AN ABSTRACT OF THE THESIS OF

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Timothy DelCurto

Three studies were conducted to evaluate: 1) rotationally grazed forage for late-summer stockpiling; 2) effects of lactation on self-fed supplement intake; and 3) influence of cow age on hand-fed supplement intake. For the first study, treatments consisted of non grazed, 2X and 3X grazed. Crude protein of forage grazed 3X was greater ($P < .10$) than non-grazed. Yield of non-grazed forage was greater ($P < .10$) than forage grazed 2X and 3X. Non-grazed forage displayed the greatest stockpiled yield and grazing influenced quality of stockpiled forage to a small magnitude. Treatments for the second study consisted of non, mid, and late-lactation on two experimental diets. Late-lactation cow BW change was less ($P < .10$) than non-lactating in both experiments and less ($P < .10$) than mid-lactating cows in Exp. 1 only. Forage intake for late-lactating cows was less ($P < .10$) than mid-lactating cows in Exp. 1 and tended to be greater ($P = .13$) than non-lactating cows in Exp. 2. Self-fed supplement intake was highly variable but not influenced by lactation. Treatments for the third study consisted of five age groups. In yr 1, weight change at d 57 for 11-yr cows was greater ($P < .10$) than 5-yr cows. In yr 2, weight change at d 28 for 8-yr cows was less ($P < .10$) than 4, 6, and 10-yr cows and 4-yr cows was greater ($P < .10$) than 6, 10, and 12-yr cows. At d 56, weight change for 4-yr

cows was greater ($P < .10$) than 6, 8, 10 and 12-yr cows and 12-yr cows was less ($P < .10$) than 6 and 10-yr cows. Weight change at calving for 4-yr cows was greater ($P < .10$) than 6, 8, and 12-yr cows. Forage intake of 10-yr cows was greater ($P < .10$) than 8 and 4-yr cows. Supplement intake of 4-yr cows was greater ($P > .10$) than 8, 10, and 12-yr cows. Six-yr cows had greater ($P < .10$) supplement intakes than 12 and 8-yr cows. Three and 4-yr cows displayed the best performance and 4-yr cows consumed the greatest amount of supplement.

Management of Stockpiled Forages and Optimal Use of Supplements by Beef Cattle while Consuming Low-quality Forages

By

Norman A. Suverly

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CONTRIBUTION OF AUTHORS

Dr. Timothy DelCurto was involved in the design, analysis, and writing of each manuscript. Mr. Scott Paxton and Mr. John Jaegar were involved with data collection, and management of the livestock and facilities used in the study. Dr. Dale Weber and Mr. Corey Parsons assisted in data collection for the study. The assays were performed with the direction of Mr. Mark Keller.

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REVIEW OF LITERATURE

Introduction

Western Oregon is a region of diverse agriculture. Over the past several decades, the region's agriculture has shifted from livestock production such as beef cattle and sheep and moved towards higher value crops such as grass seed, vegetables, and nursery stock. The combination of rich clay soils, an abundance of winter and spring precipitation, and the dry, mild summers have made it ideal to grow a variety of crops. Although less prevalent, grazing livestock such as beef cattle are still used to harvest the abundance of forage that is provided in the spring.

Beef producers throughout the western United States are reliant upon supplementation during the winter months and at times into early spring to meet the requirements of gestating and lactating cows. During the summer months, requirements can be met by grazing with access to mountain pastures or adequate precipitation.

With pastures containing grass species such perennial ryegrass (*Lolium perenne* L.), the temperate climate of Western Oregon can meet some or all of livestock feed requirements if conditions are adequate (Jaindl & Sharrow, 1991). However, producers are faced with limited quantity of winter growth and "marsh-like" conditions that can occur due to heavy precipitation. Therefore, some form of supplementation strategy, commonly silage or hay, must be implemented for the winter months.

With a yearly average of 1067.75 mm, the high precipitation in western Oregon is followed by a drought-like summer with only an average of 34.75 mm from July to

August (OCS, 1999). After early July the quality of the forage declines rapidly in terms of protein and digestibility. Therefore, it becomes necessary for the producer to supplement to meet the requirements of the cows, which are commonly lactating due to a spring calving operation. Western Oregon beef producers are essentially faced with a dynamic year in terms of forage production. They are provided with springs of abundant, high quality forage followed throughout the remainder of the year with forage of either limited quality or quantity.

What will become crucial for the viability of western Oregon beef production is implementing strategies that maximize use of high levels of spring forage production and reduce the need for supplementation. In response, a reduction in supplement input costs will occur. Annual input costs for supplementing beef cattle in the Willamette valley are an average of $112.06/cow when considering grass hay and protein supplements (Cross et al., 1988). Additionally, it will be important for the industry to understand the various factors that affect supplement intake in terms of physiological condition, feeding strategy, and animal behavior. What follows is a review of literature pertaining to general grazing and stockpiled grazing of forages, supplemental protein and energy strategies, factors influencing supplement intake, and the effects of self-fed supplements.

Defoliation Effects

The forage resource is the foundation of a beef cattle operation. It can determine the level of supplementation needed and whether or not outside sources must be purchased. What the producer chooses for supplementation will be dependent upon the chosen grazing strategy and the forage response.

Intensive grazing has shown variable results depending upon season of use. Brougham, (1960) compared frequent, high intensity grazing (i.e., grazing forage to a stubble height of 1 to 3 inches) to less-intensive grazing (3 to 7 inches) that were carried out in all four seasons in New Zealand grasslands. Frequent high intensity grazing during the winter encouraged growth of the forage and high dry matter (DM) yields after a change was made to less-intensive grazing which allowed the forage to rest. The winter climate of this region in New Zealand limits growth but does not halt it. The frequent, hard grazing reduced herbage coverage and allowed for more light penetration and increases in soil temperature to promote winter growth (Brougham, 1960). Following intensive grazing during the spring, DM yield declined rapidly but recovered after a switch to less intensive grazing. Similarly, yield was found to rapidly decline in response to intensive grazing management during summer and autumn months. However, yields did recover in autumn with less intensive grazing. Pasture productivity can be influenced by severity or frequency of grazing with the effect varying between seasons. This concept is important to understand when grazing forages in western Oregon. Climate varies considerably when transitioning from summer to winter along with a significant difference in forage production.

A study by Hedrick, (1964) evaluating the response of western Oregon pastures of orchard grass and sub-clover reported highest forage yields were produced with two inch clipping heights compared to three inches, and by cutting only twice during the spring rather than being cut three times.

Other western Oregon forage species, such as perennial ryegrass, have displayed curvilinear reductions in DM yields by as much as 37% when defoliation intervals were reduced from eight to two weeks. The more frequent defoliation also led to a reduction in digestibility by 24% (Chestnutt et al., 1977).

Motazedian and Sharrow (1986) have reported similar responses in yield where short duration grazing resulted in more DM yield than continuous grazing. In fact the defoliation interval was directly related to DM yield. The following year, it was reported that density of perennial ryegrass was highest when defoliated every 21 or 35 days rather than 7, 49, or non-defoliated. This represents how both overutilization and underutilization can potentially reduce forage yield (Motazedian and Sharrow, 1987).

In contrast to Chestnutt et al. (1977), except for one year, Motazedian and Sharrow (1990) found that DM digestibility and crude protein content of perennial ryegrass-clover pastures decreased as the period between defoliation intervals increased. Additional data supports that more frequent grazing can increase digestibility and quality of forage. The DM digestibility of alfalfa, birdsfoot trefoil, reed canarygrass, bromegrass, and orchardgrass increased as the cutting frequency increased from 1 to 4 times per season (Allinson et al., 1969).

Degree of use (i.e., stubble height) is also a significant factor in forage productivity in conjunction with defoliation interval. A three-year study conducted by Motazedian and Sharrow, (1986) observed that DM yield of perennial ryegrass increased curvilinearly as both defoliation interval and stubble height increased. Their data suggested that defoliation interval had more of a direct impact on DM yield than did stubble height. However, this does not lessen the effectiveness of stubble height since it is influenced by pasture type and species composition. Therefore, it is important to understand when the forage is being grazed, in terms of phenological stage, and what species are involved. A greater amount of growth will be stimulated when grazing during a vegetative stage of a plant rather than a reproductive stage. The occurrences of growth stages vary among plant species during the growing season. In addition, Motazedian and Sharrow, (1986) reported CP increased linearly as stubble height increased, but digestibility did not react to changes in stubble height.

Nitrogen (N) fertilization, in conjunction with grazing, is commonly used to manipulate forage yield and quality. The best response to N fertilization in Northern Ireland pastures, in terms of yield, was a defoliation interval of every two weeks with a N level of 673 kg/ha (Chestnutt et al., 1977). However, N application did not affect digestibility of perennial ryegrass. Similar results were reported by Allinson et al., (1969) where fertilization did not consistently affect the nutritive value of reed canarygrass (*Phalaris arundinaceae* L.) despite varied durations of cutting frequency.

Stockpiled Grazing

In regions such as western Oregon where there is a rapid growth of forage, management in the form of making hay or silage is common. However, this process can be costly in addition to complications with hay harvest competing with rainfall. Stockpiling of forage i.e., deferment of grazing until forage is dormant, is practiced in many regions of the United States and can be beneficial to cattle that utilize it. Research has found that stockpiled forage can extend the length of the grazing season, which ultimately leads to reduction in costs (Belesky and Fedders, 1995; Ocumpaugh and Matches, 1977). Fribourg and Bell, (1984) were able to stockpile forage with CP levels adequate to meet the requirements of mature, pregnant beef cows with some supplementation of phosphorus and potassium.

