EFFECTS OF MILK AND FORAGE INTAKE ON CALF PERFORMANCE

by

DONALD L. BOGGS

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Approved by:

Edgar F. Smith

Major Professor

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INTRODUCTION

With the increasing demand for more economical beef production, the need to produce high quality, high yielding market animals that can be marketed at an earlier age is becoming more and more evident. Extensive work has been done to improve cattle performance during the growing and finishing stages of production, and tremendous advancement has been made. Unfortunately, these stages comprise only approximately half of the market animal's lifetime and leave a definite gap in our knowledge of calf development and growth during the six to seven month preweaning stage of the calf's life.

Much of the research pertaining to preweaning calf performance has been associated woth the milk production of the cow and consistently high correlations have been recorded. However, it has been suggested that by as early as the third month of lactation, less than half of the calf's energy needs are supplied by the dam's milk. This need for non-milk energy brings us to look at the calf's ability to meet requirements on native Kansas range forage.

In the mid-western plains area, calves born in February and early March tend to have higher average daily gains than those born in April or May. The inability of these later calves to perform at their genetic potential results in a severe loss of profit. This study is designed to focus on the interrelationships of the various parameters which affect calf performance prior to weaning and thus develop a deeper knowledge of calf nutrition and development.

REVIEW OF LITERATURE

A. Factors Affecting Calf Performance

Preweaning calf performance and weaning weight are vitally important in the profitable production of beef cattle. In a study of factors influencing rate of gain of Shorthorn calves during the suckling period, Knapp and Black (1941) found milk consumption of the calves had a greater influence on daily weight gain than any other factor studied, including birth weights, sires, dams, sex, and feed consumption. Rutledge et al. (1971) found, on a within herd-sex-year basis, approximately 60 percent of the variance in 205-day weight could be attributed to differences in the dam's milk production. They also concluded that milk quantity more greatly influenced 205-day weight than milk quality. Kress et al. (1968) compared the contributions of 16 variables to weaning weight and found total milk production to be second only to total feed consumption as a predictor of calf weaning weight. Schake and Riggs (1971) observed that 18.6 Mcal of gross energy were required to produce one Mcal of empty body energy in the form of calf gain when both cow and calf energy inputs were considered. This represents a gross efficiency of only 5.4% and emphasizes the importance of increasing calf weaning weight by greater milk yield of the dam. In Herefords, they reported 45.3% of the energy required above maintenance for lactation was recovered as milk energy. Neel et al. (1973), using individually fed cows varying in weight from 367.4 to 542.0 kg, found that the average daily TDN intake ranged from 3.81 to 6.94 kg, while daily milk production averaged 4.58 kg. On the average, 4.58 kg of cow feed were required to produce one kg of weaned calf weight. Weber and Vetter (1974), utilizing mature Angus x Hereford and Angus x Friesian cows, reported calves suckling Angus x Hereford dams required 8.9 pounds of milk per pound of gain versus 9.8 pounds of milk per pound of gain for calves suckling the dairy cross females. This suggests that calves receiving less milk were more efficient in milk utilization. Drewry et al. (1959) reported 12.5, 10.8 and 6.3 pounds of milk were required per pound of calf gain for the first, third, and sixth months of lactation, respectively. Calves suckling higher producing dams made the least gain from a given volume of milk. In a study of the effects of two milk intake levels on two calf types, Wyatt et al. (1976) found that while higher milk intake produced significantly higher weaning weights, there was a decrease in conversion efficiency of milk to weight gain. At low milk intakes, larger framed calves only slightly outgained smaller framed calves. But at higher milk intakes the additional gain was much greater. The higher milk intake apparently allowed the larger framed calves to express additional growth potential.

Gifford (1949) suggested the importance of high milk production had been overestimated. Significant positive correlations between milk production and calf daily gain were found only during the first four months of lactation. Melton et al. (1967) found the correlation between average daily calf gain and average daily milk production in Hereford, Angus, and

Charolais cows was higher early in lactation than at the end. This agrees with Franke et al. (1975) who found the correlation betwe milk intake and average daily gain declined throughout a seven month lactation. After creep and forage can be utilized, milk production is less important, but calves never seem to compensate for early low milk intake (Wilham, 1972).

Maddox (1965) established that most of the calf's energy is supplied by the dam's milk only during the first month of lactation. By the second month, nearly half of the total energy comes from other sources and this portion increases throughout lactation. Sims et al. (1975) calculated daily forage intake by spring-born calves on Colorado high plains grassland to range from .8 lbs of organic matter per calf daily to over 4 pounds per calf in September. They estimated the forage energy intake represented about 20% of the gain in September. England et al. (1961) found positive correlations between cow weight change and calf weight change and suggested this indicated that pasture conditions influence both cow and calf gains similarly.

Calving time is very important to subsequent calf performance. Nelms and Bogart (1956) found calves born early in the calving season gained faster than later calves. A Wyoming study of 8,744 cow-calf pairs from four commercial ranches found the top one-third of all calves, which weaned over 100 pounds heavier and gained .4 pound per day faster, were born an average of 26 days earlier than the bottom one-third (Schoonover, 1974). Cundiff et al. (1966) showed significant interactions between birth month by pasture type and birth month by management type on weaning weight in beef calves. With an earlier calving season in Georgia, Neville (1962) found calves born later in the calving season had a significant weight advantage at 4 months old, but this advantage disappeared by weaning.

Birth weight is highly correlated with weaning weight (Gregory _et al._, 1950). Nelms and Bogart (1956) found that for each 10 pound increase in birth weight, preweaning gain increased .115 pound per day. Hohenboken _et al._ (1971) showed birth weight was highly related with preweaning TDN intake, and suggested that the increased TDN intake was responsible for the increased preweaning gain.

Sex of calf, cow condition, and cow measurements are related to calf weaning weight. Melton _et al._ (1966) reported cows nursing bull calves produced more milk than cows nursing heifers and bull calves outgained the heifer calves. Change in cow condition is negatively correlated with preweaning calf performance (Godley _et al._, 1970; Lindsey _et al._, 1970). Brinks _et al._ (1962) reported that cow weight gain during winter was positively related to preweaning performance in spring calves, but cow weight gain during lactation was negatively correlated with calf gain and weaning weight. Waggoner (1975) found cow length (measured from a line perpendicular to the point of the shoulder to the hips) was the linear measurement most highly correlated with calf weaning weight. Lindsey _et al._ (1970 reported a quadratic relationship between the ratio of cow weight to height at hooks and calf weaning weight.

Most reports agree that milk production is the major factor affecting preweaning calf performance. However, poor conversion efficiency of high milk intakes suggests that feeding cows for maximum milk yield is not economical. Insufficient evidence is available to show that calves can meet their non-milk energy needs on low quality roughage. To increase milk production, creep feed the calves, or merchandise lighter calves depends on feed costs and calf prices.

