk production at the time they were fed, as well as four months post-feeding. Nelson et al. (1962) reported milk production levels of 5.33 and 6.54 kg/day where a low and a high level of winter nutrition had been fed. Pinney et al. (1962a) reported poor winter nutrition fed the second winter as a gestating yearling heifer, seriously reduces milk flow the following summer and calf weaning weights. Gregory et al. (1950) and Hohenboken et al. (1973) reported a negative relationship between cow gains during lactation and preweaning calf gains, suggesting the increased cow gains occur at the expense of milk production and therefore calf gains. Bond et al. (1964) found gestating yearling heifers fed a low protein or low energy level the winter prior to calving produced less milk during their first lactation, than heifers on higher levels.

Furr and Nelson (1964) in a study involving fall calving cows reported a slight increase in milk production level when a high level of winter supplemental feed was fed in comparison with a low. In the same study, the milk production levels steadily decreased through the winter period, rising markedly in the spring before declining up to weaning. The cows that had been on the high nutrition level peaked higher in the spring and maintain production longer than cows on the low nutrition level. This may be related to work by Burgess et al. (1954), Nelms and Bogart (1956), Morrow and Brinks (1968), Lesmeister et al. (1973) who reported greater average daily gains in calves born early in the calving season. The higher average daily gains may be due to older calves having greater capacity to consume a larger portion of the dams milk as she approaches her peak lactation as well as possibly having a greater ability to utilize grass to a greater advantage. The capacity of the younger calf may also be limiting the level of milk produced (Gleddie and Berg, 1968), therefore if a cow reaches her peak milk production at the time she is suckling an older calf which is able to consume more of the milk, the dam will maintain the high level of milk production for a longer period of time. Boston et al. (1973) when studying whether the milk producing ability of a cow may be damaged by over conditioning as weanling heifers reported it may be with Angus cows but found no differences in Hereford cows. Swanson (1960) and Arnette (1963) with dairy and beef heifers respectively, reported a decrease in milk production due to overfat heifers. After recording weights and flesh condition scores at weaning and at 20 months of age, Koger and Crane (1974) reported no relationship between condition of heifer and milk production. The 20 month weight was found to be the best predictor of milk production.

The literature indicates there is an extreme importance of managing first calf heifers for early calving in a definite calving season with a definite time of weaning. Literature suggests a larger proportion of replacement heifers should be kept, bred, pregnancy tested and culled at the end of the breeding season if open. The heifers that conceived and calve earliest in the calving season immediately indicate a greater productivity and should be given selection preference. The literature suggests proper selection for rapid growth and early sexual maturity in yearling beef heifers and an adequate nutritional regime are essential for maintaining beef herds for early, consistent calvings throughout their productive lives.

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EFFECT OF VARIED GROWTH FROM BIRTH THROUGH THIRTY MONTHS OF AGE ON THE PERFORMANCE OF BEEF HEIFERS

SUMMARY

Polled Hereford heifers were used to study the effect of growth rate from birth through thirty months of age on the performance of heifers calving as two year olds. Heifers with high gains the first winter as weanling heifers had higher breeding efficiency when bred as yearlings, had larger pelvic areas as two year olds, gave birth to larger calves, had less calving difficulty at first parturition and had higher breeding efficiency at the subsequent breeding. Calf performance was positively related to the first winter gain of the dam.

Heifers with high second winter gain had less calving difficulty at first parturition, slightly higher milk production and slightly higher breeding efficiency when rebred. Second winter gain of the dam had a high negative relationship with calf performance from birth to weaning.

Heifers with high first winter gains and low second winter gains had the largest pelvic areas, least difficult assists and fastest calf growth to weaning. However, similar calf growth was found in heifers with low first winter and low second winter gains, as well as the best reproductive efficiency at the subsequent breeding.

INTRODUCTION

The importance of properly developing the replacement beef heifer has long been recognized. However, differences of opinion still exist among producers in regard to the best nutritional level for proper development. Extremes in the levels used have ranged from creep-fed heifers that are placed on full feed at weaning, to poorly mothered heifers that are provided a maintenance ration following weaning. Research has shown neither extreme is desirable; high levels have resulted in reduced life span and impaired milking ability (Swanson, 1960; Arnette, 1963; Pinney et al., 1972); while low levels have resulted in poor reproductive performance (Smithson et al., 1964; Turman et al., 1964 and 1965; Early, 1977), reduced milk production and poor weaning weights (Neville et al., 1960; Nelson et al., 1962; Pinney et al., 1962a). The level of energy fed precalving has influenced birth weight (Bond et al., 1964 and 1970; Turman et al., 1964; Corah, 1974), and calf birth weight has been found to be the most important dystocia causative factor attributed to the calf (Bellows et al., 1969; Rice and Wiltbank, 1970; Bellows et al., 1971b), however, no direct relationship has been established between calving difficulty and precalving nutrition.

Several researchers have studied the effects of either the first or second winter nutrition of the heifer, although few have studied interactions between the first and second winter nutrition. It was the objective of this study to determine the effects of periodic weight change on heifer development, reproduction and performance at parturition.