Although cattle have been shown to benefit from stockpiled forage, the dilemma that a producer faces is choosing quantity over quality, with CP levels commonly dropping to less than 10%. Mays and Washko, (1959) compared two grazing systems of rotational and stockpiled legume-grass pastures that were staggered among four summer dates. Stockpiled pastures that were ungrazed until June 15, July 1, and July 15 displayed the highest yields, while stockpiling until August prevented regrowth of the forage and therefore resulted in lower yields. Rotational grazing, although having lower yields, resulted in higher levels of total digestible nutrients (TDN), and palatability for the livestock. Higher palatability led to increased levels of consumption. Therefore, advantages of increased yields under stockpiling can be lost through lowered consumption rates.

Duration of the grazing period was also investigated by Fribourg and Bell, (1984) in a study analyzing yield and composition of tall fescue (*Lolium arundinaceum* Schreb.) stockpiled for different periods. Results showed longer accumulation periods displayed greater yields, yet with lower quality. Delaying the harvest of summer forage growth into October through December resulted in some loss of accumulated DM. Peak accumulation of DM occurred in October through November. While grazing duration influences stockpiled quantity and deterioration rate, it is dependent to a large extent on weather conditions (Ocumpaugh and Matches, 1977). Therefore, it is recommended to stockpile in regions receiving more than 1000 mm of precipitation annually.

Belesky and Fedders, (1995) conducted similar research using pastures containing orchardgrass (*Dactylis glomerata* L.) and white clover (*Trifolium repens* L.) with grazing occurring from late summer into fall in southern West Virginia. With animals removed after 30 days of grazing (early-closed), herbage continued to accumulate during the autumn season, which led to greater senescence of the forage over the winter when compared to late-closed grazing (60 and 90 days of grazing). Although post-grazing growth rates varied annually in the three-year study, November yields of stockpiled forage were similar and averaged 3000 kg/ha despite variations in weather. Growth rate was greatest in August and then declined thereafter.

Yield of stockpiled forage is not only influenced by grazing duration but also by initiation and time of use. In West Virginia, yield was decreased as initiation date was delayed from mid-June to mid-July and from mid-September to mid-October (Collins and Balasko, 1981b). Yield decreased in Tennessee and Delaware when delayed from July 1 to September 1 (Fribourg and Bell, 1984). Collins and Balasko (1981b) reported CP was not affected when initiation was delayed from mid-June to mid-July and when forage use ranged from December to February.

The date at which stockpiling was initiated also influenced yield's response to N fertilization. Fertilization provides additional benefits in improving nutritional quality of stockpiled tall fescue. Gerrish et al., (1994) conducted a 3 year study to evaluate N fertilization effects on stockpiled tall fescue. The reduced length of the growing season associated with delayed N application reduced the ability of tall fescue to respond to high rates of N fertilizer. Stockpiled tall fescue showed a quadratic growth curve in both years of the study having maximum DM accumulation in mid-November. However, forage quality was affected less by the fertilization than yield.

Collins and Balasko, (1981b) showed initiation of stockpiling in the fall provided higher quality forage when compared to summer initiation. Within the fall season, mid-fall initiation provided higher quality forage than early-fall. Gerrish et al., (1994) concluded that the date of stockpiled initiation and fertilization was determined more by length of the remaining growth and the first freeze than by actual date. However, how forage responds is also dependent upon species and state of quality going into initiation of stockpiling. The forage used by Gerrish et al., (1994) was of only a high quality, green tall fescue.

Timing and grazing duration are important management strategies for stockpiling pastures. However, variation among forage species can occur and it is important to understand how they react to stockpiling. Tall fescue has been reported on several occasions to be a superior forage for stockpiling (Ocumpaugh and Matches, 1977; Fribourg and Bell, 1984). A series of tall fescue plots with treatments of 2, 3, and 5 defoliations were applied over a period from late-April to mid-August. Frequent defoliation during the spring-summers season displayed a higher quality, yet with lower yield. Samples from the autumn period displayed no affect upon yield due to frequency. Rather, autumn yield was more dependent upon rainfall accumulation (Ocumpaugh and Matches, 1977).

Another cool season grass, reed canarygrass, was compared to tall fescue in an experiment conducted by Bryan et al. (1970). Both species were managed in the spring and summer and used as fall-saved pastures. Crude protein was greatest for reed canarygrass in all periods, except July and early November. Both grasses were highest in CP in early October and lowest in June and July. Digestion trials reported that tall fescue was consumed more than reed canarygrass and was more digestible, except in the month of June. Differences in digestibility were significant except within September 25 to

October 8. However, when cattle were grazing, voluntary intake of the animals was higher when compared to cattle in the digestion trial. In addition, reed canarygrass was consumed more than tall fescue under grazing conditions. In comparing the two grass species, it was reported that first-growth tall fescue matured more quickly, and as a result, quality was less than reed canarygrass on the same date. The second growth of forages differed in voluntary intake and digestibility yet, both species had a similar nutritive value. By early October, reed canary grass had a higher nutritive value than tall fescue, but by November tall fescue was higher.

Stockpiling can also be practiced in regions dominated by warm season grasses. High intensity strip grazing of bermudagrass (*Cynodon dactylon* L.) was compared to more conventional rotational grazing of larger paddocks. Strip grazing resulted in higher carrying capacities for the stockpiled period (Dalrymple et al., 1995). On top of the stockpiled bermudagrass, a supplemental hay high in CP should be provided early so as to avoid any decline in cow body condition.

Birdsfoot trefoil (*Lotus corniculatus* L.) has also shown to be advantageous as a stockpiling forage (Mays and Washko, 1959; Collins, 1982). Plots of birdsfoot trefoil were allotted to cutting treatments ranging from late-May to mid-October. Yield was greatest in the first year for plots left unharvested between late-May and mid-July. Over two years, the period from late-May until early August had an average in vitro DM (IVDMD) and N digestibility of 62.8% and 2.34%, respectively. When plots were stockpiled all spring and then harvested in early August, IVDMD was 56.4% and N was 1.96%. The study concluded that shorter stockpiling periods resulted in higher IVDMD and lower acid detergent (ADF) and neutral detergent (NDF) fiber concentrations. However, shorter periods also resulted in lower yields (Collins, 1982).

Additional data, supporting the use of stockpiled forage, concluded that extending the grazing season into the winter season could potentially reduce feeding costs for the maintenance of pregnant beef cows. Hitz and Russell, (1998) compared the nutritive value of differing perennial forage species and corn crop residues that were stockpiled for winter grazing management and to quantify the required amount of stored forage that was required to maintain pregnant beef cows. Midgestation cows were allotted strip-grazing treatments with various perennial stockpiled forage species or corn crop residues. Significant differences were found in DM, organic matter (OM), and in vitro organic matter digestibility (IVOMD) yield prior to initiation of grazing among the forage species. Corn crop residues had the highest values for all measures compared to the stockpiled species. In addition, the daily changes of DM, OM, and IVOMD yield were found to be significantly different between grazed and ungrazed (stockpiled) pastures. Ungrazed pastures had smaller declines in DM, OM, and IVOMD yield. Pregnant cows performed better when wintered on stockpiled pastures compared to corn crop residues. The cows that wintered on stockpiled tall fescue-alfalfa (*Medicago sativa* L.) had the highest mean body weight (BW) and body condition (BC) change of all wintering systems and stockpiled forages as a whole showed better cow performances when compared to corn crop residues (Hitz and Russell, 1998). Cows wintered on stockpiled pastures of tall fescue-alfalfa and smooth broomegrass also required less supplemented hay than cows of corn crop residues.

Energy Supplementation

An abundance of plant by-products and low-quality forages are available in today's agricultural industry. Due to the rumen digestive system, the beef cow is able to utilize many of these products that would otherwise go to waste. Management of forages for stockpiling has the potential for being a reliable source as presented in the previous data. What a producer chooses for a supplement can influence the level of utilization of low-quality forages such as stockpiled forages. Supplements are commonly categorized into two classes, energy or protein.

Energy supplements are usually fed in the form of grains such as corn or barley. However, high levels of this form of supplement have been shown to depress intake levels of low-quality forages (Sanson et al., 1990; Chase and Hibberd, 1987). Increasing levels of supplemental corn fed to cattle lowered dry matter intake (DMI) of a low-quality meadow hay linearly and quadratically increased total DMI (Sanson et al., 1990). It was found that, although DM digestibility of the total diet increased, digestibility of forage DM and the hemicellulose decreased quadratically. Chase and Hibberd (1987) reported similar results where increased levels of corn linearly decreased the intake of low-quality hay in addition to decreasing hemicellulose and cellulose digestibility.

These decreases in intake have been explained by several factors occurring within the rumen digestive system. Horn and McCollum, (1987) reviewed the effects of energy and (or) concentrate supplements on forage intake and utilization. Increased rates of fermentation, due to concentrates created unfavorable pH conditions for the cellulolytic enzymes in the rumen (Orskov and Fraser, 1975) resulting in decrease amounts of forage intake. Smith et al. (1973) concluded that pH had a direct affect on cellulolytic enzyme activity. It has also been reported that a lower level of microbial attachment and an increased washout of the microbes influence the mechanism by which a low rumen pH decreases digestion of roughages (Shriver et al., 1986; Mould and Orskov 1983). Mertens and Loften (1980) suggested that starch from concentrates alter digestion of fiber by increasing digestion lag time. Affects upon ruminal pH varies among energy supplements depending upon their composition, form of roughage, buffering capacity of the roughage, and rates of particle fragmentation caused by: mastication, rumination, and salivation.