B. Factors Affecting Milk Production in Beef Cows

Milk production of beef cows accounts for approximately 60% of the variance in weaning weight of beef calves (Neville, 1962; Rutledge et al., 1971). Breed and age differences of the dam account for approximately 85% of the explained variance in total milk yield (Jeffery et al., 1971). Rutledge et al. (1971) reported that cow age and calving date both had a quadratic effect on total milk production in Hereford cows. In Herefords, milk production tends to increase until cows are 5 to 6 years old, and then stabilizes (Neville et al., 1974). They suggested the number of lactations had as much effect as age of dam.

Neville (1974) reported the daily maintenance requirement for non-lactating Hereford cows was 0.0074 and 0.0104 kg of TDN per unit of body weight to the 1.00 power, respectively. Therefore, lactation increased the maintenance requirement 41%. Based on these data, the estimated net efficiency of milk production was found to be approximately 34%. Schake and Riggs

(1975) estimated the gross lactation efficiency (ratio of milk energy produced to feed energy consumed) of Hereford cows at 4.9%. The net efficiency of milk production, based on a daily production of 3.6 kg of 1.54% butterfat milk, was estimated at 23.5%. The energy and protein levels fed a cow both have highly significant effects on milk production (Bond et al., 1964). Bond and Wiltbank (1970) fed Angus heifers high, medium, and low levels of protein and high (ad libitum), medium (66% of ad libitum), and low (maintenance) levels of energy. Heifers on low protein or energy levels weighed less and gave less milk than heifers on higher nutrition levels during the first lactation. Heifers on low energy reached peak milk production within 30 days, while heifers on medium energy peaked at 60 days, and those on high levels peaked between 90 and 120 days. Working with Hereford and Hereford-cross cows, Waggoner (1975) reported a 25% increase in energy intake caused a slightly later peak in milk production, but the increase in total milk production was non-significant. Sims et al. (1971) concluded that approximately 30% of the digestible energy consumed by the cow was utilized for milk production. In a study involving fall-calving cows, Furr and Nelson (1964) found milk production decreased steadily throughout the winter, then showed a marked recovery as spring grass became available, before declining again until weaning.

Stage of lactation affects fat and solids-not-fat content of milk. Percent fat and percent solids-not-fat reach a low at approximately 60 days of lactation and then increase during the remainder of lactation (Schmidt, 1971; Johnson _et al._, 1961). Johnson _et al._ (1961) also reported percent milk fat and solids-not-fat decreased as lactation number increased. Thus, these are inversely related with milk yield. In a review of dairy calf nutrition, Radostits and Bell (1970) reported dry matter digestibility of whole milk was 95 percent.

Cow condition and weight changes are related to milk production. Cows which gain weight and condition during lactation tend to produce less milk (Jeffery _et al._, 1971; Hohenboken _et al._, 1971; Kress and Anderson, 1974). Waggoner (1975) found cow weight at calving to be highly correlated with milk production.

The literature indicates that milk production can be increased with additional feed energy. Although efficient conversion of additional milk to calf gain is questionable, it appears that lengthening the cows peak milk production period would decrease the calf's need for non-milk energy sources.

C. Techniques for Estimating Milk Production

Due to the difficulty of measuring milk production of cows suckling their calves, milk production was evaluated in the past directly by measuring the preweaning calf gain. Gifford (1953) described a procedure for estimating monthly milk production. Calves were separated from their dams for three days but allowed to nurse twice daily. On the second day one side of the udder was milked by hand while the calf suckled the other side. The following day the opposite side was milked by hand. The milk was weighed and used as an estimate of one day's production, from which monthly estimates of milk production were made.

Neville (1962) estimated milk production of Hereford cows by weight differences of their calves before and after nursing. Calves were separated from their dams at 4:30 p.m. and milk weights were estimated the following morning at 8:30 a.m. The calves were again isolated from the cows and the afternoon milk weight was obtained at 4:30 p.m. Milk consumption by the calf was considered equivalent to the dam's milk production.

Totusek and Arnett (1965) compared three methods of estimating milk production: weigh-suckle-weigh, handmilking, and preweaning calf gain. Total milk production was measured by weighing calves before and after nursing for a 210 day lactation. Handmilking one day each week was used as a direct estimate of milk production, while preweaning gain was used as an indirect estimate of milk production. Correlations between total milk production and handmilking were .84, .90, and .95 at 70, 112, and 210 days. On these same days, correlations between total milk production and body weight were .69, .80, and .88. Average daily milk measured by weigh-suckle-weigh was 5.86 kg. compared to 4.55 kg. estimated by handmilking. A correlation of .93 was found between total milk production and five selected daily estimates made by weigh-suckle-weigh during nursing. Rutledge <u>et al.</u> (1972) reported a similar correlation between observed milk yield based on weekly measurements and predicted milk yield based on regression of three bimonthly measurements. All measurements were made by the weigh-suckle-weigh procedure (Rutledge *et al.*, 1971).

Oxytocin was administered to cows to aid in milk let-down, prior to complete machine milking and handstripping (Anthony *et al.*, 1959). Schwulst *et al.* (1966) administered oxytocin following calf nursing, prior to machine milking and prior to calf nursing and compared these treatments to the calf weight change during nursing followed by machine milking. Oxytocin did not significantly affect milk consumption or total milk production, but oxytocin administered before nursing resulted in higher consumption.

Errors in lactation yields are primarily a function of the length of the interval between tests (McDaniel, 1969). He concluded 90% of milk yields estimated from a single day's yield taken once a month are within ± 5% of true production. Errors from bimonthly samples are about 30% greater, but they still allow for accurate cow ranking and progeny testing.

Separating cows and calves during the testing period could effect the cow's grazing patterns. Bluntzer and Sims (1976) successfully used calf weaners to prevent calves from nursing their dams as an option to separating the cows and calves for the calf weight nursing technique.

Length of nursing period and the ability of the calf to consume milk both affect the accuracy of measuring milk yield in beef cows. Gifford (1949) suggested that the maximum milk production, which is normally attained in the first six weeks of lactation, is affected by the capacity of the young calves to consume all of the milk available. When the milk was not completely removed, the milk production leveled off before the normal decline occurred. Dickey et al. (1971) reported that in over 900 observations of 16 hour milk yields of Angus and Hereford cows, calves averaging 3 months old required 15 to 20 minutes to consume all milk produced. Four months later only 10 to 15 minutes were required, but milk yield was less. Heifer calves tended to require 2 to 3 minutes more nursing time than bull calves. Chow et al. (1967), using machine milkers with oxytocin and the calf nursing technique, compared 6, 4, 3, 2, and 1 milkings per day and found 2 tests at 12 hour intervals to be most satisfactory for estimating milk yield in beef cows with both techniques.

Weigh-suckle-weigh procedures, conducted monthly, seem to be an accurate method of determining calf milk consumption. However, this is not necessarily an accurate method for estimating milk production. Handmilking after oxytocin is an accurate method of estimating cow milk production, but requires the assumption that all milk present is consumed, when estimating calf milk consumption.