MATERIALS AND METHODS

To study the effect of periodic growth from birth through 30 months of age on the performance of beef heifers, data was collected on 156 Polled Hereford heifers over a three-year period. All heifers came from the same herd, which was involved in a feed efficiency selection study (Blum, 1976). Heifers were all spring calves born within a 60 day calving season. They were identified and weighed immediately after birth. They remained with the dam to weaning at 6 or 7 months of age. The first winter as weaner heifers they were randomly allotted to various high roughage nutrition studies (Bolsen et al., 1974 and 1975; Bolsen and Riley, 1976) in which the average daily gains ranged from .09 to .9 kg/hd/day. All sound heifers as yearlings were bred artificially for 45 days and placed with bulls 15 days, for a 60 day breeding season. All heifers were grazed as a group from May 1 to November 1. In November, all heifers were palpated to confirm conception dates and detect open heifers. All open heifers were removed from the study. All pregnant heifers were randomly allotted within weight, condition and expected calving date, into four treatment groups where the effect of varied energy levels were studied (Corah et al., 1978). Heifers remained on the second winter nutrition study until parturition. At parturition, heifers were scored according to the degree of calving difficulty (1=no assistance, 2=slight assistance, 3=difficult delivery, 4=very difficult delivery, 5=cesarean delivery). All calves were identified and weighed immediately after birth. Following parturition all heifers were put on the same ration balanced to meet NRC requirements for energy, protein and minerals until May 1. From May 1 to October 1 (weaning) all dams and calves were grazed on summer grass. Starting May 20, all heifers were bred artificially for 45 days and then placed with the bulls 15 days, for a 60 day breeding season. At the time of weaning, all heifers were palpated to confirm conception dates and pregnancy.

From birth through 30 months of age (weaning of their first calf) all heifers were weighed monthly. Starting at six months of age, height measurements (at the withers) were taken semi-annually to 30 months of age. A weight to height ratio was used as a measure of conditioning. Horizontal and vertical internal pelvic measurements were taken prior to calving. The two pelvic measurements were multiplied to obtain an estimate of pelvic area. Both sire of dam and sire of the first calf were recorded.

In the analysis, data were corrected for year, sire of dam and sire of calf where appropriate. Initially, weight change from birth to 90 days of age, the first winter as weanling heifers, the first summer as bred yearlings and the second winter as gestating yearlings were included in the model to determine which periods significantly effected heifer performance. Weight change both the first winter and the second winter were then broken into low gaining, moderate gaining and high gaining groups for further analysis of their main effects and interactions. Where appropriate for analysis, calving ease score was grouped as: 1=no assistance and slight assistance, 2=difficult assistance and very difficult assistance and 3=cesarean delivery. The Least Squares Analysis of Variance (Kemp, 1972) was used for data analysis and to obtain means and standard errors. Duncan's New Multiple Range Test (Steele and Torrie, 1960) and the Chi-Square Test (Snedecore and Cochran, 1967) were used to determine significances between means and percentages, respectively.

RESULTS AND DISCUSSION

The effects of weaning and yearling weight, prebreeding condition, and first winter gains on reproductive efficiency the first breeding season as yearlings are given in Table 1. Heifers own weaning weight and yearling weight did not significantly affect first-service conception, final conception or conception date. Low gains the first winter as weanling heifers resulted in significantly ($P<.01$) lower first-service conception rates, while final conception rates during the 60 day breeding season were only slightly effected. Heifers with high first winter gains had the highest final conception rate but had slightly later conception dates. Heifers with a low yearling weight-height ratio, a measure of prebreeding condition, had slightly lower conception rates, but had earlier ($P<.01$) conception dates. The highest final conception rates, although statistically nonsignificant, were in heifers with moderate yearling weight-height ratios, indicating the thin or fat heifers prior to breeding had more difficulty conceiving.

Birth weights of the heifers first calf were ($P<.05$) lower in first-calf heifers with low first winter gains (Table 2). No differences in calf birth weights were seen between heifers with moderate or high first winter gains. Heifers with high first winter gains had less calving problems ($P<.05$) than heifers with moderate gains, while heifers with low first winter gains were not different ($P>.05$) from either the moderate or high gaining groups. The extra calving difficulty seen in heifers with moderate gains may be partially explained by differences in pelvic area in relation to calf birth weight between the low and moderate first winter gaining groups. The moderate gaining group gave birth to a ($P<.05$) larger calf while the pelvic area remained the same. Heifers with high first winter gains had ($P<.05$) larger pelvic areas than heifers with moderate or low first winter gains. The heavier calf birth weights, larger pelvic areas and least calving problems were all seen in heifers with high first winter gains. First winter gains had a positive effect on calf performance.

Differences of 7 kg ($P<.10$) and 10 kg ($P<.05$) for calf 90 day and weaning weight, respectively, were seen between calves of dams with low versus high first winter gains. Calf performance did not reflect the seasonal milk production level which was slightly higher in heifers with low first winter weight gains. First winter gains did not effect first-service conception at rebreeding. Slightly higher final conception rates during the subsequent 60 day breeding season were noted in heifers with low first winter gains. Conception date was ($P<.05$) earlier in heifers with high first winter gains and the interval from calving to conception was longer ($P<.05$) in heifers with moderate first winter gains. Monthly milk production levels during the first lactation were not effected by first winter weight gain (Table 3).

