Liquid supplementation of grazing cows and calves
by Allison Virginia Earley

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Animal Science
Montana State University

Abstract:
One hundred one Angus cows (612 kg) and their bull calves (214 kg) grazing improved summer pastures were used to determine cow and calf intake of liquid supplement, and its effect on forage intake and performance. Forty-seven pairs had access to liquid supplement in an open tank and 54 pairs were not supplemented. The study was conducted in southwestern Montana from July 28, 1997 to October 3, 1997. Ytterbium chloride was added to the liquid supplement (41 % CP, DM basis) to estimate individual supplement intake. Forage intake was estimated for all supplemented pairs and 10 unsupplemented pairs using estimates of fecal output obtained using chromium boluses and in situ 48 h DM digestibility. All supplemented cows and calves were fitted with a radio frequency (RF) eartag in order to electronically record each visit by an animal to the supplement feeder. Estimated supplement intake by cows and calves averaged .3 kg/d and .1 kg/d, respectively. There was no difference (P > .10) in supplement intake between cows and calves, averaging .04 % BW. Supplemented cows gained .12 kg/d more (P = .02) than unsupplemented cows; however, there was no difference (P > .10) in body condition score change between treatments. Average daily gain by supplemented calves was 30 % greater (P < .01) than ADG by unsupplemented calves. Forage intake (% BW) by supplemented cows and calves was 65 % greater (P < .05) than forage intake by unsupplemented cattle. There was no difference (P > .10) in time spent at the tank between cows and calves, averaging 4.9 min/d. Minutes per day at the feeder was lowest for 7-yr-old cows, intermediate for 6- and 8-yr-old cows, and highest for 9-yr-old cows (P < .10). There was no difference (P > .10) in bouts/d between age groups of cows. Calf use of liquid supplement was similar to use by cows. Liquid supplementation increased forage intake and ADG of cows and calves grazing improved forages in late summer. Time at the tank was not a good predictor of supplement intake, but could be used to rank supplement consumption by cows and calves.

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APPROVAL

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Allison Virginia Earley

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding contents, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Signature Allison V. Earley

Date August 28, 1998

This thesis is dedicated to my two grandfathers:

W. Edwin Jacobs,
who I think would appreciate this endeavor more than anyone else;

and

William C. Earley,
who let us help work his cattle.

Thank you both.

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ABSTRACT

One hundred one Angus cows (612 kg) and their bull calves (214 kg) grazing improved summer pastures were used to determine cow and calf intake of liquid supplement, and its effect on forage intake and performance. Forty-seven pairs had access to liquid supplement in an open tank and 54 pairs were not supplemented. The study was conducted in southwestern Montana from July 28, 1997 to October 3, 1997. Ytterbium chloride was added to the liquid supplement (41 % CP, DM basis) to estimate individual supplement intake. Forage intake was estimated for all supplemented pairs and 10 unsupplemented pairs using estimates of fecal output obtained using chromium boluses and *in situ* 48 h DM digestibility. All supplemented cows and calves were fitted with a radio frequency (RF) eartag in order to electronically record each visit by an animal to the supplement feeder. Estimated supplement intake by cows and calves averaged .3 kg/d and .1 kg/d, respectively. There was no difference ($P > .10$) in supplement intake between cows and calves, averaging .04 % BW. Supplemented cows gained .12 kg/d more ($P = .02$) than unsupplemented cows; however, there was no difference ($P > .10$) in body condition score change between treatments. Average daily gain by supplemented calves was 30 % greater ($P < .01$) than ADG by unsupplemented calves. Forage intake (% BW) by supplemented cows and calves was 65 % greater ($P < .05$) than forage intake by unsupplemented cattle. There was no difference ($P > .10$) in time spent at the tank between cows and calves, averaging 4.9 min/d. Minutes per day at the feeder was lowest for 7-yr-old cows, intermediate for 6- and 8-yr-old cows, and highest for 9-yr-old cows ($P < .10$). There was no difference ($P > .10$) in bouts/d between age groups of cows. Calf use of liquid supplement was similar to use by cows. Liquid supplementation increased forage intake and ADG of cows and calves grazing improved forages in late summer. Time at the tank was not a good predictor of supplement intake, but could be used to rank supplement consumption by cows and calves.