D. Factors Affecting Forage Consumption

Animal response is related more to quantity of forage consumed than to quality of the forage (Crampton, 1957). Crampton further suggested the extent of voluntary consumption of a forage is limited by digestion rates of cellulose and hemicellulose, rather than by the completeness of their utilization or the quantity of these nutrients in the plant. Digestion rate is affected by forage lignification. Ingalls *et al.* (1966) reported neither forage lignin, nor total intake of fiber or lignin appeared to limit consumption.

In a symposium on factors influencing the voluntary herbage intake by ruminants, Conrad (1966) noted increased acetic acid availability to tissues reduced feed intake, and thus suggested a chemostatic mechanism of intake regulation was involved.

In studying effects of milk intake on feed intake by calves, Lusby *et al.* (1976) reported high levels of milk intake depressed the consumption of non-milk nutrients and tended to decrease the total efficiency. Wyatt *et al.* (1976) reported a high level of milk consumption reduced relative forage intake as much as 50% during the early summer. Kartchner *et al.* (1976) found the interrelationship of milk consumption x forage quality accounted for over 50% of the variation in forage intake in spring calves.

Calf age, weight, and environment affect forage intake. Sims *et al.* (1975) reported the forage intake of spring calves was five times greater in September than when the calves were five months younger in April. Lusby *et al.* (1976) noted large calves consumed more forage than small calves, but found forage dry matter intake on range was less than creep dry matter intake in drylot. Conrad (1966) observed thermal stress reduced forage intake, and suggested that environment probably dominates all other factors involved in regulation of feed intake.

Baile (1968) explained the involvement of chemostatic and physical controls of intake regulation. Gifford (1949) suggests gastrointestinal capacity limits the calf's ability to consume all available milk. Furthermore, the negative relationship between milk and forage intakes indicates the presence of chemostatic regulation. Another factor to consider is the degree of rumen development in the young calf. Otterby and Rust (1965) reported fermentation in the calf's rumen at 3-4 weeks of age, but there is evidence of grass consumption prior to this age.

E. Techniques for Measuring Forage Intake

Forage intake is generally more important than digestibility in limiting calf productivity (Smith et al., 1972), but both are related to TDN intake. Forbes and Garrigus (1948) used a lignin ratio technique to determine dry matter intake of grazing animals. A total fecal collection was made to determine the total pounds of fecal lignin in a 24-hour period. Dividing the pounds of lignin by the percent lignin in the forage gave pounds of dry matter intake for the period. Gallup and Briggs (1948) suggested total fecal nitrogen should be related to dry matter intake, since metabolic nitrogen is directly proportional to dry matter intake and metabolic nitrogen makes up such a large portion of total fecal nitrogen. However, Forbes (1949) found total fecal nitrogen varied too widely to be of practical use in estimating dry matter intake on fresh grass.

Under range conditions, total collections become impractical for determining total fecal output. Conner et al. (1963) reported fecal totals were essentially the same, whether determined by "grab" samples using chromic oxide as an indicator or with total collections. Hardison and Reid (1953) used chromic oxide successfully as a fecal output indicator for grazing steers, but noted considerable intraday variation in the fecal Cr_2O_3 concentration makes it imperative that feces be sampled at specified times of the day. Kane et al. (1952) suggested the period of 1:00 p.m. to 3:00 p.m. as the best time to collect "grab" samples from cows, as both lignin and chromic oxide in the feces were near their mean concentrations for the day. Calf data (Telford, 1971) indicated the appropriate sampling period to be from 11:00 a.m. to 2:00 p.m. Chromic oxide can be included in the concentrate portion of the ration or administered with gelatin capsules either once or twice a day. Smith and Reid (1955) found no differences in accuracy of estimated fecal output when comparing various methods and times of administration of Cr_2O_3 and suggested these should be determined by the nature of the experiment and the convenience of the operation. Sims et al. (1975) escaped the problem of diurnal variation by using cerium^{141} as an external marker to determine feces production.

Digestibility has been evaluated with a variety of methods. In a comparison of techniques to evaluate *in vivo* digestibility, Scales et al. (1971) reported both the "nylon bag" technique and *in vitro* cell-wall constituent digestibility using inoculum from a handfed steer gave good estimates of digestibility with low error. Using inoculum from grazing steers gave more variable results, as did predicting digestibility using fecal nitrogen. A lignin ratio technique using potassium permanganate was found unsatisfactory as an estimator of *in vivo* digestibility. Wilson *et al*. (1971) reported lignin ratio gave consistently low estimates and fecal nitrogen gave consistently high estimates of digestibility of range forage. Lopez-Trujillo *et al*. (1976) reported apparent lignin digestibility was 30% and suggested errors in lignin ratio technique were due to artifact lignin.

Cattle are selective in their grazing habits (Barth *et al*., 1970; Weir and Torell, 1959). Thus, obtaining a representative sample of a grazing animal's diet is one of the major problems encountered in evaluating performance of range animals. Torell (1954) described a method for fistulating the esophagus of sheep to collect the forage actually eaten. Saliva and chewing may affect the chemical composition of the ingested forage. One of the most commonly noted changes in esophageal forage collections is an increase in the percent ash (Barth *et al*., 1970; Weir and Torell, 1959). Van Dyne and Torell (1964) reported the increased ash content from salivary contamination had no significant effect on the digestibility of the forage, but most researchers suggest that chemical components of forage samples collected with esophageal fistulas should be reported on an ash-free basis.

The excretion-to-indigestibility ratio technique with a fecal output indicator seems to be the most acceptable and practical method of estimating forage intake on range. Though diurnal variation is a disadvantage, chromic oxide is an acceptable indicator for establishing relative fecal output. Determining forage indigestibility is a complex problem. First, grass samples must be assumed to be representative of the calf's diet. If a lignin ratio is used, the lignin must be assumed to be completely indigestible. But, if *in vitro* digestibility is used, all calves are assumed to be functional ruminants. All of these assumptions are sources of error in determining the calf's forage intake.

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EFFECTS OF MILK AND FORAGE INTAKE ON CALF PERFORMANCE

INTRODUCTION

Preweaning calf performance and weaning weight are vitally important in the profitable production of beef cattle. Milk production of beef cows accounts for approximately 60% of the variance in weaning weight of beef calves (Neville, 1962; Rutledge *et al*., 1971). However, Maddox (1965) suggested that by as early as the third month of lactation, less than half of the calf's energy needs are supplied by the dam's milk. Sims *et al*. (1975) estimated the energy supplied by forage intake of calves on Colorado high plains grassland represent about 20% of the gain early in the grazing season to approximately 50% of the gain in September. This study was designed to study the ability of calves to meet their non-milk energy requirements on native Kansas range forage.

MATERIALS AND METHODS

Milk and forage intake of fifty-one Polled Hereford calves grazing native bluestem range were measured. The calving period was March 1 to May 2, with all calves weaned on September 29. The study was conducted at the Kansas State University Range Research Unit near Manhattan.