Calf birth weight was not effected by the weight gain of the dam the second winter as a bred yearling (Table 4). Slightly less calving problems were seen in heifers with high second winter gains. Heifers with moderate second winter gains had smaller ($P<.10$) pelvic areas than heifers with low or high second winter gains. Second winter gain had no direct relationship with calf birth weight, degree of calving difficulty or pelvic area. Second winter gains of the dam had a significant negative effect ($P<.05$) on calf performance. Calf 90 day weights were 8 kg higher and calf weaning weights were 19 kg higher for calves from dams that had low versus high second winter gains. The seasonal average milk production again was not reflected in calf performance, with a slightly lower level seen in heifers with low second winter gains where the calf performance was the highest. First service and final conception rates at rebreeding were lower in heifers with high second winter gains, although the difference was not significant. Slightly earlier conception dates and shorter intervals from calving to conception were seen in heifers with moderate or high second winter gains as compared to heifers with low gains. The results of the affect of second winter gain on seasonal monthly milk production level during the first lactation are given in Table 5. May and June milk production was not significantly effected by second winter gain. Level of July production was higher ($P<.01$) in the moderate and high gaining groups as compared with the low group. Milk production level remained slightly higher in the moderate and high gaining groups through August, September and October. Heifers with moderate or high weight gains the second winter as bred yearlings tended to peak higher and maintain a slightly higher level of milk production through the first lactation.

The effect of the interaction between the first and second winter weight gains are given in Table 6. Only variables which were significantly effected by the interaction and variables presenting a specific trend were included in the table. First and second winter gain interaction had an ($P<.05$) effect on precalving pelvic area, with the larger pelvic areas found in heifers with high first winter gains and low or high second winter gains. The number of difficult deliveries at first parturition were slightly greater in heifers with low first winter gains, especially when followed by low second winter gains. The number of cesarean deliveries were similar for heifers with low or moderate first winter gain regardless of second winter gains. Slightly less cesarean deliveries occurred in heifers with high first winter gains especially when followed by moderate or high gains the second winter. The incidences of difficult parturitions and caesarean deliveries were unusually high, even for first calf heifers. No specific trend was seen in calf weaning weights as affected by the first and second winter gain interaction while higher weaning weights occurred in calves whose dams had low first and second winter gains and dams with high first winter and low second winter gains. The number of heifers that conceived at first-service after calving was slightly lower in heifers with moderate or high first winter gains and low or high second winter gains. The highest first-service conception rates ($P<.01$) were in heifers with low first winter and low second winter gains and heifers with high first winter and moderate second winter gains. Conception rates the 60 day breeding season were ($P<.05$) lower in heifers with moderate first winter and high second winter gains and in heifers with high first winter and low second winter gains. The highest final conception rates were seen in heifers with low or moderate first winter and low second winter gains. Conception dates were earlier in heifers with low first and second winter gains and heifers with high first winter and moderate second winter gains. The interval from calving to conception was shortest in heifers with high first and second winter gains. When including the prebreeding weight-height ratio as a measure of prebreeding condition, a greater degree of conditioning prior to breeding was found to have an adverse effect on rebreeding efficiency. Therefore, heifers with high first winter gain, high summer gain and high second winter gain may be in an excessive state of condition for efficient rebreeding. Another explanation for the higher rebreeding efficiency seen in heifers with low first winter gains, is the low gain, especially the first winter, may not have been extreme enough to show an adverse effect.

When looking at the effect of first winter weight gain and the effect of second winter weight gain individually, weight gain the first winter as a weanling heifer had a greater influence on calf birth weight, calving ease, calf performance and rebreeding efficiency. Although, from this data, it is difficult to conclude any single combination of first and second winter gains is best for all factors desired. The data does indicate heifers with high first winter gains and low second winter gains had larger pelvic areas, less difficult assists and faster growing calves to weaning, while similar calf performance and the highest rebreeding efficiency was obtained in heifers with low first and second winter gains.

In this study, pelvic area was found to have only a slight effect on the degree of calving difficulty when adjusting for dam weight (Table 7). There were slightly more difficult assists in heifers with pelvic areas less than 230 cm^2, but less cesarean deliveries.

The effects of calving difficulty on rebreeding efficiency are given in Table 8. The number of heifers that conceived at first-service and during the breeding season was highest in heifers which had experienced a difficult parturition. The average conception date was later and the interval from calving to conception was longer in heifers that experienced cesarean deliveries.

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TABLE 1. THE EFFECT OF WEIGHT, WEIGHT CHANGE AND COW CONDITION THE FIRST YEAR ON REPRODUCTIVE EFFICIENCY AT FIRST BREEDING[a]

	Head/trt	Conceived 1st service	Conceived final[b]	Conception date[c]
Weaning weights[d]				
Low (<173 kg)	88	34^{e} (38%)	83^{e}(94%)	163^{e}(1.98)
High (>173 kg)	68	28^{e} (41%)	62^{e}(91%)	161^{e}(2.28)
Yearling weights				
Low (<284 kg)	78	32^{e} (41%)	72^{e}(92%)	161^{e}(2.13)
High (>284 kg)	78	30^{e} (38%)	73^{e}(94%)	164^{e}(2.10)
First winter gains				
Low (<95 kg)	31	6^{e} (19%)	28^{e}(90%)	145^{e}(8.43)
Mod. (95-132 kg)	92	45^{f} (49%)	86^{e}(93%)	149^{e}(4.89)
High (>132 kg)	33	11^{ef}(33%)	31^{e}(94%)	157^{e}(8.17)
Yearling weight/height[g]				
Low (<14.90)	35	14^{e} (40%)	31^{e}(88%)	158^{e}(3.22)
Mod. (14.90-16.50)	79	30^{e} (38%)	76^{e}(96%)	164^{f}(2.07)
High (>16.50)	42	18^{e} (43%)	38^{e}(90%)	163^{f}(2.90)

[a]Weaning weight, yearling weight, first winter gain and sire of heifer were included in model.

[b]Final conception for a 60-day breeding season.

[c]Conception date given as a Julian date.

[d]Mean standard errors are given in parenthesis unless designated as a %.