INTRODUCTION

Agriculture is the leading industry in Montana with cash receipts totaling over two billion dollars (Mont. Ag. Stat. Serv., 1997). Cash receipts from the sale of cattle and calves account for 32% of all commodities sold in Montana (Mont. Ag. Stat. Serv., 1997). Lindholm and Stonaker (1957) reported that calf weaning weight (WW) is the most important trait affecting net income of cow/calf operations.

Nutrition is an important aspect of both cow and calf performance and it is estimated that feed costs account for 60 to 70% of a producers total expenditures (USDA, 1994). Sixty-six percent of the land in Montana farms and ranches is classified as rangeland or pasture (Mont. Ag. Stat. Serv., 1997) and most cow/calf producers utilize these rangelands to decrease production costs. However, the quantity and quality of forage available on rangelands can be limiting during certain times of the year and supplementation may be required to optimize cow and calf performance. Forage quality decreases through the summer as plants mature and lactating cows grazing rangelands may be energy and protein deficient from August through October (Adams and Short, 1988). This period of reduced forage quality also corresponds to the period of increased reliance on forage by the calf due to declining milk production of the cow. When forage quality decreases, it may be profitable to supplement animals to increase forage intake and supply animals with limiting nutrients in order to improve performance. Wagnon (1965) suggested it is more efficient to promote weight gains of cows during this period than to promote weight gains by cows during the winter months.

Liquid supplements provide a source of energy and protein to the ruminant and can be self-fed which reduces labor costs (Grelen and Pearson, 1977). Several researchers have reported increased weaning weights and ADG for calves of liquid supplemented cow/calf pairs (Grelen and Pearson, 1977; Hennessy, 1986; Bowman et al., 1994). There is very little data reporting calf use of supplements and it is not known if these calves performed better due to higher milk intakes or calf use of the supplement.

The objectives of this study were to determine the level of supplement intake and use by cows and calves with access to liquid supplement in an open tank; and to determine the effects of liquid supplementation on cow and calf performance, forage intake, forage digestibility and cow milk production.

LITERATURE REVIEW

Factors Influencing Calf Performance

Lindholm and Stonaker (1957) reported that calf weaning weight (WW) is the most important trait affecting net income of cow/calf operations. Average daily gain (ADG) and weaning weight (WW) are measures of calf performance and can be influenced by a variety of genetic and nutritional factors.

Supplementation

Grazing animals are supplemented with energy or protein in order to improve energy balance during certain times of the year; however, animal response to supplementation can be influenced by the type of supplement provided. Energy supplements are less expensive than protein supplements, but animal responses to energy supplementation have been inconsistent (Horn and McCollum, 1987). Perry et al. (1991) reported lower levels of energy available to the cow pre- and post-partum resulted in decreased milk production and lower calf weights at 70 d. Bellows and Thomas (1976) reported no improvement in calf gains from grain supplementation of cows before and during the breeding season. Furr and Nelson (1964) reported that creep-fed calves were 39 kg heavier at weaning than non-creep-fed calves. Lack of cow response to energy supplementation could be due to decreased forage intake observed with energy supplementation (Bellows and Thomas, 1976; Kartchner, 1981). Higher starch intakes decrease rumen pH, which inhibits fiber digestion (Horn and McCollum, 1987).