Milk consumption was measured monthly for 6 months (April through September) by a calf suckling technique. Cows and calves were separated at 8:00 a.m. At 6:00 p.m. the calves were allowed to nurse the cows dry. Cows and calves were separated overnight. At 6:00 a.m. the following day the calves were weighed, allowed to nurse and reweighed. The post-nursing weight minus the pre-nursing weight was taken as an estimate of 12-hour milk yield. To eliminate day-to-day variation and error three daily 12-hour estimates were averaged, then doubled to estimate 24-hour consumption. These three daily estimates were taken every other day to prevent any severe interruption of the grazing pattern of either the cows or calves. Calf weaners (Bluntzer and Sims, 1976) were used during the April trial, in place of cow-calf separation, but were discontinued due to their inability to prevent calves from suckling. Milk consumption was assumed to equal milk production.

Forage intake was measured monthly for 5 months (May to September) by the chromic oxide indicator technique (Telford, 1971). Chromic oxide (5 gm/head/day) was administered in gelatin capsules during a 4-day preliminary period and the first

3 days of the 4-day collection period. Fecal grab samples for each calf were composited over the 4-day collection. All samples were dried in a forced air oven at 55^{o} C until a constant weight was achieved; ground in a Wiley mill (40-mesh screen); and stored in glass bottles until laboratory analysis was completed. Samples were wet ashed (Harris, 1970) with modified nitric acid and perchloric acid digestions. Three ml. of 48% hydroflouric acid were added to the wet ash solution and brought to 100 ml volume to dissolve residual silica. Laboratory experience had shown considerable chromium was bound to this silica residue. Chromium was then determined by spectrophotometry at λ = 452nm with appropriate standards. Grass samples were collected with esophageally fistualted steers. Digestibility of grass samples was estimated by _in vitro_ dry matter digestibility (Tilley and Terry, 1963). Forage intake was calculated as:

$$FI = \frac{\left(\frac{\text{gm Cr fed}}{\text{\% Cr in feces}}\right) - (\text{Milk intake x \% dry matter in milk x milk indigestibility})}{\text{\% forage indigestibility}} \times 100$$

For analysis, calves born March 1 - March 20, March 21 - March 31, and April 1 - May 2 were grouped as Brith Periods 1, 2 and 3, respectively. Cows and calves were located in four pastures, three of which had been burned in late spring. Cows 5-8 years of age were considered as the same age, as were those 9 years and older. The least square analysis of variance (Kemp, 1972) and Duncan's New Multiple Range Test (Steele and Torrie, 1960) were used for data analysis.

RESULTS AND DISCUSSION

The mean daily milk production of the cow herd was 5.68, 5.82, 5.00, 4.77, 3.45, and 3.68 kg/day, for April through September, respectively. Using three day sample periods tended to reduce day-to-day variation in measuring milk production. Neither cows nor calves seemed abnormally disturbed during separation periods.

Bull calves consumed significantly ($P<.05$) more milk during April. Since the bull calves were slightly older and heavier, they may have been able to consume more of the available milk, so this sex difference may not be associated with the milking ability of the cow. This is in agreement with Gifford (1949).

The effects of birth period on milk production tend to be associated with extending peak milk production into the lactation and the severity of the eventual production decline. During the first two months of lactation there were no significant differences in milk production among the three birth periods. However, during the third month cows calving during Birth Period 2 (March 21 to March 31) produced more milk ($P<.05$) than cows calving earlier or later. They maintained this advantage through the remainder of lactation (Table 1). This quadratic effect of birth date was reported earlier by Rutledge et al. (1971).

Though age of dam effects were variable throughout the various sampling periods (Table 2), there was a definite quadratic trend with 5-8 year old cows generally producing the most milk. This agrees with Melton et al. (1967); and Rutledge

Table 1. Least square means of milk production (kg/day) for birth periods.

Birth Period	Number of Calves	Months						
		April	May	June	July	August	September	Summer
1 (3/1-3/30)	14	5.95^{ab}	5.50	3.95^{a}	4.14	3.14	3.23	4.44
2 (3/21-3/31)	22	6.91^{b}	6.09	5.50^{b}	5.00	3.23	3.64	4.94
3 (4/1-5/2)	15	5.86^{a}	5.77	4.50^{a}	4.55	3.18	3.09	4.49

Birth Period	Number of Calves	Calf Age Range Periods (Days)					
		30-60	60-90	90-120	120-150	150-180	180-210
1 (3/1-3/20)	14	6.36	4.82^{a}	3.91	4.41^{ab}	3.41	3.27
2 (3/21-3/31)	22	6.32	6.14^{b}	5.00	4.82^{b}	3.36	3.50
3 (4/1-5/2)	15	5.86	4.64^{a}	4.41	3.32^{a}	2.82	2.55

[a,b]Values within a column with similar superscripts are not significantly ($P<.05$) different.

Table 2. Least square means of milk production (kg/day) for age of dam.

		Months						
Dam age	Number of Calves	April	May	June	July	August	September	Summer
3 Years	5	5.59^{a}	5.59^{a}	4.68	4.91	2.32^{a}	3.18^{ab}	4.60^{ab}
4 Years	6	6.55^{b}	6.36^{b}	4.41	4.00	3.09^{ab}	2.91^{a}	4.45^{ab}
5-8 Years	27	6.59^{b}	6.14^{b}	5.14	4.95	3.45^{b}	3.91^{b}	5.11^{b}
9 + Years	13	6.32^{b}	5.00^{a}	4.36	4.41	3.86^{b}	3.27^{ab}	4.34^{a}

		Calf Age Range Periods (Days)					
Dam age	Number of Calves	30-60	60-90	90-120	120-150	150-180	180-210
3 Years	5	8.27^{b}	5.68^{ab}	4.23	5.91	3.05	2.27
4 Years	6	6.00^{b}	5.00^{ab}	4.14	4.50	2.64	2.64
5-8 Years	27	6.68^{b}	5.64^{b}	5.09	4.27	3.50	3.73
9 + Years	13	3.82^{a}	4.50	4.32	4.00	3.55	3.32

[a,b] Values within a column with similar superscripts are not significantly ($P<.05$) different.

et al. (1971). Number of lactations did not significantly affect milk production. In contrast, Neville et al. (1974) found the number of lactations had as much effect on milk production as age of dam.

Increase in cow condition, measured by increased cow weight to height ratio, was related to decreased milk production during the first four sampling months. Similar results were obtained by Jeffery et al (1971); Hohenboken et al. (1971); and Kress and Anderson (1971).

Forage Intake:

The calve's mean forage dry matter consumption was 0.49, 1.43, 1.83, 2.57, and 4.53 kg/day for May through September, respectively. When expressed as a percent of the calve's body weight, these intakes would represent 0.62%, 1.46%, 1.51%, 1.75%, and 2.72%, respectively. Grass samples collected by esophageally fistulated two year old steers were assumed to represent the diet of the suckling calves. In vitro digestibility determination (Table 3) requires the assumption that all calves were functional ruminants by the time of the May sampling period. This could be a source of error, especially for the calves born late in the calving season (Otterby and Rust, 1965).

During the preweaning grazing period, bull calves ate 0.23 kg/day ($P<.05$) more grass than heifers. This advantage is present, though not statistically significant, at all ages and sampling periods and could result from the bull calve's slightly heavier unadjusted body weight.