[ef]Numbers in the same column within the same subheading with different superscripts differ (P<.01).

[g]Yearling weight-height was included in model.

TABLE 2. EFFECT OF FIRST WINTER GAINS ON CALF BIRTH WEIGHT, CALVING EASE, PELVIC AREA, CALF PERFORMANCE, MILK PRODUCTION AND REBREEDING PERFORMANCE[a]

First winter gains	Low (<95 kg)		Moderate (95-132 kg)		High (>132 kg)	
Calf birth weight (kg)[b]	29[c]	(1.09)	31[d]	(.57)	32[d]	(1.06)
Calving ease score	3.08[cd]	(.37)	3.39[c]	(.19)	2.71[d]	(.36)
Precalving pelvic area (cm^2)	250[c]	(8.37)	247[c]	(5.41)	270[d]	(10.09)
Calf 90-day weight (kg)	84[e]	(4.05)	86[ef]	(2.39)	91[f]	(4.09)
Calf weaning weight (kg)	139[c]	(6.82)	150[d]	(4.03)	155[d]	(6.91)
Milk production level (kg/24 hr)	4.78[c]	(.43)	4.42[c]	(.19)	4.50[c]	(.25)
Heifers re-exposed	27		84		29	
Conceived 1st service	13[c]	(48%)	28[c]	(33%)	14[e]	(48%)
Conceived final[g]	22[c]	(81%)	56[c]	(66%)	19[c]	(66%)
Conception date (Julian)	162[c]	(5.85)	163[c]	(3.74)	148[d]	(6.16)
Calving to conception (days)	72[c]	(6.86)	86[d]	(4.36)	73[c]	(7.22)

[a]Sire of heifer, sire of calf, first winter gain, summer gains, second winter gain and summer and second winter gain.

[b]Unless designated as a %, numbers in parenthesis are mean standard errors.

[cd]Numbers in the same row with different superscripts differ ($P<.05$).

[ef]Numbers in the same row with different superscripts differ ($P<.10$).

[g]Final conception for a 60-day breeding season.

TABLE 3. THE EFFECT OF FIRST WINTER GAINS ON MILK PRODUCTION LEVEL THE FIRST LACTATION PERIOD[a]

First winter gains	Low (<95 kg)	Moderate (95-132 kg)	High (>132 kg)
Milk production (kg/24 hr)[b]			
May	6.62[c] (.93)	5.49[d] (.40)	6.17[cd] (.55)
June	6.46[e] (.78)	5.88[ef] (.38)	4.87[f] (.46)
July	5.32[c] (.71)	5.15[c] (.30)	5.58[c] (.42)
Aug	4.21[c] (.60)	4.20[c] (.26)	4.22[c] (.36)
Sept	3.50[c] (.58)	3.13[c] (.25)	3.45[c] (.34)
Oct	2.62[c] (.50)	2.71[c] (.21)	2.72[c] (.30)

[a]Sire of heifer, first winter gain, summer gain, second winter gain, and summer and second winter interaction were included in the model.

[b]Mean standard errors are given in parenthesis.

[cd]Means in the same row with different superscripts differ ($P<.10$).

[ef]Means in the same row with different superscripts differ ($P<.05$).

TABLE 4. EFFECT OF SECOND WINTER GAINS ON CALF BIRTH WEIGHT, CALVING EASE, PELVIC AREA, CALF PERFORMANCE, MILK PRODUCTION AND REBREEDING PERFORMANCE[a]

Second winter gains	Low (<-9 kg)	Moderate (-9-27 kg)	High (>27 kg)
Calf birth weight (kg)[b]	31^c (.97)	30^c (.66)	31^c (.89)
Calving ease score	3.17^c(.33)	3.10^c(.22)	2.90^c(.30)
Precalving pelvic area (cm^2)	263^c (9.55)	245^d (5.83)	258^c (9.80)
Calf 90-day weight (kg)	93^e (3.39)	83^f (2.59)	85^f (3.60)
Calf weaning weight (kg)	159^e (5.68)	145^f (4.37)	140^f (6.07)
Milk production level (kg/24 hr)	4.28^c(.27)	4.71^c(.19)	4.72^c(.35)
Heifers re-exposed	25	88	27
Conceived 1st service	10^c (40%)	39^c (44%)	6^c (22%)
Conceived final[g]	20^c (80%)	62^c (70%)	15^c (56%)
Conception date (Julian)	162^c (6.28)	157^c (5.66)	156^c (5.69)
Calving to conception (days)	81^c (7.37)	77^c (4.20)	73^c (6.67)

[a]Sire of heifer, sire of calf, first winter gain, summer gains, first winter and summer gain interaction and second winter gain were included in the model.

[b]Unless designated as a %, numbers in parenthesis are mean standard errors.

[cd]Numbers in the same row with different superscripts differ (P<.10).

[ef]Numbers in the same row with different superscripts differ (P<.05).

[g]Final conception for a 60-day breeding season.

TABLE 5. THE EFFECT OF SECOND WINTER GAINS ON MILK PRODUCTION LEVEL THE FIRST LACTATION PERIOD[a]

Second winter gains	Low (<-9 kg)	Moderate (-9-27 kg)	High (>27 kg)
Milk production (kg/24 hr)[b]			
May	6.24[c](.58)	6.18[c](.41)	5.87[c](.76)
June	5.57[c](.49)	5.67[c](.35)	5.96[c](.65)
July	4.50[c](.45)	5.96[d](.32)	5.60[d](.59)
Aug	3.87[c](.38)	4.37[c](.27)	4.40[c](.50)
Sept	3.18[c](.36)	3.25[c](.25)	3.64[c](.47)
Oct	2.36[c](.32)	2.84[c](.22)	2.85[c](.41)

[a]Sire of heifer, first winter gain, summer gain, first winter and summer gain interaction, and second winter gain were included in model.