Pritchard and Males, (1982) conducted a study looking at the effect of supplementation on wheat straw diets and how it influences levels of rumen ammonia (NH_3), volatile fatty acid (VFA), and cow performance. Supplementation of wheat straw, fed either once or twice daily with a pelleted supplement of barley, soybean meal, and urea increased ruminal ammonia levels, ruminal pH, and increased performance when compared to non-supplemented straw diets. Therefore, supplementation in the form of protein rather than energy is important for wintering cows on wheat straw or other by-products. The authors felt that low rumen-NH_3 was limiting energy made available from straw and that maintaining rumen NH_3 above 5 mg/d may be beneficial.

There is strong evidence to show that protein to energy ratios can improve performance and intake. As long as dietary protein is adequate, energy can be increased (DelCurto et al., 1990b; Clanton et al., 1982). Sanson et al., (1990) showed that cows fed ear corn alone lost more weight than cows fed ear corn plus a protein supplement or a protein supplement alone. It was stated that variability occurs in forage utilization when supplements contain combinations of oil meals and cereal grains. Duff et al. (1996)

reported that total DM intake and intake of prairie hay did not differ among treatments of no supplement, corn+soybean meal, corn+soybean meal+urea, and corn+soybean meal+urea+soybean hulls. Passage rate of indigestible acid detergent fiber (IADF) was greater for corn and soybean meal than corn+urea and the soybean hull substitution. Ruminal pH was not affected by treatments. The authors suggest that corn can be replaced by soybean hulls in a urea-based protein supplement without adverse affects upon intake or ruminal fermentation.

Despite the evidence that exists supporting negative effects of energy supplementation upon forage utilization, energy supplementation may be necessary to meet increased demand of animals due to physiological status, environmental conditions, or an inadequate supply of low-quality forages.

Protein Supplementation

Increased levels of energy supplementation have been shown to reduce intake levels of low-quality forage. However, research in protein supplementation of low-quality forages has been shown to increase levels of performance and improve intake. Common forms of protein supplements, such as alfalfa hay and oil-seed meals, are classified as hand fed supplements where the producer influences daily levels of intake.

Albro et al. (1993) compared the effects upon digestion and performance of whole, raw soybeans, extruded soybeans, and 62% soybean meal – 38% barley grain mixture. When compared to no supplement, supplementation increased DM digestibility but had no affect on NDF digestibility. No differences in DM and NDF digestibility were found among the treatment forms. However, in situ tests displayed DM disappearance differences between whole soybean and extruded soybean and the forage NDF disappearance rate was decreased by protein supplementation. In another portion of the study, DMI of steer calves was not affected by treatment form, but average daily gain (ADG) was increased by supplementation when compared to control. The authors concluded that whole and extruded soybean seems to be as effective as soybean meal and barley for supplementing beef cattle.

Effects of frequency and concentration of protein fed to steers consuming wheat straw and pregnant beef cows grazing dormant tallgrass prairie grass was investigated by Beaty et al., (1994). Decreasing frequency of supplementation from daily to three times weekly decreased straw intakes of steers, but at the same time increased DM and NDF digestion. Increases in supplement CP concentration from 10 to 40% increased the DMI of steers quadratically and DM and NDF digestion linearly. Pregnant beef cows maintained BW and condition up to calving and prior to breeding due to increased levels of CP concentration. Reducing the supplementation frequency resulted in higher weight loss during winter calving. The authors concluded intake of low-quality forages and performance can be maximized with daily protein supplementation. However, studies have shown performance not to be negatively affected when feeding high protein supplements was less frequent (Melton et al., 1960; Mc Ilvain & Shoop, 1962; Wallace, 1988).

Substantial research has been conducted evaluating various physical forms of supplemental protein. Cochran et al. (1986) compared performance of cows with treatments of no supplement, alfalfa cubes, and cottonseed meal-barley cake all on dormant range forage. Overall, the results displayed that supplemented cows performed better than non-supplemented. However, within the supplemented cows, form had no influence on weight gains.

An additional study compared, on a isonitrogenous basis, the use of a less expensive high quality early vegetative tall fescue hay to alfalfa hay with steers and gestating cows utilizing tall fescue straw (Horney et al., 1996). Supplemented steers had greater DMI compared to non-supplemented steers and steers supplemented with early vegetative tall fescue had higher DMI than steers supplemented with alfalfa hay. Dry matter digestibility was also higher for supplemented steers than non-supplemented and for steers supplemented with tall fescue hay rather than steers receiving alfalfa hay. Results were similar among the gestating cows with supplemented cows gaining more BW and losing less condition than non-supplemented cows. Cows supplemented with tall fescue hay tended to lose less condition than cows supplemented with alfalfa. Overall, the use of high quality tall fescue as a supplement for low-quality forages provides similar or better performance results than that of cows supplemented with alfalfa hay.

Alfalfa hay is a common protein supplement in the Intermountain West. However, regions such as the Mid-west have access to alternative supplements such as soybeans. DelCurto et al., (1990b) compared effects of soybean meal/sorghum grain, alfalfa hay, and dehydrated alfalfa hay pellets as supplements. Steers and mature, nonlactating cows were fed the four treatments (including no supplement) while utilizing dormant tallgrass prairie forage. Higher forage intakes were displayed by steers fed dehydrated alfalfa pellets when compared to the other supplement forms yet, DMI was similar to alfalfa hay and the two alfalfa forms had greater DMI than soybean meal/sorghum. For cows fed dehydrated alfalfa pellets, weight gain performance was optimized with the least amount of weight loss at calving and just prior to breeding. It was concluded alfalfa hay and dehydrated alfalfa was at least as effective as soybean meal/sorghum grain for pregnant cows.

Lintzenich et al., (1995) evaluated the use of dehydrated alfalfa by comparing three different alfalfa processing methods. Four treatments consisting of no supplement, pelleted alfalfa, pelleted dehydrated alfalfa, and longstem alfalfa were compared to evaluate differences in intake and digestibility of dormant bluestem-range forage. Alfalfa supplementation as a whole was advantageous by increasing bluestem forage intake, total intake, digestibility, nitrogen flows to the duodenum, ruminal fill, fluid dilution rates, dietary digestible energy (DE) concentration, and ruminal total VFA and NH_3-N concentrations. However, forage utilization was impacted little by the method of alfalfa processing, except where bluestem forage intake, total intake, and ruminal fill tended to be greater when alfalfa pellets were dehydrated.

Protein supplementation effects on DMI, digestibility, and in turn, performance have been attributed to an increased rate of forage digestion and passage (Ellis, 1978). McCollum and Galyean, (1985) researched this further with a study using cottonseed meal supplement of prairie hay to evaluate voluntary intake, rumen fermentation, and rate of passage of rumen-cannulated steers. Cottonseed meal displayed higher rumen-NH_3 levels, higher particle passage and fluid outflow, and higher forage intakes than non-supplemented steers. Proportions of rumen molar acetate to propionate decreased with cottonseed meal supplementation.

Passage rates, rumen fermentation, and weight change were also evaluated by comparing alfalfa pellets to cottonseed cake as protein supplements for dormant blue grama (*Bouteloua gracilis* Willd. Ex Kunth) forage (Judkins et al., 1987). They found that average daily gain (ADG) did not differ between cottonseed cake and alfalfa pellets. In addition, rumen passage rates, fluid dilution rate, volume, and outflow rate were not different among treatments. Rumen pH was not influenced by supplementation yet, proportions of acetate and propionate differed among treatment groups with acetate being the lowest in alfalfa pellets, intermediate in cottonseed cake, and highest in cows receiving no supplement.

Protein supplementation demonstrates itself as being an advantageous practice. With increased voluntary intake due to improved rumen conditions, producers can better manage the use of low-quality forages. Various forms of protein supplements exist, and research has shown some advantages of one over another. However, it is not as important has the overall quality of the supplement.

Self-Fed Supplements

Self-fed supplements are another feeding strategy for meeting protein and energy requirements. They are commonly in the form of molasses based blocks, tubs, and liquid lick tanks. Animals consume them on an ad libitum basis, which can reduce the level of competition (Bowman and Sowell, 1997). They are popular with many producers because they require little labor when compared to hand-fed supplements and can act as a carrier for vitamins and minerals. Delivery method of self-fed supplements can be thought of as an unlimited amount of trough space being allowed to each animal as long as enough of the supplement is provided per animal. Hand-fed supplements on the other hand limit trough space because they are typically fed in bunks and(or) troughs. Although competition is reduced, problems arise with having less control over the allowance of supplement fed to each animal.

The use of a self-fed, liquid molasses supplement with the addition of urea or biuret (Bond and Rumsey, 1973) was used to study performance, ruminal difference, and feeding patterns of beef cows and yearlings wintering on an alfalfa and timothy (*Phleum pratense* L.) hay mix. Molasses supplementation alone lowered hay intake when compared to non-supplemented cows yet, cows on molasses-biuret had significantly greater intakes of hay than molasses and molasses-urea cows. Cattle performance was variable with the molasses-biuret displaying the only increase in weight gain among supplements. However, cattle displayed decreased weights with the remaining supplements. Earley et al., (1998) found that liquid supplementation of grazing cows displayed greater ADG and forage intake than non-supplemented cows. The intake of supplement was variable with a range from 0 to 1.2 kg/d.