Table 3. *In vitro* dry matter digestibility (%) of bluestem pastures sampled with esophageal-fistulated steers.

	Pastures	
Months	10 (non-burned)	11,16,17 (burned)
May	55.47	54.17
June	49.34	50.39
July	40.33	38.97
August	38.72	40.12
September	48.45	55.81

Calves born during Birth Period 3 ate 0.33 kg/day ($P<.05$) less grass than calves born during Birth Period 1 and 2. This was most apparent over the last three months of the grazing period (Table 4), and is probably due to smaller size and later rumen development.

Calves in Pasture 10, a non-burned pasture, consumed .24 kg/head/day more grass for the entire grazing period than calves in burned pastures (Pastures 11, 16, 17). This difference was present only during May, June, and July (Table 5) and could indicate a difference in diet composition between the burned and non-burned pastures. Since there were no differences in *in vitro* digestibilities (Table 3), there could be differences in forage acceptability and palatability.

Milk consumption had a negative effect on grass intake of calves two to six months old. Two month old calves ate 0.03 kg/day less grass per kg of milk consumed ($P<.05$), and 6 month old calves ate .07 kg/day less grass per kg of milk ($P<.05$). This agrees with Lusby *et al.* (1976), who reported high milk intake depressed the consumption of non-milk nutrients, and with Wyatt *et al.* (1976) who found high milk consumption reduced relative forage intake as much as 50% during early summer.

Calf age and weight both had positive, but nonsignificant, effects on grass consumption. Older calves probably had earlier ruminal development, so were better able to consume and utilize available forage.

Table 4. Least square means of dry matter grass intake (kg/day) for birth periods.

Birth Period	Number of Calves	Months					
		May	June	July	August	September	Summer
1 (3/1-3/20)	14	$.58^{b}$	1.55	1.97	2.98^{b}	3.68	2.41^{b}
2 (3/21-3/31)	22	$.48^{ab}$	1.47	2.01	2.65^{ab}	3.62	2.38^{b}
3 (4/1-5/2)	15	$.38^{a}$	1.41	1.77	2.32^{a}	3.14	2.06^{a}

Birth Period	Number of Calves	Calf Age Range Period (Days)					
		30-60	60-90	90-120	120-150	150-180	180-210
1 (3/1-3/20)	14		$.85^{ab}$	1.61	2.29	2.77^{ab}	4.28
2 (3/21-3/31)	22	.42	1.13^{b}	1.73	2.21	2.66^{a}	3.53
3 (4/1-5/2)	15	.31	$.64^{a}$	1.98	1.96	3.25^{b}	3.39

^{a,b}Values within a column with similar superscripts are not significantly (P<.05) different.

Table 5. Least square means of dry matter grass intake (kg/day) for pastures.

Pasture	Number of Calves	Months: May	June	July	August	September	Summer
10	5	.60[b]	1.91[c]	2.28	2.44	3.52	2.46[b]
11	6	.51[ab]	1.60[b]	1.77	2.66	3.30	2.26[ab]
16	27	.36[a]	1.17[a]	1.97	2.83	3.59	2.27[ab]
17	13	.44[ab]	1.23[ab]	1.64	2.67	3.50	2.14[a]

Pasture	Number of Calves	Calf Age Range Periods (Days): 30-60	60-90	90-120	120-150	150-180	180-210
10	5	.43	1.06[b]	1.85[ab]	2.26	2.76	3.96
11	6	.49	.86[ab]	2.19[b]	2.15	2.83	3.37
16	27	.48	.72[a]	1.39[a]	2.35	3.17	3.57
17	13	.46	.86[ab]	1.65[a]	1.86	2.82	4.03

[a,b,c] Values within a column with similar superscripts are not significantly ($P<.05$) different.

Performance:

The mean 205-day adjusted weaning weight of all calves was 184 kg with a cumulative average daily gain for the lactation period of .70 kg/day. Handling stress during the experimental procedures probably caused the calf performance to be lower than normal. Least square means of cumulative life average daily gain are reported in Table 6.

Milk production and past producing ability of the cow, as measured by previous 205-day adjusted weaning weight ratios, were found to have the greatest influence on calf performance ($P<.001$). Each additional 1 kg/day of milk consumed, yielded an additional 7.20 kg of 205-day adjusted weaning weight and .034 kg/day average daily gain. However, the influence of milk production declined throughout lactation. This agrees with most of the literature. Increased milk production had a negative effect on time of rebreeding. Each additional kg of milk produced delayed rebreeding 1.4 days.

Grass intake had almost no effect on variation of total calf performance during lactation. However, grass influence was variable at various times during the lactation. During the first 2 months, grass intake was negatively related to average daily gain. This indicates calves eating the most grass were not receiving an adequate supply of milk, and were not yet able to meet their nutritional needs with the added grass intake. During the third, fourth, and fifth months (60-150 days) the added grass intake tended to improve gain ($P<.10$). Each additional kg/day of grass consumed resulted in

Table 6. Least square means of cumulative life average daily gain (kg/day) and for adjusted 205-day weaning weight (kg).

	Number of Calves	Calf Age Range Periods (Days)						Birth —	205-day
		30-60	60-90	90-120	120-150	150-180	180-210	Weaning[1]	Weight[1]
Sex									
Male	24	.23	.27	.38	.50	.62^{a}	.69	.69	185
Female	27	.24	.29	.40	.53	.65^{b}	.69	.69	184
Birth Period									
1 (3/1-3/20)	14		.28	.40^{ab}	.51	.60^{a}	.69^{ab}	.70	186
2 (3/21-3/31)	22	.25^{b}	.29	.40^{b}	.51	.60^{a}	.72^{b}	.70	186
3 (4/1-5/2)	15	.21^{a}	.26	.37^{a}	.51	.70^{b}	.67^{a}	.67	181
Pasture									
10	14	.19^{a}	.26	.38^{ab}	.52^{ab}	.66^{c}	.71^{b}	.70^{bc}	187^{bc}
11	14	.25^{b}	.27	.36^{a}	.48^{a}	.62^{ab}	.65^{a}	.65^{a}	177^{a}
16	11	.23^{b}	.29	.41^{b}	.51^{ab}	.61^{a}	.70^{b}	.68^{ab}	183^{ab}
17	12	.27^{c}	.30	.41^{b}	.54^{b}	.65^{bc}	.71^{b}	.72^{c}	191^{c}
Dam Age									
3 Years	5	.32^{b}	.23^{a}	.33^{a}	.46^{a}	.61^{a}	.64^{a}	.66^{a}	187
4 Years	6	.20^{a}	.30^{b}	.41^{b}	.53^{ab}	.66^{b}	.71^{ab}	.68^{a}	183
5-8 Years	27	.21^{a}	.30^{b}	.42^{b}	.55^{b}	.65^{b}	.74^{b}	.73^{b}	184
9 Years	13	.19^{a}	.28^{b}	.40^{b}	.50^{a}	.61^{a}	.68^{a}	.68^{a}	184

[1]Adjusted for dam's previous producing ability.