[b]Mean standard errors are given in parenthesis.

[cd]Means within the same row with different superscripts differ ($P<.01$).

TABLE 6. THE EFFECT OF FIRST AND SECOND WINTER WEIGHT GAIN INTERACTION ON HEIFER PERFORMANCE[a]

First winter gains:	Low	Low	Low	Mod	Mod	Mod	High	High	High
Second winter gains:	Low	Mod	High	Low	Mod	High	Low	Mod	High
Number of heifers[b]	5	14	8	14	57	13	6	17	6
Precalving pelvic area (cm^2)	253^{c} (13)	251^{c} (8)	254^{c} (10)	250^{c} (11)	243^{c} (4)	246^{c} (12)	278^{c} (15)	236^{c} (8)	280^{c} (18)
Difficult assists	4^{c} (80%)	7^{cd} (50%)	5^{c} (63%)	5^{cd} (35%)	16^{cd} (28%)	5^{cd} (38%)	1^{d} (16%)	8^{cd} (47%)	3^{cd} (50%)
Cesarean deliveries	1^{c} (20%)	5^{c} (38%)	2^{c} (25%)	5^{c} (36%)	17^{c} (29%)	4^{c} (30%)	2^{c} (33%)	1^{d} (5%)	0^{d} (0%)
Calf weaning weight (kg)	161^{e} (10.5)	138^{f} (6.4)	137^{f} (8.6)	156^{ef} (6.8)	150^{ef} (3.5)	136^{f} (8.6)	160^{ef} (9.5)	145^{ef} (6.4)	153^{ef} (11.4)
Conceived 1st service	4^{c} (80%)	5^{d} (35%)	4^{d} (50%)	4^{d} (28%)	23^{d} (40%)	1^{d} (8%)	2^{d} (33%)	11^{c} (65%)	1^{d} (16%)
Conceived final[g]	5^{e} (100%)	11^{e} (78%)	6^{e} (75%)	12^{e} (85%)	39^{e} (68%)	5^{f} (38%)	3^{f} (50%)	12^{e} (71%)	4^{e} (66%)
Conception date (Julian)	147^{e} (11)	158^{ef} (8)	170^{f} (9)	160^{ef} (6)	165^{ef} (3)	159^{ef} (10)	153^{ef} (12)	149^{e} (8)	155^{ef} (9)
Calving to conception (days)	60^{e} (12.2)	71^{e} (8.7)	77^{ef} (9.7)	88^{f} (6.5)	86^{f} (3.6)	82^{ef} (11)	84^{ef} (13.6)	74^{ef} (8.5)	68^{e} (10.5)

[a]Sire of heifer, first winter gain, second winter gain, and first winter and summer gain interaction, summer gain, and first winter and summer gain interaction were included in the model.

[b]Mean standard errors are given in parenthesis unless designated as a %.

[cd]Numbers within the same row with different superscripts are different ($P<.01$).

[ef]Numbers within the same row with different superscripts are different ($P<.05$).

[g]Final conception for a 60-day breeding season.

TABLE 7. EFFECT OF PELVIC AREA ON CALVING EASE

Precalving pelvic area	Small (<230 cm^2)	Average (230-265 cm^2)	Large (>265 cm^2)
Number of heifers	20	43	18
No assistance	4^b(20%)	7^b(16%)	4^b(22%)
Difficult assistance	13^b(65%)	21^b(49%)	10^b(56%)
Cesarean deliveries	3^b(15%)	15^c(35%)	4 (22%)

[a]Sire of heifer, sire of calf, sex of calf, precalving pelvic area, precalving weight, calf birth weight and precalving weight-height ratio were included in model.

[bc]Numbers in the same row with different superscripts differ ($P<.01$).

TABLE 8. EFFECT OF CALVING DIFFICULTY ON REBREEDING PERFORMANCE[a]

	No assistance	Difficult assistance	Cesarean delivery
Number of heifers[b]	46	49	30
Conceived 1st service	15[d] (33%)	27[d] (55%)	13[d] (43%)
Conceived final	31[d] (67%)	41[d] (84%)	22[d] (73%)
Conception date (Julian)	161[d] (3.4)	161[d] (3.3)	165[d] (4.0)
Calving to conception (days)	79[d] (3.8)	75[d] (3.7)	92[e] (4.5)

[a]Adjusting calving ease, first winter gain, second winter gain, and first and second winter interaction were included in the model.

[b]Means are given in parenthesis unless designated as a %.

[c]Final conception for a 60 day breeding season.

[de]Means in the same row with different superscripts are different ($P<.05$).

EFFECT OF VARYING ENERGY LEVELS, FED DURING GESTATION, ON THE PERFORMANCE OF BEEF HEIFERS

SUMMARY

Gestating yearling heifers were used to study the effect of feeding different energy levels during the mid- and late-gestation period. Control heifers were fed 100% NRC recommended allowance for energy throughout the mid- and late-gestation period. Reducing the energy level to 70% NRC during mid-gestation and raising it to 100 or 120% NRC during late-gestation improved first-service and final conception rates at rebreeding while not affecting heifer condition at calving, calving difficulty, milk production or calf performance. Feeding a continuous low level of energy (70% NRC) throughout the mid- and late-gestation period resulted in very thin heifers at parturition that had little or no effect on calving ease or calf performance, a slight reduction in milk production and a severe reduction in first-service and final conception rates.