Protein supplements are more expensive, but the effect on performance is less variable (Adams, 1985). Wallace (1988) reported that protein was the first limiting nutrient in diets of cattle grazing dormant forage and that cattle responded better to protein than grain supplements. Kartchner (1981) reported higher forage intakes by cows consuming low quality forages with protein supplementation. Protein increases forage intake by stimulating microbial growth, thereby increasing digestion and rate of passage (Coleman and Wyatt, 1982; McCollum and Galyean, 1985; Petersen, 1987). Dhuyvetter (1991) reported increased gains for calves of 3-yr-old cows supplemented with protein pre- and postpartum; however, supplementation did not influence milk production of the cow. Wallace (1988) also reported higher WW for calves of mature cows supplemented with protein in late gestation.

Liquid supplements provide a source of energy and protein to the ruminant and can be self-fed which reduces labor costs (Grelen and Pearson, 1977) and decreases interference with normal grazing behavior. Pate et al. (1990) reported improvements in calf performance by calves of 3-yr-old cows that were offered liquid supplement; however, Landblom and Nelson (1990) found no difference in gains of calves with access to a molasses feedblock. Grelen and Pearson (1977) reported that calves of cows on a year-round liquid supplementation program had 7 kg higher WW than calves of cows who received cottonseed cake only during the winter. Hennessy (1986) reported 20% higher WW for calves receiving a cottonseed meal or molasses/cottonseed meal mix compared to unsupplemented calves. He attributed this increase in WW to increased milk production of the cow. Bowman et al. (1994) provided 2 yr old cows with liquid supplement offered in an open tank for 2 1/2 months post-partum. During the supplementation period, calves of supplemented cows had 15.5 % greater ADG than calves of unsupplemented animals. These researchers wondered if supplemented calves performed better due to higher milk intakes or if calves consumed liquid supplement.

There are very few studies that have collected supplement and milk intake data from calves of supplemented cows.

Forage quality as well as the type of supplement offered can influence animal response to supplementation. Langlands and Donald (1978) found that yearling heifers responded to supplementation when grazing native range but not improved pastures. Butterworth et al. (1973) reported that supplementation was more effective in the winter when forage availability was lowest, than in the spring when more forage was available. Jones (1966) reported that weight loss was reduced when cattle were grazing lower quality pastures and offered a molasses-urea feedblock.

In a review of liquid supplemented ruminants consuming low quality forages, Bowman et al. (1995b) concluded that performance and forage intake by supplemented animals were confounded by pasture condition, forage quality, animal variation and supplement delivery system. These authors noted that forage intake and gains by unsupplemented cattle were related to CP content of the forage. Langlands and Donald (1978) reported increased weight gains by supplemented animals when the CP content of the forage was less than 10 %. Moore et al. (1995) compiled data from 51 studies and concluded that animal response to supplementation (dry or liquid) depends on the ratio of digestible organic matter (DOM) to CP content of the forage. When the DOM:CP is greater than 7, supplementation will increase animal weight gains and forage intake. However, when the DOM:CP is less than 7, weight gains could be increased but there was generally a decrease in forage intake. Emanuele (1997) reviewed the use of molasses supplements in dairy rations and concluded that the readily digestible sugars provided by these supplements will not decrease rumen pH or inhibit fiber digestion when they make up less than 15 % of the ration on a DM basis. He also noted that animal response is greater when the ration contains adequate amounts of rumen degradable amino acids and peptides. Bowman et al. (1995a) reported a 47 % increase in forage intake and 36 % increase in DM digestibility by liquid supplemented cows grazing native fall range (8 % CP, 72 % NDF). Daniels et al. (1998) also reported 47 % greater forage intakes and 25 – 59 % higher DM digestibility by liquid supplemented cows grazing native winter range (5 % CP, 79 % NDF).

Forage Intake

Plane of nutrition available to the calf other than milk can influence calf growth (Neville, 1962). Forcherio et al. (1995) related increased calf gains to greater milk production by the cow and slightly greater forage intake by the calf. Peischel (1980) reported that forage consumed by the calf had a positive effect on calf weaning weight. Boggs et al. (1980) concluded that grass intake was negatively related to ADG in the first 2 months of life and poorly related to calf performance over the entire pre-weaning period. However, he also reported that added grass intake did improve gain in the third, fourth, and fifth months of the calf's life.