[a,b,c]Values within a column with similar superscripts are not significantly ($P<.05$) different.

approximately 0.02 kg/day increased gain. During late lactation, the influence of grass intake on calf performance became very minimal, perhaps due to the decline in quality and acceptability of the grass.

Birth period had a nonsignificant effect on calf performance. However, calves born during Birth Periods 1 and 2 (3/1-3/31) gained 0.03 kg/day faster and had a 5.0 kg higher 205-day adjusted weaning weight, than calves born during Birth Period 3. These values are in agreement with Schoonover (1974), and may reflect differences in forage intake, as older calves consumed 0.33 kg/day ($P<.05$) more grass than younger calves.

Sex had a nonsignificant effect on calf performance, even though bull calves consumed .23 kg/day more grass. This is in contrast to Melton et al. (1966), who found bull calves received more milk and outgained heifer calves. A possible explanation for the lack of effect is the past performance of the cows. Previous 205-day adjusted weaning weight ratios showed cows nursing heifers had produced calves that were 3% heavier than those nursing bull calves.

Pasture differences significantly affected ($P<.05$) calf performance, but these differences were extremely variable throughout the preweaning period (Table 7) and followed no trend related to milk or forage intake. Since experimental procedures in each pasture were conducted separately, some of the pasture treatment error may actually represent group experimental error. The tendency for calf gains to be affected by

Table 7. Least square means of periodic average daily gain (kg/day for pastures.

Pasture	Number of Calves	Months: April	May	June	July	August	September
10	14	.75	$.65^{ab}$	$.74^{ab}$	$.75^{a}$	$.87^{b}$	$.59^{b}$
11	14	.76	$.58^{a}$	$.82^{b}$	$.65^{b}$	$.76^{a}$	$.47^{a}$
16	11	.75	$.75^{c}$	$.70^{a}$	$.71^{ab}$	$.70^{a}$	$.51^{a}$
17	12	.85	$.70^{bc}$	$.68^{a}$	$.71^{ab}$	$.74^{a}$	$.72^{c}$

Pasture	Number of Calves	Calf Age Range Periods (Days): 30-60	60-90	90-120	120-150	150-180	180-210
10	14	$.71^{ab}$	.62	.75	$.82^{b}$	$.83^{c}$	$.56^{a}$
11	14	$.78^{b}$	.66	.75	$.68^{a}$	$.69^{b}$	$.48^{a}$
16	11	$.82^{c}$	.69	.75	$.71^{a}$	$.61^{a}$	$.53^{a}$
17	12	$.62^{a}$	.68	.73	$.75^{ab}$	$.71^{b}$	$.73^{b}$

^{a,b,c}Values within a column with similar superscripts are not significantly ($P<.05$) different.

pasture factors was greater during late summer, and may suggest environmental stress differences in the various pastures.

Age of dam had a quadratic effect ($P<.05$) on average daily calf gain during lactation (Table 8). This is primarily a function of milk production, although calves suckling 3 year old cows received more milk ($P<.10$) than those suckling either 4 year old cows or cows 9 years and older. Nevertheless they gained slightly less per day.

Birth weight had little effect on daily gain, but heavier calves at birth maintained this advantage in their 205-day adjusted weaning weight, weaning 1 kg heavier for each additional 1 kg of birth weight ($P<.10$).

Table 8. Least square means of periodic average daily gain (kg/day) for age of dam

Age of Dam	Number of Calves	Months					
		April	May	June	July	August	September
3 Years	5	.77	.66	.71	.67[a]	.75	.54
4 Years	6	.83	.68	.76	.70[ab]	.79	.56
5-8 Years	27	.79	.65	.75	.76[b]	.80	.59
9 + Years	13	.71	.70	.71	.70[ab]	.75	.60

Age of Dam	Number of Calves	Calf Age Range Periods (Days)					
		30-60	60-90	90-120	120-150	150-180	180-210
3 Years	5	.80[b]	.59	.70	.75	.67[a]	.59
4 Years	6	.79[b]	.67	.78	.72	.73[ab]	.53
5-8 Years	27	.64[a]	.69	.77	.76	.75[b]	.60
9 + Years	13	.71[ab]	.70	.72	.72	.69[a]	.57

[a,b]Values within a column with similar superscripts are not significantly ($P<.05$) different.

SUMMARY

Milk and forage intake were measured for fifty-one spring-born Polled Hereford calves grazing native bluestem range. Milk consumption and past producing ability of the cows represented the greatest sources of variation in calf performance. Age of dam had a quadratic effect on milk consumption and cumulative life average daily gain. The effect of forage intake approached significance during the middle of the lactation period but were minimal during late lactation. Sex of calf, birth weight, and calving date had nonsignificant effects on calf performance, however heavier calves at birth had heavier 205-day adjusted weights.

Calving date was quadratically related to milk consumption. Peak yield occurred 30-60 days after calving. Milk consumption was negatively related to forage intake. Bull calves ate significantly more grass than heifers and the older two-thirds of calves consumed more grass than the younger calves. Daily milk intake decreased steadily from May through September while daily forage intake increased steadily. Monthly average daily gain was constant until September which was lower. Our data indicate that calves could not meet their non-milk energy requirements during the late summer on native bluestem range.

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APPENDIX

Table 1. Least square means of periodic average daily gain (kg/day) for birth periods.

Birth Period	Number of Calves	Months					
		April	May	June	July	August	September
1 (3/1-3/20)	14	.90	.76[b]	.73	.70	.73[a]	.60[b]
2 (3/21-3/31)	22	.74	.66[ab]	.73	.71	.79[b]	.59[ab]
3 (4/1-5/2)	15	.69	.59[a]	.75	.71	.79[b]	.52[a]

Birth Period	Number of Calves	Calf Age Range Periods (Days)					
		30-60	60-90	90-120	120-150	150-180	180-210
1 (3/1-3/20)	14		.65	.75	.70[a]	.70[a]	.60
2 (3/21-3/31)	22	.77	.68	.75	.75[ab]	.78[b]	.60
3 (4/1-5/2)	15	.70	.65	.73	.78[b]	.65[a]	.52

[a,b]Values within a column with similar superscripts are not significantly ($P<.05$) different.

Table 2. Analysis of variance for total milk production (kg/day).

Source	df	Mean Squares	Prob.
Sex	1	1.882	0.17
Birth Period	2	1.215	0.29
Pasture	3	0.586	0.60
Dam Age	3	1.685	0.17
Birth Weight	1	4.013	0.05
April Cow Weight	1	0.016	0.90
Lactation Number	1	0.019	0.89
Cow Height	1	0.413	0.51
Residual	36	0.938	

Table 3. Analysis of variance for total grass intake (kg/day).

Source	df	Mean Squares	Prob.
Sex	1	0.494	0.05
Birth Period	2	0.154	0.28
Pasture	3	0.152	0.29
Dam Age	3	0.085	0.54
Birth Weight	1	0.003	0.87
Birth Date	1	0.286	0.13
Milk Intake	1	0.009	0.78
Weaning Weight	1	0.005	0.84
Residual	36	0.117	

Table 4. Analysis of variance for birth to weaning ADG.