When using self-fed supplements, there is concern over intake variation that occurs among individual animals when compared to hand-fed supplements. Variability occurred among grazing sheep supplemented with feedblocks with 19% of the sheep abstaining from consumption (Ducker et al., 1981). However, the percentage of non-feeders has shown to have been as high as 31 to 33 % when using dry, hand-fed supplements (Arnold and Maller, 1974; Curtis et al., 1994). Although the proportion of non-feeders can be reduced, individual animal intakes can vary. Lobato et al. (1980) reported that sheep consumed between 55 to 201 g hd^{-1} $wk^{-1}$of a molasses-urea block. Nolan et al., (1974) reported 17% of Hereford cattle did not consume a liquid urea-molasses supplement and intakes ranged from 30 ml to 2.4 l/day. Considerable variation exists in the intakes of both self-fed and hand-fed supplements. It is difficult to identify the source of variation due to a wide array of influential factors. Weber et al., (1992) reported factors such animal preferences, forage quantity and quality, weather, and block formulations when evaluating intake of beef cattle consuming mineral, salt, and protein blocks. Daily consumption rates for 21% protein blocks ranged from 3 to 484 g cow^{-1} d^{-1} for individually fed cows and 4 to 632 g cow^{-1} d^{-1} for group fed cows. Intakes of a 36% protein block ranged from 42 to 611 g cow^{-1} d^{-1} and 51 to 651 g cow^{-1} d^{-1} for individual and group-fed cows, respectively (Weber et al., 1992).

Further explanation of variation was examined by Sowell et al. (1995) by comparing feeding behavior of 2 and 3-year-old cows supplemented with a liquid molasses supplement. Two-year-old cows spent less time and visited the self-fed molasses lick tanks less frequently than older 3-year-old cows. However, when a more hand-fed method is approached with the use of a computer controlled lick-tank, 2-year-old cows displayed similar amounts of intake when compared to 3-year-old cows (Bowman et al., 1995). In addition, 3-year-old cows consumed more forage DM and NDF than 2-year-old cows. The use of the computer lick tank essentially provided two feeding environments of an unlimited trough space of a self-fed supplement and the controlled allowance of a hand-fed supplement.

Daniels et al., (1998) also found forage DMI to be lower for cows having ad libitum access to lick tanks when compared to cows with computer regulated supplementation. Cows with ad libitum access had higher supplement intakes than those on the computer controlled feeder. When compared among ages, 4, 5, and 6-year-old cows had the highest intakes, followed by 3-year and then 2-year-olds. Overall the use of the liquid supplements improved forage intake and tended to reduce body condition loss.

When non-protein nitrogen (NPN) is used with self-fed molasses supplements, performance is not consistent. Non-protein nitrogen is commonly used as an additive to beef cattle supplements such as grain and liquid supplements to increase protein intake. Several experiments have looked at the effects of NPN on cattle performance, as well as energy and protein intake when fed at various levels. Rush and Totusek, (1976) concluded that cattle do not perform as well on low-quality forage when urea represents one-third or more of the supplemental nitrogen. Clanton, (1978) states that NPN is not as effective in meeting protein requirements as supplements containing all natural protein sources. They have also been found to decrease ADG when fed at too high of levels.

Statement of the Present Problem

Winter-feeding and supplementation in general is the highest cost for beef cattle producers. Their ultimate goal is matching animal requirements to the available forage resources for the least amount of money. If utilization of low-quality forage can be improved, it is in the best interest of the producer to reduce the need for high cost supplements by implementing the best feeding strategy in conjunction with supplying the best form of supplement. The challenge for the producer will be to provide an adequate source of low-quality forages to be supplemented. Crop residues such as corn stalks, wheat stubble, and grass-seed straw have been used as low-quality basal diets. Stockpiling of forage is another alternative for producers yet, data is limited. Existing data primarily addresses stockpiling forage for winter grazing and stockpiling in midwestern and eastern regions of the United States. Little is known about stockpiling forage for summer grazing in the Pacific Northwest.

The use of protein and energy supplements in beef cattle production has been well documented over the last twenty years. It is generally perceived that protein supplements improve voluntary intake and digestion of low-quality forages, and energy supplements can have negative effects on intake and digestion without adequate levels of protein. However, feeding strategies chosen by producers can result in varied intake between individual animals. Variation resulting from hand-fed supplements is influenced by limited trough space, competition among the animals, and non-feeders. Self-fed supplements have been shown to reduce the number of non-feeders and competition by allowing an unlimited amount of trough space per animal yet, displaying wider ranges of per animal intake.

Although competition can be reduced with feeding strategy, intake variation may still occur due to a variety of factors stemming from the animal and its surroundings. Physiological characteristics of the animal such as age, body condition, and production status dictate nutrient requirements that could ultimately influence supplemental intake. In addition, climatic conditions such as temperature may influence intake levels. More research needs to be explored to identify factors that influence intake and response to hand-fed and self-fed supplements.

The objectives of the studies presented in this thesis are to determine: 1) effects of frequency and timing of grazing on quality and yield of stockpiled forages in western Oregon; 2) effects of lactation and stage of lactation on self-fed supplement intake and subsequent performance of beef cattle utilizing low-quality forages; and 3) influence of cow age on hand-fed supplement intake and subsequent performance of beef cattle winter grazing stockpiled forage.

MANUSCRIPT 1

Effects of Timing and Grazing Frequency on Quality and Yield of Stockpiled Forages in Western Oregon

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Abstract

Six paddocks (15 ha each), consisting of cool season grasses, were used to evaluate the use of a spring, rotational grazing system for the purpose of stockpiling and conditioning forage for late summer use by beef cattle. A variable number of mature, lactating cows and their nursing calves were used to graze each paddock for three rotations. A "put and take" stocking rate was used to graze each paddock to the same end point of 1136 kg/ha in four day grazing bouts. Treatments consisted of: 1) non-grazed, control; 2) grazed twice (2X); and 3) grazed three times (3X). Utilization cages and .25m^2 samples were used to determine forage yield and quality in late summer as well as in the spring prior to each grazing rotation. Crude protein of paddock forage grazed 3X was 17.8% greater ($P < .10$) than non-grazed forage yet, did not differ ($P > .10$) when compared to paddock forage grazed 2X. No differences ($P > .10$) were found among non-grazed paddock forage and paddock forage grazed 2X. The NDF for paddock forage grazed 2X and 3X tended to be lower ($P = .13$ and .16, respectively) than non-grazed paddock forage. Yield of non-grazed paddock forage was 3651.30 and 4463.4 kg/ha greater ($P < .10$) than paddock forage grazed 2X and 3X, respectively. No difference ($P > .10$) was observed in yield among paddock forage grazed 2X and 3X. We concluded that although abstinence from grazing spring forage displays the best response in terms of stockpiled yield, producers are likely to dependent upon grazing the spring forage growth. Grazing does not consistently influence the quality of stockpiled forage to a great magnitude yet, the influence can be important when utilizing low-quality forages.

Parameters, such as temperature and accumulated precipitation, can be used to gauge the termination of spring grazing.

Key Words: Stockpiled forage, Forage quality, Rotational grazing

Introduction

Forage production essentially comes to a halt during the summer in the Pacific Northwest due to an average rainfall of 34.75 mm during the months of July to August (OCS, 1999). As a result, pastures decline in production when used throughout the growing season and become of a low quality that may not meet requirements of mature lactating cattle. Stockpiling of forage has been shown to extend the length of the grazing season and is economically important when compared to feeding hay (Mays and Washko, 1959; Fribourg and Bell, 1984; Collins and Balasko, 1981b). However, proper nutritional management is important to assure efficient use of stockpiled forages.

Most research on stockpiling forage has focused on the initiation of stockpiling during late summer for winter grazing purposes. Limited information is available concerning the effects of rotational grazing to stockpile for late-summer use. In addition, little is known about the management of stockpiled forages in the Pacific Northwest. Therefore, objective of this study was to determine effects of frequency and timing of grazing spring forages on quality and yield of stockpiled forages reserved for late summer use in Western Oregon.

Materials and Methods

The experiment was conducted at Oregon State University's Soap Creek Ranch located near Corvallis, OR, from April 6 to August 3, 1998. Paddocks, dominated by tall fescue (*Festuca arundinaces* L.), perennial ryegrass (*Lolium perenne* L.), and clover (*Trifolium spp.* L.), were used to determine quality and yield of stockpiling western Oregon cool season grasses used in late-summer grazing systems. Crossbred beef cows (average wt = 642 kg) and their nursing calves were used to rotationally graze the paddocks resulting in treatments of timing and frequency of grazing. Frequency treatments were: non-grazed (control), grazed twice (2X), and grazed three times (3X).

The study area was divided into six paddocks (1-6), 15 ha in size, and separated with a barbed wire fence. Cattle had access to water and free-choice minerals. Paddocks were grazed individually starting with paddock 1. Paddocks were grazed in 4-day bouts with 20 days of rest while subsequent paddocks were being rotationally grazed. Rotations continued until each paddock was grazed three times.

Two days prior to each grazing rotation, ten .25 m^2 sample areas were hand-clipped to a stubble height of 2 to 3 cm to estimate forage yield. A put-and-take stocking rate was used assuming each cow consumed 2.9% of its BW (18.6 kg/day) and by grazing to an end point of 1136.36 kg/ha.

Two utilization cages, consisting of 12.5 gauge galvanized mesh wire and two t-posts, were applied to each paddock prior to the first grazing rotation to determine the effects of non-grazed. Cages were slightly greater than .25m^2 in area and prohibited grazing. An additional 10 utilization cages were applied to each paddock after the second grazing rotation to determine the effects of 2X grazed. Forage samples were then hand-clipped on d 122 within and outside of each cage within the .25 m^2 area to estimate forage quality and yield affected by grazing treatments of non-grazed, 2X, and 3X.