INTRODUCTION

The cost of feed is a major expense to any cow-calf operation, with the most costly portion of the feed being energy (TDN). Previous studies have indicated reducing energy levels during critical periods may be false economy. Research by Smithson et al. (1964), Turman et al. (1964 and 1965) and

McCartor (1972) showed inadequate TDN levels fed prior to calving resulted in delayed estrus and poor conception. Feeding restricted energy levels precalving reduces calf vigor (Corah, 1974), milk production and calf growth (Nelson et al., 1962; Corah, 1974). Inadequate levels of energy fed after calving greatly reduces conception rates at rebreeding (Baker and Quesenberry, 1944; Marsh et al., 1959), milk production and calf weaning weights (Pinney et al., 1962a; Furr and Nelson, 1964; Turman et al., 1964; Corah, 1974).

Many recommendations have been made on the basis of these studies but there are many questions left unanswered. It would be advantageous to know whether an improved level of performance can be obtained more economically by feeding a higher energy level for only a portion of the winter period, and if so, which period is most critical. Winters et al. (1942) reported 80% of the total fetal development occurs within the last 100 days of gestation, suggesting proper nutrition the last two months prior to calving are essential in order to insure normal fetal development and preparation for lactation. This project used first-calf heifers to study the effects of feeding different levels of energy during late gestation on cow and calf performance.

MATERIALS AND METHODS

Two hundred and sixty gestating Polled Hereford, Hereford, Angus and Simmental heifers bred to calve in the spring were used. Data was collected in 1975, 1976 and 1977. The mid- and late-gestation period was divided into two phases designed around the start of the calving season (March 1). Phase 1 was from 120 to 50 days prior to the first scheduled calf of the group. Phase 2 was the last 50 days of gestation or until the heifer calved, which was 75 to 100 days in some cases. Following is a diagram of the two phases.

Nov. 1 — Phase 1	Jan. 10 — Phase 2	March 1
120 to 50 days prior to the first scheduled calf	Last 50 days prior to the first scheduled calf	Calving

The amount of hay, milo and protein supplement fed was based on the amount of energy desired for the different energy levels. The three energy (TDN) levels and their percent of NRC requirements were as follows.

%NRC	Kgs TDN/hd/day
70%	2.67 kgs TDN
100%	3.82 kgs TDN
120%	4.58 kgs TDN

All rations were formulated to have equal protein and mineral content.

Heifers were allotted by breed, condition, weight and calving date into one of four treatment groups. Combining the trial phases with the energy levels and year they were fed, the four treatment combinations were as follows.

Treatment	Energy (TDN) level fed Phase 1	Phase 2	Year fed
1	100% NRC	100% NRC	75, 76, 77
2	70% NRC	120% NRC	75, 76
3	70% NRC	100% NRC	75, 76, 77
4	70% NRC	70% NRC	77

Heifer weights were taken at the beginning of Phase 1, at the end of Phase 1 and at the end of the feeding period (precalving). Condition scores were taken at the times mentioned above. The score was a visual appraisal from one to ten (1=very thin, 10=excessively fat). Degree of calving difficulty was recorded at parturition on all heifers based on the following system: 1=no assistance, 2=slight assistance, 3=difficult delivery, 4=very difficult delivery and 5=cesarean delivery. Calves were identified with ear tags and weighed within 24 hours of birth. Due to early weaning trials and different calf management in the Hereford, Simmental and Angus calves, only weaning weights of the Polled Herefords (140 head) could be used to determine the effect of treatment on calf performance. Following calving, all heifers were group fed a ration balanced to meet NRC requirements for energy (TDN), protein and minerals. Milk production data were collected monthly throughout the lactation period on all 1977 Polled Hereford heifers (42 head) by the calf weigh-suckle-weigh method described by Boggs (1977). Heifers were bred artificially for 45 days then exposed to the bull for 15 days. Breeding dates were recorded through the breeding season. Sixty days after the breeding season heifers were palpated to determine pregnancy and to confirm conception dates.

Data were corrected for breed, year, ration, breed by ration interaction, starting condition, weight and calving date. The Least Squares Analysis of Variance (Kemp, 1972) was used to analyse data and to obtain means and mean standard errors. Duncan's New Multiple Range Test (Steele and Torrie, 1960) and the Chi-Square Test (Snedecor and Cochran, 1967) were used to determine significances between means and percentages, respectively.

RESULTS AND DISCUSSION

Heifers fed a moderate level of energy (100% NRC) during mid-gestation (Phase 1) gained more weight ($P<.01$) than heifers on low levels of energy (70% NRC) through the same period. A higher than expected weight gain in Treatment 2 and a lower than expected weight gain in Treatment 3 were seen during Phase 1, since all Treatments 1, 2 and 3 received the same level of energy (70% NRC). During late gestation (Phase 2), the same weight change was seen between heifers on a moderate level of energy (100% NRC, Treatments 1 and 3) and a high level of energy (120% NRC, Treatment 2). Heifers on the continuous low level of energy (70% NRC, Treatment 4) had a 17 kg less weight gain when compared to the other treatments.