Source	df	Mean Squares	Prob.
Sex	1	0.001	0.70
Birth Period	2	0.007	0.43
Pasture	3	0.040	0.00
Dam Age	3	0.000	0.01
Birth Weight	1	0.306	0.97
Past 205-Ratio	1	0.197	0.00
Milk Intake	1	0.019	0.00
Height at Weaning	1	0.017	0.15
Forage Intake	1	0.000	0.99
Residual	37	0.008	

Table 5. Analysis of variance for adjusted 205-day weight.

Sources	df	Mean Squares	Prob.
Sex	1	37.687	0.74
Birth Period	2	249.952	0.50
Pasture	3	1888.823	0.00
Dam Age	3	56.346	0.92
Birth Weight	1	1071.792	0.09
Past 205-Ratio	1	13753.996	0.00
Milk Intake	1	9024.980	0.00
Height at weaning	1	703.146	0.17
Forage Intake	1	0.375	0.97
Residual	36	350.046	

6. Calf Data.

COW ID	BIRTH DATE	BIRTH WT	APRIL WT	APRIL MILK	MAY WT	MAY MILK	MAY GRASS	JUNE WT	JUNE MILK	JUNE GRASS	JULY WT	JULY MILK	JULY GRASS	AUGUST WT	AUGUST MILK	AUGUST GRASS	SEPTEMBER WT	SEPTEMBER MILK	SEPTEMBER GRASS
6006	3/ 1	32.7	46.75	3.63	59.0	3.13	0.70	76.3	1.82	1.66	97.6	2.95	1.59	118.9	2.72	3.19	128.0	2.04	2.36
6010	3/ 6	36.3	74.44	7.04	92.6	4.54	0.77	113.9	4.09	3.03	142.5	4.54	2.39	174.3	3.18	2.72	194.3	2.27	2.75
6015	3/ 8	33.6	69.90	5.45	87.2	4.77	*****	106.2	3.40	2.25	129.4	3.40	1.81	154.3	2.95	2.35	177.5	4.09	4.47
6016	3/ 9	31.8	62.19	6.31	75.4	3.63	0.63	92.6	3.40	2.23	117.1	2.27	2.74	143.4	2.50	2.99	158.9	2.27	2.82
6020	3/11	23.1	65.37	7.72	87.2	6.81	0.90	110.8	5.90	2.89	139.8	4.99	2.25	169.8	3.63	3.23	184.3	2.27	6.14
6052	3/16	32.7	67.64	5.90	84.4	6.35	0.54	108.0	5.90	1.33	134.4	5.22	2.36	168.0	3.40	4.17	181.6	5.90	4.58
6054	3/17	40.9	63.55	3.63	79.4	5.90	0.60	97.6	3.63	2.19	120.3	3.86	1.68	143.4	2.50	2.79	159.8	2.72	3.29
6055	3/17	32.7	68.09	7.04	89.9	6.58	0.84	108.9	3.86	1.68	134.8	3.86	2.41	163.4	3.40	4.36	182.9	4.09	3.19
6056	3/17	31.3	65.37	6.81	81.7	4.99	0.36	103.9	6.81	*****	128.9	5.67	3.10	158.0	2.50	2.06	177.0	2.72	2.94
6057	3/18	31.3	67.64	8.40	81.7	6.13	0.54	101.7	5.22	3.00	123.9	6.13	1.97	149.8	5.22	2.52	169.3	5.45	3.37
6058	3/18	32.7	61.73	8.17	78.1	4.31	0.60	97.1	3.63	*****	122.6	2.72	1.64	153.4	3.86	2.46	178.4	2.95	3.51
6060	3/20	36.3	80.60	6.81	99.0	6.81	0.34	118.9	5.22	1.51	146.2	5.45	1.90	172.0	4.77	2.30	192.0	3.40	4.35
6061	3/19	35.4	52.20	0.00	79.9	4.09	0.64	97.1	3.63	1.32	117.1	4.31	1.23	136.6	2.50	3.28	158.9	3.63	3.49
6062	3/19	33.1	61.73	0.00	79.0	4.09	0.71	98.5	4.54	1.88	121.7	2.95	1.44	152.1	3.18	2.58	172.5	3.18	4.02
6067	3/21	34.0	72.63	8.17	93.5	9.53	0.37	114.8	5.67	2.40	139.4	6.81	1.34	166.1	2.95	3.69	185.7	5.45	4.78
6068	3/21	37.7	76.71	9.08	91.7	7.72	0.75	118.9	7.04	1.71	148.4	7.72	2.16	177.0	4.09	3.12	201.5	3.86	*****
6069	3/22	32.2	56.74	7.04	75.8	6.81	*****	94.9	4.77	1.06	119.4	5.22	1.32	144.3	3.18	2.34	162.5	3.18	3.37
6071	3/22	33.6	64.45	0.00	80.8	6.35	0.72	101.7	4.54	2.50	124.8	4.99	3.79	152.1	2.95	2.30	169.8	4.31	4.03
6072	3/22	30.4	55.38	0.00	74.0	5.90	0.54	94.9	5.22	1.22	121.7	4.99	1.43	151.2	3.19	3.42	167.0	1.82	3.04
6073	3/22	34.0	68.09	8.17	86.7	6.35	0.36	108.0	5.67	2.28	136.2	4.31	1.94	162.5	2.95	1.75	184.3	4.31	3.77
6074	3/23	33.6	69.90	7.26	98.0	10.44	0.40	119.8	8.40	1.02	146.2	8.40	1.47	173.4	6.81	2.14	202.5	5.90	4.87
6077	3/24	39.6	71.72	6.58	92.1	6.13	0.73	113.5	4.99	1.75	140.3	4.09	2.00	171.1	3.40	3.78	197.9	3.18	3.34
6078	3/25	35.4	76.71	9.99	96.2	6.35	0.65	118.9	7.49	1.49	148.4	8.40	1.50	177.9	4.31	3.55	198.4	5.67	3.62
6079	3/26	34.5	71.72	7.49	85.8	5.45	0.35	105.4	5.67	1.52	129.4	5.67	1.33	157.1	2.95	2.43	173.9	4.31	4.32
6080	3/26	37.2	59.01	5.22	73.5	4.54	0.58	90.8	3.18	1.33	108.0	4.09	1.92	128.9	2.04	3.19	141.2	2.72	2.59
6081	3/26	36.6	60.83	7.49	79.4	5.90	0.27	95.8	4.31	1.39	118.0	3.63	1.25	142.5	2.95	2.93	160.2	2.95	3.29
6083	3/26	41.8	74.44	8.17	89.9	6.35	0.31	104.9	5.67	1.43	128.0	4.31	5.05	154.3	3.86	2.42	171.1	2.95	2.52
6086	3/27	34.5	54.02	4.54	63.1	4.09	0.48	77.2	2.72	1.03	94.4	2.95	2.16	116.2	1.36	2.26	129.8	2.27	3.24
6089	3/28	30.0	50.39	5.90	63.5	4.09	0.51	78.5	2.95	1.52	98.0	2.95	1.53	120.7	2.50	3.44	139.8	3.40	3.23
6091	3/28	33.6	62.64	6.35	85.3	6.13	0.29	103.5	6.58	0.95	125.3	6.13	1.66	148.4	4.09	1.87	173.4	3.86	4.25
6092	3/29	33.1	59.01	4.99	78.1	6.81	0.38	95.8	5.22	0.90	118.9	3.63	2.56	143.9	3.63	2.48	167.5	3.86	4.25
6093	3/30	35.4	63.10	7.04	76.3	4.54	0.35	94.4	4.09	1.66	116.2	4.99	1.48	146.2	2.50	2.62	170.7	4.99	3.65
6095	3/30	34.0	61.28	4.99	80.8	5.90	0.45	105.3	6.58	1.11	130.7	6.58	1.77	156.2	3.63	2.21	173.4	4.54	3.29
6098	3/31	40.4	62.64	0.00	79.9	5.90	1.16	93.5	4.77	3.14	118.9	4.54	2.11	146.6	4.09	2.19	164.3	3.40	5.87
6099	3/31	39.5	67.18	6.81	89.0	5.45	0.28	107.1	5.22	1.35	134.4	4.31	1.41	164.3	3.63	3.14	186.1	3.63	4.03
6100	3/31	31.8	52.66	5.45	73.5	7.26	0.33	93.1	8.40	1.06	120.7	6.58	1.89	145.3	4.54	2.45	173.4	5.90	3.91
6101	4/ 1	38.6	62.64	6.58	76.3	4.77	0.22	92.6	4.31	0.74	114.4	3.63	1.23	139.8	4.09	2.08	156.2	3.86	2.57
6102	4/ 2	35.0	61.28	5.45	76.3	6.35	0.25	92.6	4.77	0.74	116.2	3.86	1.86	136.2	3.18	1.88	159.8	3.19	4.81
6104	4/ 4	40.9	68.09	7.26	91.7	7.26	0.29	108.0	4.31	1.24	132.5	4.54	*****	154.3	3.18	2.44	171.6	2.95	3.27
6105	4/ 5	33.6	57.19	4.77	75.4	7.49	*****	93.1	6.35	0.50	117.1	6.13	1.29	143.0	3.40	2.47	164.3	3.40	3.44
6105	4/ 5	33.6	48.12	5.67	69.0	7.04	0.33	84.4	5.90	0.55	106.2	4.77	1.05	129.8	3.18	2.72	153.4	4.99	2.40
6109	4/ 6	35.4	53.56	5.90	74.4	6.35	0.35	92.1	4.99	1.09	116.2	4.99	1.97	139.8	3.86	2.34	157.1	3.40	4.55
6116	4/ 8	34.0	50.84	4.77	64.9	6.13	*****	80.8	4.31	0.65	101.7	4.77	1.08	125.7	2.72	1.45	145.3	3.18	3.05
6117	4/ 8	35.0	50.84	4.77	73.5	6.81	0.31	93.5	5.45	1.12	120.3	6.13	1.52	151.6	4.54	1.89	176.6	3.40	3.02
6122	4/12	36.3	44.94	3.40	55.4	3.63	0.20	70.8	3.18	0.97	85.3	3.40	1.03	109.9	3.18	2.00	127.1	3.18	2.63
6126	4/15	34.0	44.94	4.54	61.3	4.54	0.27	74.4	4.77	1.00	91.7	4.54	2.46	114.4	1.59	1.82	133.9	2.95	7.79
6128	4/19	34.0	44.94	0.00	63.5	6.35	0.45	82.2	4.77	1.01	107.1	6.81	1.70	129.8	4.31	1.95	153.4	4.99	2.98
6129	4/17	39.5	59.92	8.62	75.4	4.99	0.26	86.2	3.40	1.15	99.4	2.50	1.79	121.7	4.99	2.06	135.3	2.27	3.40
6133	4/25	33.1	39.95	7.04	58.1	4.99	0.45	75.4	5.22	0.50	95.3	4.99	1.36	118.0	3.18	2.53	126.9	3.86	2.71
6134	4/24	35.4	44.48	5.67	62.2	5.45	0.26	79.0	6.81	0.47	96.2	4.99	0.92	119.8	3.18	2.58	142.1	3.86	2.96
6137	5/ 2	41.8	0.00	0.00	56.3	4.77	0.23	68.5	3.18	0.68	83.5	3.40	1.57	103.5	1.82	*****	116.7	1.13	3.25