After clipping, forage samples were gathered separately in paper bags, dried in a forced-air oven (60°C) for 24 h, ground through a 1-mm screen, and analyzed for DM, CP (AOAC, 1995), NDF, and ADF (Goering and Van Soest, 1970). Forage yield was calculated by averaging weights of the ten clipped, dried, and unground samples for each paddock and then extrapolating them to a 15 ha area.

Stockpiled forage yields of the last grazing bout of each paddock were analyzed through regression to determine trends throughout rotations two and three. Accumulated precipitation, accumulated solar radiation, and mean temperature (Agrimet, 1999) were also obtained for the study period of April 1 to June 19, 1999 and regressed with stockpiled forage yield of final grazing bout date. A comparison of the total stockpiled forage available to the total forage consumed in the spring, as influenced by grazing frequency, was also made.

Data was analyzed using the GLM procedure of SAS (1996) with paddock as the experimental unit. Means were separated with LSD following significant F-tests. Least square means and P-values are reported. Change in forage yield, precipitation, solar radiation, and temperature over time was analyzed using simple linear regression.

Results and Discussion

Forages of all three grazing rotations during the spring would be considered of a moderate quality, yet sufficient to meet requirements of mature lactating cows (Table 1). Average forage available in the spring was 1854.49, 2665.80, and 2050.99 kg/ha for rotations one, two, and three, respectively. The CP harvested after only one rotation was 189.26 kg/ha less ($P < .10$) than after two rotations and 287.10 kg/ha less ($P < .10$) than after three rotations. There was no difference (P > .10) in the CP harvested between rotations two and three (Table 1).

Crude protein of 3X grazed paddock forage was 17.8% greater (P < .10) than non-grazed paddock forage, yet did not differ (P > .10) when compared to 2X grazed paddock forage. No differences (P > .10) were found when comparing CP between non-grazed and 2X grazed paddock forage (Table 2).

Table 1. Chemical composition and harvest amounts of spring forage as related to grazing rotation[a]

	Grazing rotation[b]				Rotation contrasts		
Item	1	2	3	SE[c]	1 vs 2	1 vs 3	2 vs 3
Composition, %				-	-	-	-
CP	14.81	12.34	10.32	-	-	-	-
NDF	49.42	58.77	60.28	-	-	-	-
ADF	26.72	28.65	36.01	-	-	-	-
Harvested, kg/ha				-	-	-	-
Yield available	1854.49	2665.80	2050.99	-	-	-	-
DM harvested	649.87	2179.31	3093.94	401.87	.03	.002	.17
CP harvested	98.86	288.12	385.96	59.34	.06	.007	.30

[a]Values expressed on a DM basis
[b]Rotations occurred from April 8 to May 2, rotation 1; May 2 to May 26, rotation 2; May 26 to June 19, rotation 3
[c]Pooled standard error n=6

Neutral detergent fiber of non-grazed paddock forage tended to be greater than 2X and 3X grazed paddocks (P = .13 and .16, respectively). No difference (P > .10) was found when comparing NDF of 2X and 3X grazed paddock forage. When comparing ADF among the three grazing treatments, no differences (P > .10) were found (Table 2).

Yield of stockpiled forage for non-grazed paddocks was 3651.30 kg/ha greater (P < .10) than 2X grazed paddock forage and 4463.50 kg/ha greater (P< .10) than 3X grazed paddock forage. Data is missing from non-grazed paddocks 1 and 2 due to incorrect placement of the cages. No differences (P > .10) were found in forage yield between 2X

Table 2. Effect of grazing frequency on stockpiled forage quality and yield[a]

	Treatments				Treatment contrasts[c]		
Item	0	2	3	SE[b]	0 vs 2	0 vs 3	2 vs 3
CP, %	6.68	7.24	7.87	.33	0.31	0.05	0.22
NDF, %	67.44	63.81	64.16	1.54	0.13	0.16	0.86
ADF, %	37.28	36.82	38.69	1.11	0.78	0.39	0.21
Yield, kg/ha	6277.73	2626.43	1814.33	517.25	0.0003	0.0001	0.25

[a]Values expressed on a DM basis
[b]SE = standard error with n=4, 0; n=6, 2; n=6, 3
[c]Contrasts expressed as probability (p-value)

and 3X grazed paddocks (Table 2, Figure 1). Losses in yield due to prolonged grazing are consistent with other researchers who have evaluated stockpiled forage (Collins, 1982; Mays and Washko, 1959; Fribourg and Bell, 1984). The loss of yield is due to a lack of regrowth restricted by a decline in precipitation.

Cows consumed 2179.31 kg/ha of forage in paddocks grazed 2X leaving 2626.43 kg/ha of stockpiled forage in August. Paddocks grazed 3X resulted in cattle consuming 3093.94 kg/ha of forage, which tended to be greater (P = .17) than paddocks grazed 2X. Paddocks grazed 3X left 1814.32 kg/ha of stockpiled forage. Non-grazed paddocks resulted in 6277.73 kg/ha of stockpiled forage (Table 1, Figure 2).

Spring grazing, when compared to non-use, increased CP%. Although CP levels of all three treatments would be considered low-quality, an increase from 6.68% to 7.87% (non-grazed vs 3X grazed) is a significant amount of additional CP to provide for cattle when they are dependent upon a low-quality basal diet. The increase of 19% CP becomes particularly important when stockpiled yield is reduced by more than 3000 kg/ha as a result of spring grazing. Fiber levels influenced by spring grazing displayed lower levels of NDF yet, did not display an influence upon ADF. This suggests that spring grazing lowered the amount of hemicellulose provided in the stockpiled forage while less digestible constituents, such as lignin, remained consistent.

Stockpiled forage yield decreased in a curvilinear fashion as the last grazing bout

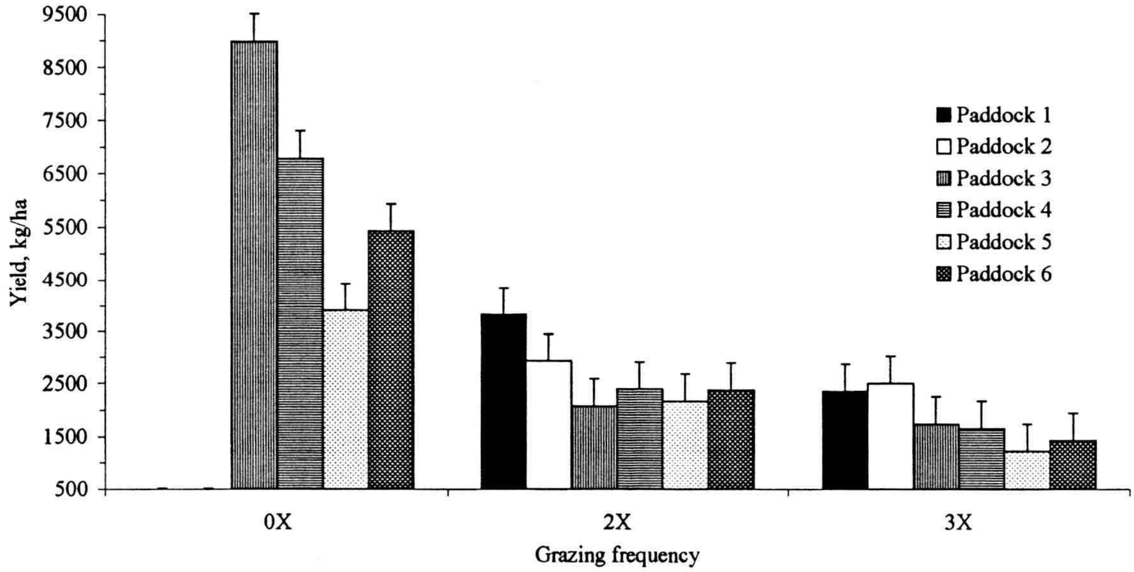

Figure 1. Effects of frequency of spring grazing on stockpiled forage yield

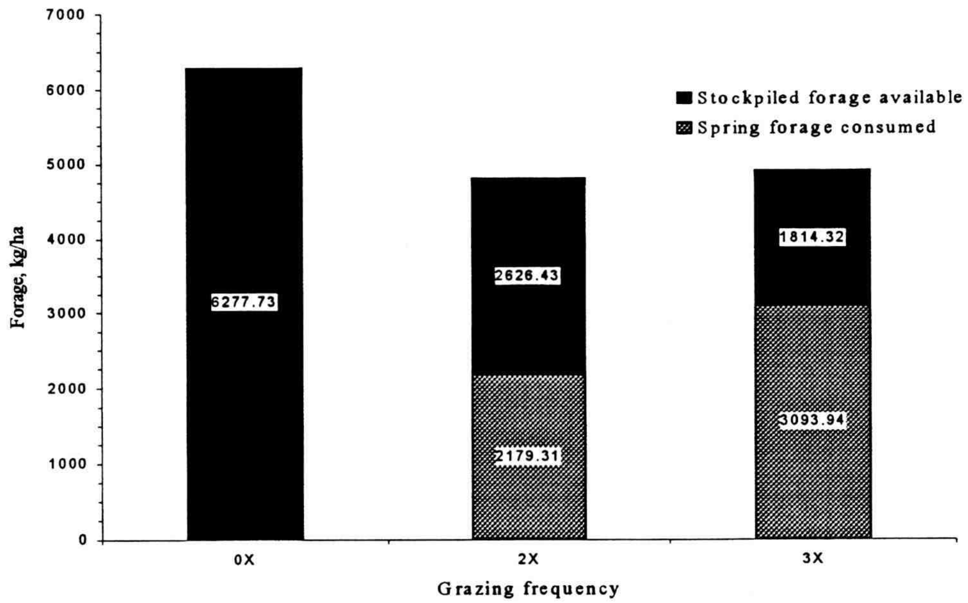

Figure 2. Total forage consumed vs stockpiled availability as influenced by grazing frequency