Heifer condition at the end of Phase 1 and at precalving (end of Phase 2) was ($P<.05$) effected by level of energy fed

(Table 1). Heifers on a 100% NRC level of energy during Phase 1 (Treatment 1) had no reduction in the degree of conditioning by the end of Phase 1, while reductions were seen in heifers on a low level of energy (70% NRC, Treatments 2, 3 and 4). As in weight change, a slightly greater than expected decrease in condition at the end of Phase 1 was seen in Treatment 3. At the time of calving (end of Phase 2) essentially no differences in condition were seen between heifers in Treatments 1, 2 and 3 which were fed either a moderate (100% NRC) or a high (120% NRC) level of energy during Phase 2. Heifers on a low level of energy (70% NRC, Treatment 4) during Phase 2 had a ($P<.01$) lowered degree of conditioning. During the total feeding period, condition was maintained in Treatment 1, was decreased during Phase 1 and increased during Phase 2 in Treatments 2 and 3 to be no different from Treatment 1 (controls), and was decreased throughout the feeding period in Treatment 4.

The effect of precalving energy level on calf birth weight was not statistically significant although was 2 kg lower in heifers on the continuous restricted energy level (Treatment 4, Table 2). The average calving ease score was highest in heifers fed 100% NRC through Phase 1 and 2 (Treatment 1), intermediate in Treatments 2 and 3, and least in Treatment 4. The actual percentage of assists were 68 in Treatment 2, 58 in Treatment 1, 48 in Treatment 3 and 18 in Treatment 4, indicating an adverse effect of high energy level fed precalving on calving ease.

The level of energy fed precalving had no significant effect on the calf's 90 day or weaning weight (Table 2). A slight, but nonsignificant, lower seasonal milk production (.32 kgs/24 hr period) was seen in heifers fed a continuous restricted energy level (70% NRC, Treatment 4) precalving. Milk production throughout the lactation period (Table 3) was similar for heifers fed 100% NRC energy during both Phase 1 and 2 (Treatment 1) and heifers fed 70% NRC during Phase 1 and 100% NRC during Phase 2 (Treatment 3). Heifers fed the continuous low level of energy through both Phase 1 and 2 (Treatment 4), had a lower milk production ($P<.10$) at 90, 150 and 180 days of lactation.

Heifers which received a low (70% NRC) energy level during Phase 1 and a moderate or high (100% or 120%, Treatments 2 and 3) level of energy during Phase 2 had higher conception rates at first-service than heifers on the 100% NRC energy for both Phase 1 and 2 (Treatment 1, Table 2). Heifers fed a restricted (70% NRC, Treatment 4) level of energy throughout Phase 1 and 2 had the poorest (28%) first-service conception rates. Final conception rates for a 60 day breeding season were no different between Treatments 2 and 3, which suggests that no additional performance in first-service or final conception rates are obtained when the extra 20% NRC was fed during Phase 2 of Treatment 2. The 88 and 87% final conception rates for Treatments 2 and 3, respectively, were 10% higher than the control (Treatment 1). Heifers on the continuous restricted level of energy (70% NRC, Treatment 4) had a severely reduced (67%) final conception rate for the breeding season.

The feeding of a low level of energy (70% NRC) from 120 to 50 days prior to calving, followed by a moderate (100% NRC) or high (120% NRC) up to calving, had no adverse effect on heifer condition at calving, degree of calving difficulty, milk production or calf performance, but did improve rebreeding efficiency. It should be mentioned that no additional improvement was seen in any of the above traits due to feeding the extra 20% NRC energy during Phase 2 (Treatment 2). The feeding of a low (70% NRC) level of energy throughout the 120 day precalving feeding period resulted in thin heifers at calving, slightly lighter calf birth weights, less calving problems, slightly less milk production and reduced first-service and final conception rates.

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TABLE 1. CONDITION AND WEIGHT CHANGE (AND STANDARD ERRORS) AS AFFECTED BY ENERGY LEVEL FED TO GESTATING YEARLING HEIFERS[a]

Treatments:	1		2		3		4	
Years fed:	75, 76, 77		75, 76		75, 76, 77		77	
Energy fed								
Phase 1[b]	100%	NRC[c]	70%	NRC	70%	NRC	70%	NRC
Phase 2	100%	NRC	120%	NRC	100%	NRC	70%	NRC
Heifer number	88		54		85		33	
Heifer starting weight (kg)	401[d]	(10.1)	387[d]	(13.1)	400[d]	(10.1)	405[d]	(17.4)
Heifer weight change (kg)								
Phase 1	26[d]	(3.01)	21[d]	(3.95)	9[e]	(3.32)	15[ed]	(5.12)
Phase 2	40[f]	(5.29)	39[f]	(6.93)	38[f]	(5.85)	21[g]	(9.00)
Heifer condition								
Start of phase 1	4.97[d]	(.55)	4.97[d]	(.55)	4.97[d]	(.55)	4.97[d]	(.55)
End of phase 1	4.96[f]	(.07)	4.70[fg]	(.09)	4.54[g]	(.08)	4.76[fg]	(.12)
End of phase 2	4.98[d]	(.09)	4.93[d]	(.12)	4.91[d]	(.10)	4.20[e]	(.16)

[a]Breed, year, ration, breed by ration interaction, starting condition score, starting weight and calving date were included in the model.

[b]Phase 1 = 120 to 50 days prior to the first scheduled calf of the group.
Phase 2 = 50 days prior to the first scheduled calf up to calving which was 100 days in some cases.

[c]100% NRC level of energy = 3.82 kg TDN per day, 70% NRC = 2.62 kg TDN, and 120% NRC = 4.58 kg TDN.

[de]Means in the same row with different superscripts differ (P<.01).

[fg]Means in the same row with different superscripts differ (P<.05).