Some researchers have documented the relationship between milk intake and forage intake by calves. Baker et al. (1976), Le Du et al., (1976a, 1976b), and Le Du and Baker (1979) reported an inverse relationship between calf milk intake and forage OM intake. Broesder et al. (1990) reported that reducing the amount of milk replacer fed to calves resulted in an increase in OM intake of alfafa hay; however, total OM intake remained constant among milk reduction groups. Boggs et al. (1980), Clutter and Nielson (1987) and Ansotegui et al. (1991) reported that calves increased forage intake to make up for decreased milk production, but Peischel (1980) and Sowell et al. (1996) reported different findings.

Milk Production

Rutledge et al. (1971) reported that milk production, calving date, age of dam, calf birth weight, cow weight, year, sire and calf sex accounted for 92.4% of the variation in calf weight at 205 days. They concluded that milk production was the single most important factor in the equation, accounting for 60 % of the variation in 205-d calf weight. Neville (1962) included the same variables in his regression model and reported that they accounted for 82% of the variation in 120- and 240-d weights, and 240-d gains; with milk production accounting for 66% of the variation in calf weight at 240-days. Furr and Nelson (1964) reported that milk production accounted for 66 to 72 % of the variation in ADG; however, correlation estimates between average daily gain and milk yield decreased as lactation progressed. Neville (1962) and Rutledge et al. (1971) also reported that the correlation between milk intake and calf ADG decreased as lactation progressed. Kress and Anderson (1974) reported correlation estimates between cow milk production and calf ADG of .50 early in lactation, which decreased to .18 near weaning. Melton et al. (1967) reported that ADG and milk production were only significantly correlated in the first 77 d of lactation, and that the correlation between ADG and milk production declined as lactation progressed (.58 to .03). Neville (1962) concluded that cow milk production is most important in the first 60 days of a calf's life. This time period corresponds to the time of peak milk production by the cow (Totusek et al., 1973; Kress and Anderson, 1974; Williams et al., 1979; Casebolt et al., 1983; Bushkirk et al., 1992). Weight of dam (Rutledge et al., 1971; Urick et al., 1971) and age of dam (Neville, 1962; Havstad et al., 1989) can influence calf WW, primarily through the amount of milk they produce (Neville, 1962; Rutledge et al., 1971).

Estimating Supplement Intake

Lack of data regarding individual intake of supplements makes it difficult to interpret effects of supplementation on individual animal performance in grazing trials (Nolan et al., 1974). Inconsistencies in performance of liquid supplemented animals could be a result of the wide variation in individual animal intakes (Sowell et al., 1995).

Nolan et al. (1975) used tritiated water to estimate individual animal intake of a urea-molasses supplement by 200 grazing sheep. Ninety-seven of the sheep were classified as nonconsumers and individual intake by consumers ranged from 5 to 550 ml/d. Sheep consuming supplement lost less weight and showed increased wool growth compared to nonconsuming animals. Lobato et al. (1980) estimated individual intakes of supplemental oats, hay and a molasses block by grazing sheep using chromic oxide as a marker. Eight of 15 sheep did not consume any of the molasses block. There was a positive correlation between liveweight gain and individual intake of oats and hay, but not the molasses block (Lobato et al., 1980). Mulholland and Coombe (1979) reported a 40 % coefficient of variation (CV) in individual supplement intake by grazing wethers supplemented with urea, molasses and minerals, and only two animals were classified as nonconsumers. These researchers did not find a strong relationship between supplement intake and rate of liveweight change.