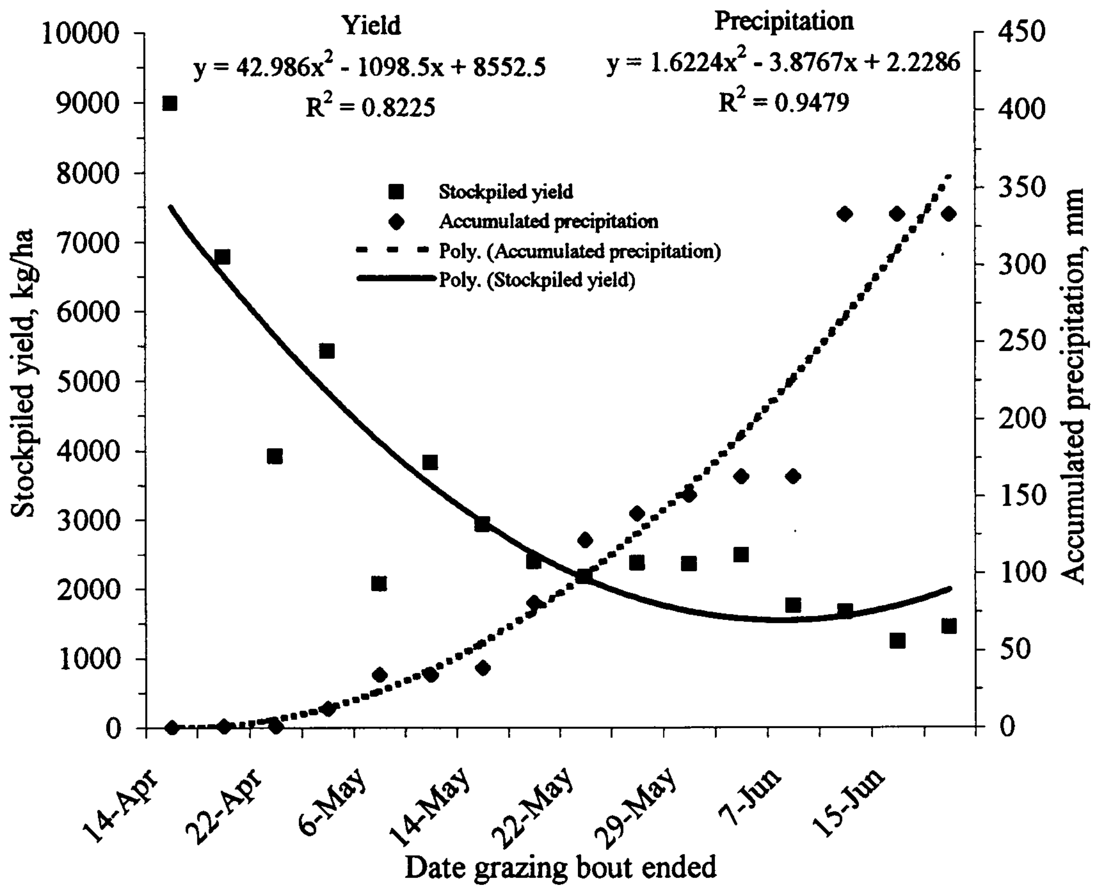

Figure 3. A comparison of the relationship of stockpiled forage yield vs last grazing bout to accumulated precipitation vs time. Stockpiled forage yields were estimated on day 122 clippings as of a result of the date of the last grazing bout.

increased through the three grazing rotations ($y = 42.986x^2 - 1.098.5x + 8552.5$; $R^2 = .8225$; Figure 3). During these rotations, accumulated precipitation increased in a curvilinear fashion ($y = 1.6224x^2 - 3.8767x + 2.2286$; $R^2 = .9479$; Figure 3). When comparing the two curves simultaneously, it was observed that accumulated precipitation began to level off at 150 to 175 mm in late May. At this same time, the effect of date of the last grazing bout stockpiled forage yield was beginning to level off (Figure 3). This time period could be used as a reference point for terminating grazing and allowing for herbage accumulation (stockpiling). It is important that the stockpiling period has an ample amount of precipitation. This is consistent with Ocumpaugh and Matches (1977), who stated autumn stockpiled yield has a dependence upon accumulated precipitation.

Average precipitation for the months of April, May, and June, 1998 were 45.75, 145.00, and 24.25 mm, respectively. Precipitation averages for the past 28 years were 64.00, 48.75, and 30.75 mm for April, May, and June, respectively (OCS, 1999).

Accumulated solar radiation increased linearly ($y = 448.06x - 20.271$; $R^2 = .9873$) in relationship to time during spring grazing. However, weather patterns during the study period were observed to be irregular with various periods of cloud cover and sunshine. When comparing this to patterns of stockpiled yield, no preferable time-point was found in which to terminate grazing in relation to solar radiation (Figure 4).

Mean daily temperature displayed a curvilinear increase ($y = .0416x^2 - .353x + 11.517$; $R^2 = .26$) throughout spring grazing with temperatures significantly increasing in late May (Figure 5). During this time, accumulated precipitation was leveling off so when considering both precipitation and temperature, grazing could be terminated during the month of May to allow for a greater amount of vegetative growth before the forage reaches the dormant stockpiled stage.

Average mean temperature for April, May, and June 1998 was 9.86, 12.41, and 15.9 °C, respectively. This is similar to average of the last 28 years of 9.61, 12.5, and 16.06 °C (OCS, 1999).

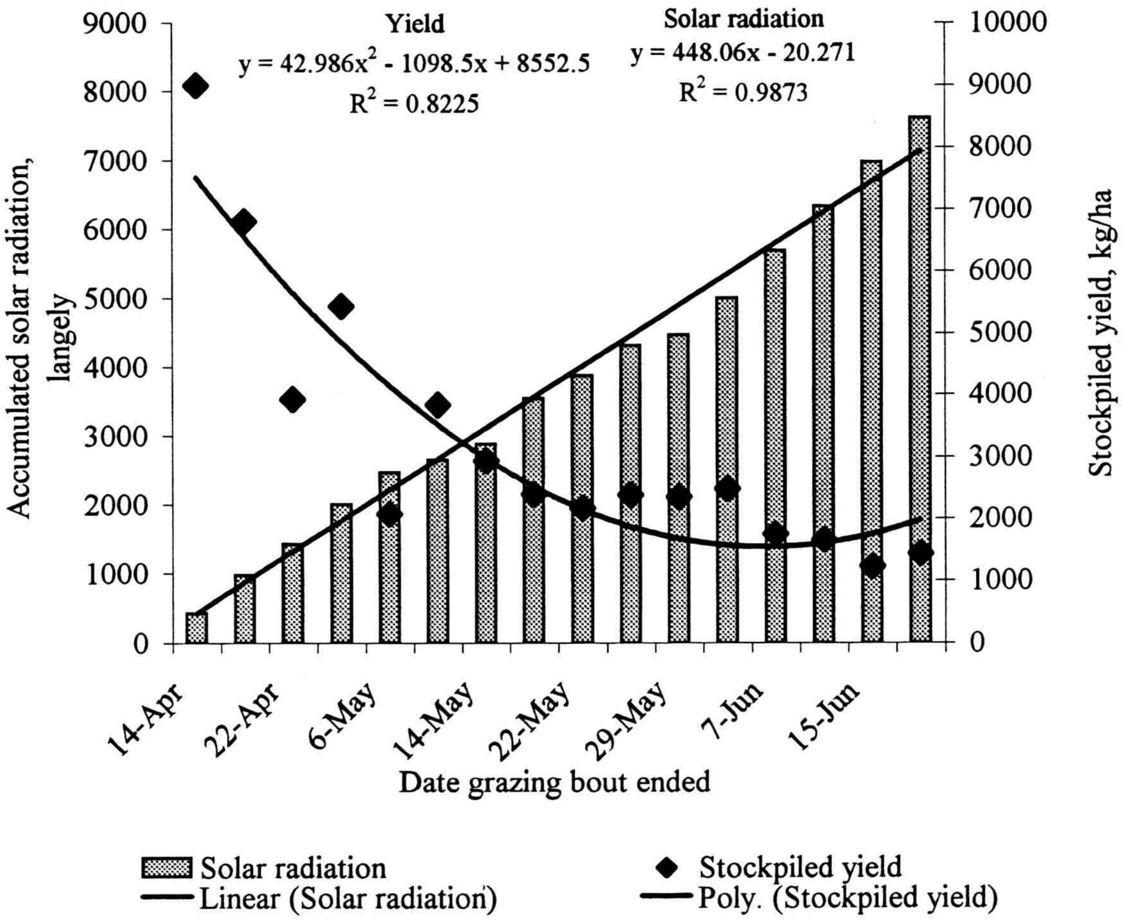

Figure 4. A comparison of the relationship of stockpiled forage yield vs last grazing bout to accumulated solar radiation vs time. Stockpiled forage yields were estimated on day 122 clippings as of a result of the date of the last grazing bout.