TABLE 2. CALVING EASE SCORE, CALF PERFORMANCE AND REBREEDING PERFORMANCE AS AFFECTED BY ENERGY LEVEL FED TO GESTATING YEARLING HEIFERS[a]

Treatments:	1		2		3		4	
Years fed:	75, 76, 77		75, 76		75, 76, 77		77	
Energy fed during[b]								
Phase 1[c]	100%	NRC	70%	NRC	70%	NRC	70%	NRC
Phase 2	100%	NRC	120%	NRC	100%	NRC	70%	NRC
Heifer number	88		54		85		33	
Calf birth weight[e]	34^e	(.70)	34^e	(.98)	34^e	(.81)	32^e	(1.20)
Average calving ease score	2.63^e	(.18)	2.34^e	(.25)	2.35^e	(.21)	1.97^e	(.31)
No difficult assists	51^e	(58%)	37^{eg}	(68%)	41^{eh}	(48%)	6^f	(18%)
Calf 90-day weight (kg)[i]	87^e	(2.57)	88^e	(2.91)	85^e	(2.43)	83^e	(3.63)
Calf weaning weight (kg)[i]	146^e	(4.05)	148^e	(4.54)	149^e	(3.83)	150^e	(5.68)
Milk production (kg/24 hr)[j]	4.61^e	(.25)			4.63^e	(.23)	4.30^e	(.23)
Rebreeding performance								
Heifer number	77		43		78		30	
Conception 1st service	32^{gh}	(42%)	20^{gh}	(47%)	41^g	(53%)	8^h	(27%)
Conception final[k]	60^{gh}	(78%)	38^g	(88%)	68^g	(87%)	20^h	(67%)

[a]Breed, year, ration, breed by ration interaction, starting weight and condition score and calving date were included in model.

[b]Mean standard errors are given in parenthesis unless % is designated.

[c]See footnote b on Table 1.

[d]See footnote c on Table 1.

[ef]Numbers in same row with different superscripts differ (P<.01).

[gh]Numbers in same row with different superscripts differ (P<.05).

[i]Calf weight data was collected only on Polled Hereford heifers.

[j]Milk production data was collected only on Polled Hereford heifers in 1977.

[k]Final conception rate within a 60-day breeding season.

TABLE 3. MILK PRODUCTION MEANS (AND STANDARD ERRORS) THE FIRST LACTATION AS AFFECTED BY ENERGY LEVEL FED TO GESTATING YEARLING HEIFERS[a]

Treatments:	1	2	3	4
Years fed:	75, 76, 77	75, 76	75, 76, 77	77
Energy fed				
Phase 1[b]	100% NRC[c]	70% NRC	70% NRC	70% NRC
Phase 2	100% NRC	120% NRC	100% NRC	70% NRC
Milk production (kg/24 hr)[d]				
30 days	5.94^{e} (.48)		6.03^{e}(.45)	5.56^{e}(.46)
60 days	5.75^{e} (.42)		5.45^{e}(.39)	5.62^{e}(.40)
90 days	5.41^{ef}(.41)		5.85^{e}(.38)	5.10^{f}(.39)
120 days	4.09^{e} (.32)		4.41^{e}(.30)	4.19^{e}(.31)
150 days	3.37^{e} (.29)		3.44^{e}(.27)	2.76^{e}(.28)
180 days	2.80^{e} (.26)		2.76^{e}(.25)	2.65^{f}(.25)

[a]Breed, year, ration, breed by ration interaction, starting weight and condition score and calving date were included in model.

[b]See footnote b on Table 1.

[c]See footnote c on Table 1.

[d]Milk production data was collected on the Polled Hereford heifers in 1977.

[ef]Means in the same row with different superscript differ ($P<.10$).

EFFECT OF VARIED GROWTH FROM BIRTH THROUGH THIRTY MONTHS OF AGE ON THE PERFORMANCE OF BEEF HEIFERS

by

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One hundred and fifty-six Polled Hereford heifers were grouped according to weight change during the first winter into low (<95 kg), moderate (95-132 kg) and high gaining groups (>132 kg) and grouped by weight changes the second winter into low (<-9 kg), moderate (-9-27 kg) and high gaining groups (>27 kg) to determine the effect of growth rates from birth to 30 months of age on performance. Low first winter gains reduced first service and final conception rates at first breeding as yearlings. First winter gains had a greater positive effect on heifer development, calving ease score, calf performance and rebreeding performance than second winter gains.

Two hundred and sixty Angus, Hereford, Polled Hereford and Simmental first calf, two-year-old gestating heifers were used to study the effect of feeding different levels of energy during mid- and late-gestation. Energy levels were: 100% NRC (M), 3.82 kg TDN/day; 120% NRC (H), 4.58 kg TDN/day; 70% NRC (L), 2.67 kg TDN/day. The trial was divided into two phases: Phase 1 was 120 to 50 days prior to the first scheduled calf of the group and Phase 2 started 50 days prior to the first scheduled calf and continued to calving. Combining both phases the four treatments were: M-M, L-H, L-M, L-L. All heifers had free access to minerals and all rations were isonitrogenous. Heifers were allotted by breed, condition, weight and date of calving, and were group fed by treatment. Following calving all heifers were group fed the same ration balanced to meet NRC requirements. Heifers on continued restricted energy levels

(L-L) had slightly lighter calves at birth, less calving difficulty, similar calf weaning weights, but severely reduced conception rates as compared to the M-M group. Heifers on reduced energy during Phase 1 and increased energy during Phase 2 (L-H and L-M), had similar calving ease scores, the same calf performance and higher conception rates than heifers on NRC levels (M-M) throughout gestation.