Nolan et al. (1974) estimated individual supplement intake using isotope labeling and reported that 8 of 48 heifers refused to consume liquid supplement. Individual animal intakes ranged from 30 ml to 2.4 L/d; and rate of liveweight change was significantly correlated with supplement intake. Langlands and Donald (1978) used tritiated water to estimate individual intake of a molasses supplement by seven grazing heifers and steers. Four percent of the animals refused to consume supplement and the CV between individual intakes was 37 %. One would assume that the variability of larger herds of cattle under increased stocking rates would be greater. Llewelyn et al. (1978) used the tritiated water marker method to estimate individual supplement consumption of 37 pregnant heifers grazing a 223 ha paddock. Intakes ranged from 0 to 2.6 kg/d with 62 % of the animals consuming some supplement. Rate of liveweight loss was reduced by supplementation (Llewelyn et al., 1978)

Curtis et al. (1994) used ytterbium (Yb) as a marker to estimate supplement intake by grazing sheep. These authors reported that the mean retention time of Yb was not affected by diet and that the concentration of Yb in fecal grab samples could be used to rank individual supplement intakes. They suggested using Yb with a second marker such as chromic oxide to estimate fecal output. Gibson et al. (1995) evaluated the use of chromic oxide continuous release boluses to estimate fecal output and Yb marked liquid supplement to estimate supplement intake. The technique overestimated liquid supplement intake by 10%, but there was a linear relationship ($P < .001$; $R^2 = .92$) between actual supplement intake and predicted supplement intake (Gibson et al., 1995). Bowman et al. (1995a) used the method of Gibson et al. (1995) to estimate liquid supplement intake by 60 cows grazing fall native range and reported supplement intake by individual animals ranged from .002 to 2.54 kg/d. Twenty-nine percent of the animals consumed only trace amounts of supplement.

Estimating Forage Intake

Measuring forage intake under range conditions presents many challenges. It is impossible to directly measure forage intake by grazing animals; however, it can be calculated indirectly by dividing fecal output by the indigestibility of the forage.

The best measurement of fecal output is obtained through total fecal collections using fecal bags, but under range conditions the bags can fall off, tear, or alter grazing behavior due to numerous collection times. Fecal output by grazing animals can be estimated using external markers as reviewed by Pond et al. (1987). Chromic oxide (Cr_2O_3) is the most commonly used external marker for estimating fecal output because it is easy to analyze, relatively inexpensive and is available in a continuous release bolus (Paterson and Kerley, 1987). Chromic oxide is not associated with either the liquid or particulate phase of rumen digesta and traditionally has been dosed for several days in order to achieve steady state conditions of excretion (Pond et al., 1987). However, Laby et al. (1984) developed a continuous release chromic oxide bolus that eliminated the need for several dosings making it more practical for use under grazing conditions. The continuous release bolus increases the flexibility of fecal sampling routines and further reduces animal handling requirements (Parker et al., 1990). Furnival et al. (1990) reported that in sheep, the continuous release chromium bolus produced more reliable estimates of fecal output than twice daily dosings of chromic oxide in gelatin capsules. Diurnal variation in excretion is removed with the continuous release bolus so that the remaining variability is more closely associated with patterns of feed intake and digesta flow (Laby et al., 1984; Furnival et al., 1990; Parker et al., 1990; Momont et a., 1994). Chromic oxide excretion plateaus 5 to 6 days after bolusing (Laby et al., 1984) and the optimum window of chromic oxide excretion occurs between 6 and 14 days post-dosing (Kattnig et al., 1990). Hollingsworth et al. (1995) and Momont et al. (1994) also reported that estimates of fecal output were not influenced by supplemental treatments. There are no chromic oxide boluses specifically designed for use in calves; however, Swensson et al. (1995) reported that one sheep continuous release boluses could be used to estimate fecal output in grazing calves weighing less than 150 kg.

Forage digestibility can be estimated using internal markers (Cochran et al., 1987), *in situ* (Bowman et al., 1995a) or *in vitro* techniques (Tilley and Terry, 1963).