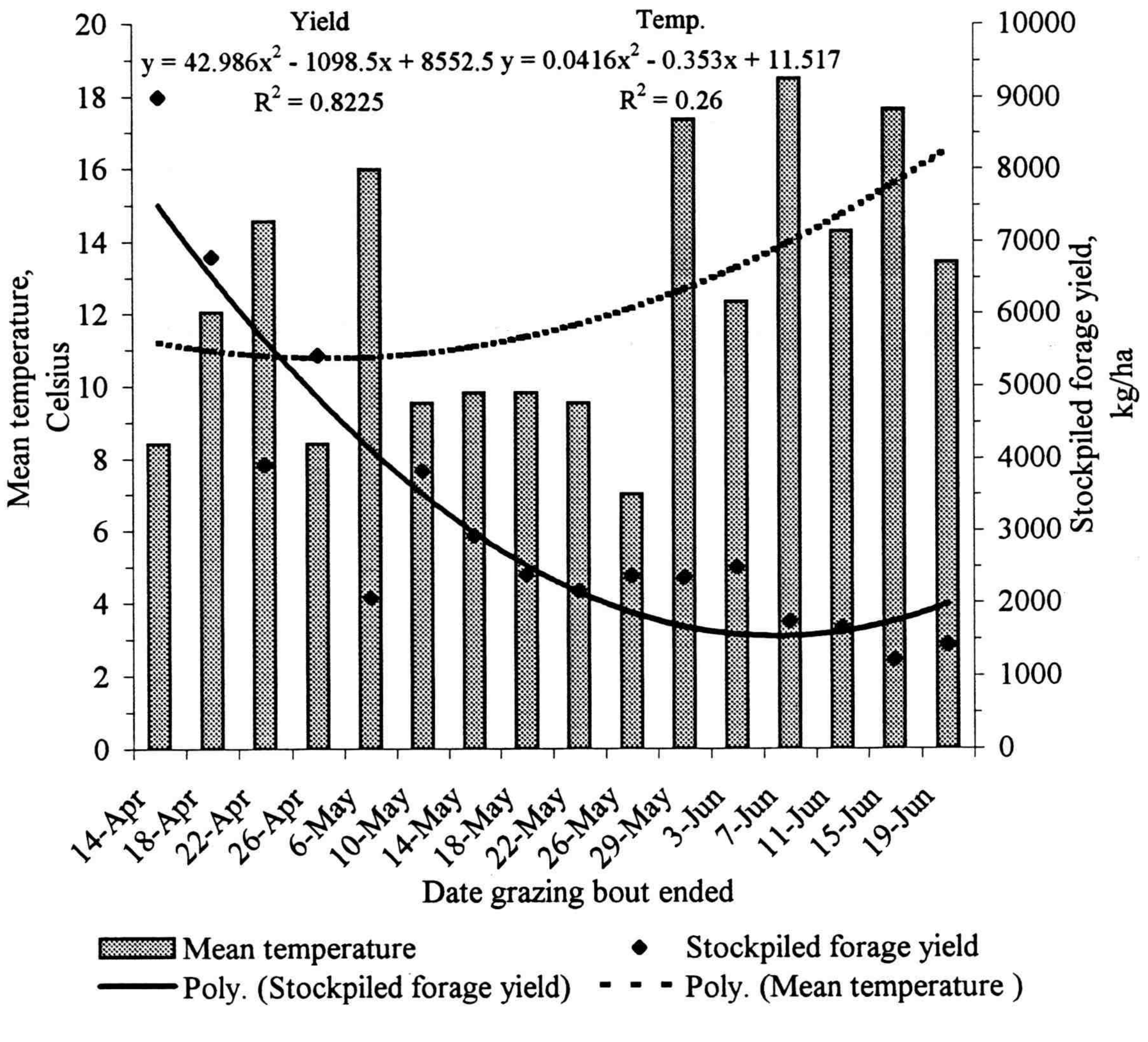

Figure 5. A comparison of the relationship of stockpiled forage yield vs last grazing bout to mean temperature vs time. Stockpiled forage yields were estimated on day 122 clippings as of a result of the date of the last grazing bout.

Implications

Abstinence of grazing for western Oregon spring pastures displayed the best response in terms of stockpiled forage yield yet, displayed the lesser quality. The implementation of rotational grazing significantly reduced the amount of stockpiled forage available for late-summer use. Grazing did not seem to influence the quality of stockpiled forage in a great magnitude and the forage quality was considered low regardless of grazing treatment. However, even small increases in CP content are advantageous when low-quality forages are provided as the basal diet. Spring forage for in western Oregon is likely to be utilized by most producers. Therefore, a timing point within the spring grazing system could possibly be determined as when to cease grazing. Accumulated precipitation and temperature would be the best parameters to gauge the preference point.

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MANUSCRIPT 2

Effects of Lactation and Stage of Lactation on Self-Fed Supplement Intake and Performance of Beef Cows Consuming Low-Quality Forage[1]

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Abstract

Forty-eight mature crossbred cows (average wt = 642 kg; body condition (BC) = 6.18) were assigned to two low-quality basal diets evaluating the use of a self-fed baked molasses supplement (25% CP) with beef cows grazing stockpiled forage (Diet 1, 8.20% CP, 41.44% ADF) or fed meadow hay (Diet 2; 7.49% CP, 39.51% ADF). For each basal diet, cows were allotted to the following treatment groups: 1) late-lactation lactating (149 to 175 days postpartum); 2) late-lactation weaned (non-lactating cows, calves removed from late-lactating cows just prior to study); and 3) mid-lactation lactating (109 to 131 days post-partum). A dual marker technique was used to determine supplement (Ytterbium chloride) and total DM intake (sustained release chromium boluses). On stockpiled forage diets, late-lactation cows body weight was 30.09 kg less ($P < .10$) than non-lactating cows and 21.32 kg less ($P < .10$) than mid-lactation cows. Late-lactation cows BC was .48 units less ($P < .10$) than dry cows yet, did not differ ($P > .10$) when compared to mid-lactation cows. On low-quality hay diets, late-lactation cows body weight was 31.27 kg less ($P < .10$) than non-lactating cows yet, no difference in BC was observed ($P > .10$) with mid versus late lactating cows. No differences were observed ($P > .10$) among the treatments for forage and supplement intake for cows and calves in both stockpiled and low-quality hay diets. Self-fed supplement intake increased over time and averaged 1.69 kg for cattle consuming stockpiled forage and 1.21 kg for cattle consuming low-quality hay. Milk production of late-lactation tended to be lower than mid-lactation cows on stockpiled forage or meadow hay ($P = .14$ and $.15$, respectively). We conclude that non-lactating cows displayed the best response to self-fed supplementation of low-

quality forages. In addition, supplement intake was highly variable but not influenced by lactation and stage of lactation effects.

Key Words: Beef cattle, Protein supplementation, Intake, Low-quality forages, Lactation

Introduction

Protein supplementation is a routine practice in the beef cattle industry, particularly for cattle grazing dormant or stockpiled forages or fed low-quality hays or straws. Supplementation stimulates increased voluntary forage intake and improves cattle performance (Kartchner, 1980; DelCurto et al., 1990a,b; Horney et al., 1996; Weder et al., 1999). Improvements in intake are often attributed to increased rates of forage digestion and digesta passage (Church and Santos, 1981). Improved intake and utilization of low-quality roughages, in turn, promote improved beef cow BW gain, body condition, reproductive efficiency, and weaning weight of calves (Clanton, 1982; Cochran et al., 1986; DelCurto et al., 1990b).

Most research on protein supplementation of beef cows has focused on oilseed meals, nonprotein nitrogen, or strategies of supplementation such as timing, frequency and amounts. Limited information is available concerning the use of self-fed supplements provided in lick tanks, blocks, or tubs. In addition, concerns have arisen due to the variation in intake that can occur among individual animals due to factors of animal preference, weather, and supplement form (Weber et al., 1992). The producer essentially has less control of how much the animal is consuming. However, when compared to hand-fed supplements, self-fed supplements can reduce the level of competition among animals (Bowman and Sowell, 1997).

Physiological conditions (such as weight, age, growth, gestation, and lactation) dictate dry matter intake (DMI) and nutrient requirements. Despite this, little is known about how lactation and stage of lactation influences animal response to self-fed protein supplementation of low-quality roughages. Therefore, the objectives of these studies were to determine the effects of lactation and stage of lactation on supplement intake, variation in supplement intake and, subsequent performance characteristics of beef cows and calves consuming low-quality roughages.

Materials and Methods

Forty-eight mature crossbred beef cows were used to determine cow and calf intake of self-fed supplements and, subsequent effects on performance. The cows had access to a commercially available baked molasses supplement (Western Feed Supplements, Yakima, WA) offered in 90 kg blocks (26.5% CP) contained in open tubs. Cows were assigned to one of two low-quality basal diets evaluating the use of the supplement with cows grazing stockpiled forage (Diet 1; 8.20% CP, 41.44% ADF) or fed meadow hay (Diet 2; 7.49% CP, 39.51% ADF). For each basal diet, cows were allotted to the following treatment groups: 1) late-lactation lactating (149 to 175 days postpartum); 2) late-lactation weaned (non-lactating cows, calves removed from late-lactating cows just prior to study); and 3) mid-lactation lactating (109 to 131 days post-partum). The study was conducted from August 5, 1998 to September 23, 1998 in western Oregon on Oregon State University's Soap Creek Ranch. Pastures were dominated by tall fescue (*Festuca arundinaces* L.), perennial ryegrass (*Lolium perenne* L.), and clover (*Trifolium spp.* L.).