**** Missing observations

EFFECTS OF MILK AND FORAGE INTAKE ON CALF PERFORMANCE

by

DONALD L. BOGGS

B.S., University of Illinois, 1975

AN ABSTRACT OF A MASTER'S THESIS

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Milk and forage dry matter intake were measured for fifty-one spring born, suckling, Hereford calves grazing native bluestem range. Milk consumptions, measured monthly by a calf suckling technique, were 5.68, 5.82, 5.00, 4.77, 3.45 and 3.68 kg/day, respectively for the months of April through September. Calves were grouped by birth date into Birth Period 1 (first one-third born), Birth Period 2 (second one-third born) and Birth Period 3 (last one-third born). Cows calving in Birth Period 2 produced more milk ($P<.05$) during the 3rd and 5th months of lactation, retained peak production longer and declined more gradually. Age of dam had a quadratic effect ($P<.05$) on milk production.

Forage dry matter intake was determined using the excretion to indigestibility ratio technique, with chromic oxide as a fecal output indicator. Grazed forage was collected via esophageal fistulated steers and analyzed for _in vitro_ dry matter digestibility. Forage intakes for May through September were 0.49, 1.43, 1.83. 2.57 and 4.53 kg/day, representing 0.62%, 1.46%, 1.51%, 1.75% and 2.72% of the calve's body weight, respectively. Bull calves ate 0.23 kg/day ($P<.05$) more grass than heifers. The older two-thirds of the calves consumed 0.33 kg/day ($P<.05$) more grass than the younger one-third. Forage intake decreased 0.03 kg/kg increase in milk consumption ($P<.05$) when calves were 2 months old and 0.07 kg ($P<.05$) when calves were 6 months old. Pasture effects were variable through lactation.

Milk consumption and past producing ability of the cow were the greatest sources of variance ($P<.001$) for calf performance. Each additional 1 kg/day milk consumption resulted in an additional 0.034 kg/day average daily gain (ADG) and 7.20 kg of 205-day adjusted weaning weight. Sex, birth weight and birth period had nonsignificant effects on average daily gain. Age of dam had a quadratic effect ($P<.05$) on average daily gain. Effect of forage intake on overall average daily gain was minimal, but variable during the lactation period. Forage intake had a negative effect on monthly average daily gain during the first 2 months of lactation, but during the third, fourth and fifth months each additional 1 kg of forage intake increased average daily gain 0.02 kg/day. The influence of forage intake on average daily gain in late lactation was minimal, indicating that as quality declined, calves perhaps could not consume enough grass to meet their non-milk energy requirements.