Internal markers can be used to estimate digestibility for each individual animal (Cochran et al., 1987); however, *in situ* and *in vitro* techniques give a more direct estimate of digestibility. *In vitro* lab analysis does not always give an accurate estimate of digestibility of the forage, but *in situ* estimates obtained from a few animals may not be representative of the entire herd (Parker et al., 1991). Peischel (1980) and Ansotegui (1986) reported that the rumen kinetics of suckling calves is similar to that of mature cows. Peischel (1980) reported that calves selected diets higher in protein than mature cows throughout the season; however, Grings et al. (1995) found that suckling calves selected higher quality diets only earlier in the summer when they received most of their nutrients from milk.

Mayes et al. (1986) reported that forage intake could be estimated without the need to estimate fecal output or forage digestibility using plant n-alkanes as markers. Dove and Mayes (1991) reviewed the use of plant alkanes as markers to estimate forage intake and digestibility of individual animals. Forage intake can be estimated using a pair of alkanes, one dosed (artificial, even-chained) and one natural (odd-chained), if they have similar fecal recoveries. The n-alkanes C_{32} and C_{33} fit this criteria. The C_{36} alkane is relatively indigestible and can be used to estimate digestibility. Satisfactory results have been obtained using this method (Mayes et al., 1986; Dove and Mayes, 1991), but results have been more variable in cattle than in sheep. Most of the work with cattle has been done in confinement and diurnal variation in excretion patterns can be a problem. The alkanes are available as continuous release boluses for three sizes of animals; however, they are 50 % more expensive than the chromic oxide boluses and the lab analysis of alkanes in forage and feces is more laborious than that of chromium. In addition, samples must be freeze-dried and not oven-dried for analysis. Different plants have different amounts of alkanes and a good sample of forage grazing animals are selecting is critical for obtaining accurate estimates of intake and digestibility. Most of the research conducted using alkanes has been done in Australia and few researchers in the United States have reported results using this technique.

Estimating Milk Intake

Milk production by the cow is influenced by breed and level of nutrition (Kress and Anderson, 1974; Casebolt et al., 1983), and its measure corresponds to milk intake by the calf. Milk production or calf milk intake has been estimated using weigh-suckle-weigh techniques (Lam et al., 1970; Kress and Anderson, 1974; Williams et al., 1979), tritiated water (MacFarlane et al., 1969), portable milking systems with oxytocin injections (Beal et al., 1990), and hand-milking (Totusek et al., 1973). Lam et al. (1970) compared three weigh-suckle-weigh techniques and reported that all three methods gave comparable rankings of milk production and were equally reliable. Beal et al. (1990) found that repeatability of milk production estimates using a portable milking system and oxytocin injections was higher than repeatability of estimates obtained from weigh-suckle-weigh methods. Other researchers found that hand-milking underestimated milk yield and that weigh-suckle-weigh estimates were a more accurate estimate of the amount of milk consumed by the calf (Totusek et al., 1973). Williams et al. (1977) determined that the average separation time of calves nursing in their natural environment was 4.5 h and that calves nursed 3.2 to 3.5 times per day in mid-spring. Williams et al. (1979) suggested that 8 h separation intervals gave the best estimate of milk production when using weigh-suckle-weigh techniques. Sowell et al. (1996) reported that the number of times calves suckle per day decreased as calves' aged and that they suckled 2 to 2.5 times per day in August and September.

Behavior of Supplemented Animals

Wagnon (1965) suggested that variation in individual supplement consumption may be influenced by differences in social dominance of individual animals. This may result in varying weight gains of supplemented cattle. Wagnon (1965) collected behavior data of a mixed-age group of Hereford cattle (2 to 10 yr) using visually recorded observations. Cattle were called to the supplement feeding area and hand-fed. He reported that older cows tended to have a higher social dominance ranking (peaking at age 9) and that 2-yr-old cows were generally driven away from the supplement by older animals. However, when 2-yr-olds were removed from the herd, the 3-yr-olds were now chased away by the older cows. Two and three year old cows gained more weight when they were managed separately from the rest of the herd. Heavier weights were also associated with social dominance, while aggressiveness and agility were used as tools, but did not necessarily dictate social dominance (Wagnon, 1965). Lower ranking cows tended to visit the feeder when there was less competition. Wagnon (1965) also reported that cows missing an occasional day were 7, 8 and 10-year-old cows, or those of mid to higher social rank; however, the percent refusing to eat was probably not different between age groups. Wagnon et al. (1966) reported that in a herd of 4-yr-old cows, social dominance was associated with breed, and there was a positive correlation between social dominance and size within breeds. Friend and Polan (1974) reported that there was a quadratic relationship between average time spent eating and social rank so that mid-ranked cows spent the least amount of time eating.

Sowell et al. (1995) recorded visual observations of animals using self-fed liquid supplement tanks, and reported that 2-yr-old cows visited the feeder less often and spent less time at the tank than 3-yr-old cows. They also noted that two out of 40 cows never came to the supplement tank and that time at the tank ranged from 0 to 254 minutes in eight observation days. Bowman et al. (1995a) reported that 3-yr-old cows consumed more supplement than 2-yr-olds when cattle had access to liquid supplement in an unrestricted lick tank. However, supplement intake between 2- and 3-yr-old cows was similar when supplement was dispensed in a computer controlled lick tank that delivered a set amount of supplement every hour. Daniels et al. (1998) provided 2 to 6-yr-old cows grazing native range pastures with access to liquid supplement during the winter. Supplement intake was lowest for 2-yr-old cows, intermediate for 3-yr-old cows and highest for 4-, 5-, and 6-yr-old cows.

Lobato et al. (1980) noted that intake of hay and oats by sheep was also influenced by social dominance. Lobato and Pearce (1980) measured the number of sheep using supplement by placing a plastic sponge soaked in colored paste in the sides of the crate containing the supplement block. Eighty-six, eighty-nine and ninety-six percent of the groups had licked the blocks by the end of 1, 2, and 3 weeks, respectively.

Visual observations are labor and time intensive and other researchers have used electronic radio frequency equipment to study animal behavior. Basarab et al. (1996) and Sowell et al. (1998) used radio frequency equipment to monitor feeding and watering behavior of cattle in a feedlot. Putnam et al. (1968) reported that time at the feedbunk was associated with the amount of feed consumed. Tait and Fisher (1996) used electronic equipment to estimate use of a molasses feed block by individual grazing animals. A molasses feed block was placed on an electronic scale in a 4 ha pasture grazed by 20 yearling Holstein steers. All steers consumed the blocks and individual intake ranged from .72 to 1.65 kg/d (Tait and Fisher, 1996). Bailey (1976) reported that bull calves grazing a 32 ha pasture consumed a salt supplement offered in a creep feeder; however, these researchers did not estimate use or intake by individual animals. Cockwill et al.

(1998) recorded attendance at a mineral feeder by grazing cows and calves using a radio frequency technology. Percentages of cows and calves attending the mineral feeder depended on the formulation of the mineral supplement, and ranged from 26 to 97 % with fewer calves than cows attending the feeder.

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PERFORMANCE, FORAGE AND SUPPLEMENT INTAKE BY GRAZING COWS AND CALVES

Summary

One hundred one Angus cows (612 kg) and their bull calves (214 kg) grazing improved summer pastures, were used to determine cow and calf intake of liquid supplement, and its effect on forage intake and performance. Forty-seven pairs had access to liquid supplement in an open tank and 54 pairs were not supplemented. The study was conducted in southwestern Montana from July 28, 1997 to October 3, 1997. Ytterbium chloride was added to the liquid supplement (41 % CP, DM basis) to estimate individual supplement intake. All supplemented animals and 10 unsupplemented pairs were dosed with sustained release chromium boluses to estimate fecal output (FO). Extrusa samples were collected using ruminally cannulated cows and were incubated in situ for 48 h to determine DM digestibility. Forage intake was calculated using estimates of FO and 48 h DM digestibility. Individual forage and supplement intakes were estimated and analyzed using individual animal as the experimental unit. Supplement intake by cows averaged .5 kg/d (as-fed) and ranged from 0 to 2.2 kg/d (96 % CV). Supplement intake by calves ranged from .1 to .5 kg/d (81 % CV) and averaged .2 kg/d (as-fed). Supplement intake, when expressed as a % BW, was not different ($P > .10$) between cows and calves, averaging .04 % BW. Supplemented cows gained .12 kg/d more ($P = .02$) than unsupplemented cows and were 9 kg heavier ($P = .02$) at weaning. Change in body condition score was not different between treatments ($P > .10$).

Supplemented calves had higher ($P < .01$) WW, 205-d adjusted WW, and ADG than unsupplemented calves (299 vs 282 kg WW, 279 vs 267 kg adj. WW, and 1.3 vs 1.0 kg/d ADG). Forage intake by supplemented cows and calves was 64 % greater ($P < .01$) than forage intake by unsupplemented cattle (3.6 vs 2.2 % BW for cows and 2.8 vs 1.7 % BW for calves). There was no difference ($P > .10$) in calf milk intake estimates between treatments. Liquid supplementation increased forage intake and ADG of cows and calves grazing improved forages in late summer.

Introduction

Nutrition is an important aspect of both cow and calf performance and it is estimated that feed costs account for 60 to 70 % of a producers total expenditures (USDA, 1994). Sixty-six percent of the land in Montana farms and ranches is classified as rangeland or pasture (Mont. Ag. Stat. Serv., 1997), and most cow/calf producers utilize rangelands or pastures to decrease production costs. However, the quality and quantity of forage available to grazing animals can be limiting during certain times of the year, and supplementation may be required to optimize performance of grazing animals. An estimated 25 % of cattle in most western states are supplemented during the summer months (USDA, 1994), but these additional supplementation costs affect profitability. Liquid supplements can be self-fed which reduces labor costs (Grelen and Pearson, 1977). Liquid supplementation also increases forage intake and digestibility of native range (Bowman et al., 1995a; Daniels et al., 1998).

Profitability for the cow/calf producer can be increased by improving calf performance (Lindholm and Stonaker, 1957). Bowman et al. (1994) supplied primiparous 2-yr-old cows with liquid supplement for 2 ½ months postpartum and reported calves of supplemented cows gained 15.5% more than calves of cows receiving no supplementation. However, by weaning, there was no difference in calf weights between treatments. It is not known if calves of the supplemented cows performed better during the supplementation period due to increased milk production of the cow or if calves consumed liquid supplement. I could not find any published data reporting the use of liquid supplements by suckling calves. Estimates of individual supplement consumption make it easier to interpret effects of liquid supplementation on animal performance. The objectives of this study were to determine if calves consume liquid supplement directly, and to evaluate the relationship between cow and calf supplement intake and calf performance.

Materials and Methods

The study was conducted on a ranch in southwestern Montana from July 28, 1997 to October 3, 1997. Forty-seven Angus cows (age 6-9 yr) and their bull calves had access to a commercially available liquid supplement (Nutra-Lix, Inc., Billings, MT[1]) in an open tank (Supp) and 54 pairs (cow age 3-5 yr) were unsupplemented (Unsupp). The supplement was 22 % CP on an as-fed basis (43.5 % of the CP from urea, as-fed) and 41 % CP on a DM basis. Cattle grazed improved irrigated pastures throughout the study. The Supp group was rotated three times between two different pastures, and the Unsupp

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