Cows and calves were weighed following a 16-h fast at the beginning and end of the study period and cows were also scored for body condition (1 - 9 scale; Momont and Pruitt, 1993) at these times. Body condition was recorded using the average of two scores that were measured for each cow. Milk intake was estimated for all suckling calves on d 17 using a weigh-suckle-weigh technique (Williams et al., 1979). Cows were dosed with sustained release Cr_2O_3 boluses on d 1 of the trial for Exp. 1 and d 8 for Exp. 2 to determine DMI. Ytterbium (Yb) chloride was added to the supplement to determine individual supplement intake. Fecal grab samples were collected on d 12 to 18 and 19 to 25 for Exp. 1 and 2, respectively. Fecal samples were dried in a forced-air oven (60°C), ground through a 1mm screen, and analyzed for DM (AOAC, 1995), Cr by atomic absorption spectrophotometry (Williams et al., 1962), and Yb by inductively coupled plasma emission spectroscopy (Ellis et al., 1982). Extrusa samples were collected on d 17 using four ruminally cannulated crossbred steers and were dried and ground to determine DM, Ash, CP (AOAC, 1995), NDF, ADF (Goering and Van Soest, 1970) and digestibility. Digestibility was estimated using TDN calculations based on the ADF percentage of the basal diets. Digestibility was estimated also using a modified technique of IVDMD (Tilly and Terry, 1963). Estimates of individual fecal output (FO), DMI and supplement intake were obtained using equations by Earley et al. (1998). Calf fecal samples and basal diets were analyzed for Indigestible Acid Detergent Fiber (IADF) (Sunvold and Cochran, 1991) to estimate the total tract digestibility compared between calves of mid and late-lactating cows.

Validation of the marker release rate was determined by administering Cr_2O_3 boluses to the four ruminally cannulated steers. Steers were fitted with fecal bags to determine actual FO. Three to five fecal grab samples were collected from each steer from d 49 to 55 and analyzed for Cr concentration to estimate FO. The actual mean FO was 3.09 kg. Estimated mean FO was 3.53 kg, which overestimated the FO of the cows by 14.24%.

Each container of supplement was weighed and recorded just prior to feeding and weighed again every seven days or until the supplement was completely consumed. Changes in weights were used to estimate supplement intake over the 50 day period.

Data was analyzed using the GLM procedure of SAS (1996) with individual animal as the experimental unit. Cow and calf initial weight and cow initial condition score was included as a covariate in the model. Means were separated with LSD tests. Least square means and P-values are reported. Chromium bolused cows were eliminated from the data set if Cr concentrations were outside a 95% confidence interval.

Results and Discussion

Forage quality was similar between experiments of stockpiled forage and meadow hay (Table 1). Forages of both experiments would be considered of deficient for lactating cows and marginal for mature gestating nonlactating cows. Estimates of

Table 1. Chemical composition of stockpiled forage (diet 1) and meadow hay (diet 2) basal diets.[a]

Item	Stockpiled forage	Low-quality hay	Supplement
CP, %	8.20	7.49	24.35
NDF, %	68.31	71.07	10.12
ADF, %	41.44	39.51	5.25
TDN, %	55.30	57.50	-
Ash, %	15.20	-	-

[a]Values expressed on a DM basis

IVDMD were not reliable due to the procedure's inability to display consistent results for the rumen extrusa samples (Table 1).

On stockpiled diets, BW change of late-lactation cows was 30.09 kg less ($P < .10$) than BW change of non-lactating cows, and 21.32 kg less ($P < .10$) than BW change of mid-lactation cows. Late lactation cows' BC change was .48 units less ($P < .10$) than dry cows yet, did not differ ($P > .10$) when compared to mid-lactation cows' (Table 2).

On low-quality hay diets, BW of late-lactation cows was 31.27 kg less ($P < .10$) than non-lactating cows yet, did not differ ($P > .10$) when compared to mid-lactation cows. There was no difference in BC change ($P > .10$) among the three treatments (Table 2).

Milk production for late-lactation cows tended to be lower than mid-lactation cows in both experiments ($P = .14$ and .14, respectively.) Milk production for late and mid-lactation was 2.73 vs 5.11 kg for Exp. 1 and 3.24 vs 4.77 kg for Exp. 2. (Table 2).

Intake of the self-fed supplement increased over the 50 day trial and averaged 1.69 kg for cattle consuming stockpiled forage and 1.21 kg for cattle consuming low-quality hay. Intake ranges were consistent with the expectations of the manufacturers of the protein tubs.

Forty-eight cows were dosed with sustained release Cr_2O_3 boluses to estimate fecal output however, Cr could not be detected in 33% of the cow fecal samples due to regurgitation of the boluses prior to or during the sample collection period. Fecal outputs were over estimated by 14% compared to fecal collections from the bolus validation. Supplement intake was estimated by the Yb concentration in the feces and associated intake and fecal output with Cr_2O_3 boluses. Yb concentration was measured on calves but intake was not directly measured because of the inability to isolate a

Table 2. Effect of lactation and stage of lactation on self-fed beef cow weight and body condition change, calf gain, and milk production

	Treatments				Treatment contrasts[b]	
Item	Non-lactating	Late-lactation	Mid-lactation	SE[a]	Non vs late	Mid vs late
Stockpiled diet						
Initial						
Cow wt, kg	650.45	635.45	612.27	19.82	.61	.41
Condition, 1-9	6.44	5.94	5.78	.40	.39	.79
Calf wt, kg	205.45	231.82	158.64	7.73	.02	.01
0 to 56 days						
Cow wt change, kg	20.95	-9.14	12.18	5.23	.01	.01
Cond.change, 1-9	.31	-.17	-.16	.19	.08	.91
Calf gain, kg	20.73	45.45	42.68	3.59	.01	.59
Milk prod., kg	-	2.73	5.11	1.07	-	.14
Low-quality hay diet						
Initial						
Cow wt, kg	651.36	655.45	654.55	29.55	.92	.98
Condition, 1-9	6.31	6.47	6.16	.30	.71	.48
Calf wt, kg	231.36	216.82		9.86	.30	.01
0 to 56 days						
Cow wt change, kg	28.18	-3.09	-2.23	7.27	.01	.93
Cond.change, 1-9	.00	-.28	-4.40	.18	.27	.54
Calf gain, kg	23.18	45.95	49.68	2.31	.01	.27
Milk prod., kg	-	3.24	4.77	.71	-	.15

[a]SE = standard error with n = 8

[b]Contrasts expressed as probability (p-value)

reliable dual marker. Fecal output and DMI were estimated assuming late and mid-lactation calves consumed 1.0 and .75% BW of forage DM per day, respectively. On stockpiled diets, forage intake for late-lactating cows was 3.34 kg less ($P < .10$) than mid-lactating cows yet, did not differ ($P > .10$) when compared to non-lactating cows. For supplement intake, no differences were observed ($P > .10$) between the three treatments (Table 3).

On low-quality hay diets, forage intake for late-lactating cows tended ($P = .13$) to be greater than non-lactating cows yet, did not differ ($P > .10$) when compared to mid-lactating cows. For supplement intake, no differences were observed ($P > .10$) between the three treatments.

Cow supplement intakes displayed a high degree of variability ranging from .002 to 3.08 kg hd^{-1} day^{-1} averaged across treatments and basal diets (Figure 1). The variation in supplement intake appears to not be related to lactation and stage of lactation effects. In addition, supplement variation is consistent with other researchers who have evaluated self-fed supplement intake (Weber et al., 1992; Earley et al., 1998).

Supplement intake increased ($P < .10$) linearly as cow weight change increased. Supplement intake increased .005 kg for each 1 kg increase in weight change. The relationship is expressed by $y = .0050x + .742$ (y = dependent variable, supplement intake; x = independent variable, weight change). However, the change in cow body weight explained for only 12.40% of the increase in supplement intake: $R^2 = .1240$ (Figure 2).

Calf consumption of protein supplements was not influenced by lactation (P > .10) or stage of lactation (P > .10; Table 3). Calf intakes were highly variable ranging from 0 to .5 kg hd^{-1} day^{-1}. In fact, significant amounts of supplement intake (greater

Table 3. Effect of lactation and stage of lactation on daily, self-fed beef cow supplement and forage intake, and calf intake[a]

	Treatments				Treatment contrasts[b]	
Cow intake, kg	Non-lactating	Mid-lactation	Late-lactation	SE[c]	Non vs late	Mid vs late
Stockpiled diet						
Forage	14.42	18.97	15.63	1.86	.51	.04
Supplement	.94	.64	1.52	.22	.78	.37
Low-quality hay diet						
Forage	13.18	13.86	14.12	.39	.13	.69
Supplement	.83	.49	.63	.21	.52	.67
Calf intake, kg		Mid-lactation	Late-lactation	SE[d]		Mid vs late
Stockpiled diet						
Supplement		.01	.03	.01		.35
Yb conc.		31.58	46.9	10.83		.69
Low-quality hay diet						
Supplement		.004	.001	.002		.39
Yb conc.		9.92	1.64	5.85		.32

[a]Values in table expressed on DM basis

[b]Contrasts expressed as probability (p-value)

[c]SE=standard error with n=4, non-lactating; n=6, mid-lactation, n=7, late-lactation on stockpiled diets and n=5, non-lactating; n=6, mid-lactation; n=4, late-lactation on low-quality hay diets

[d]SE=standard error with n=8

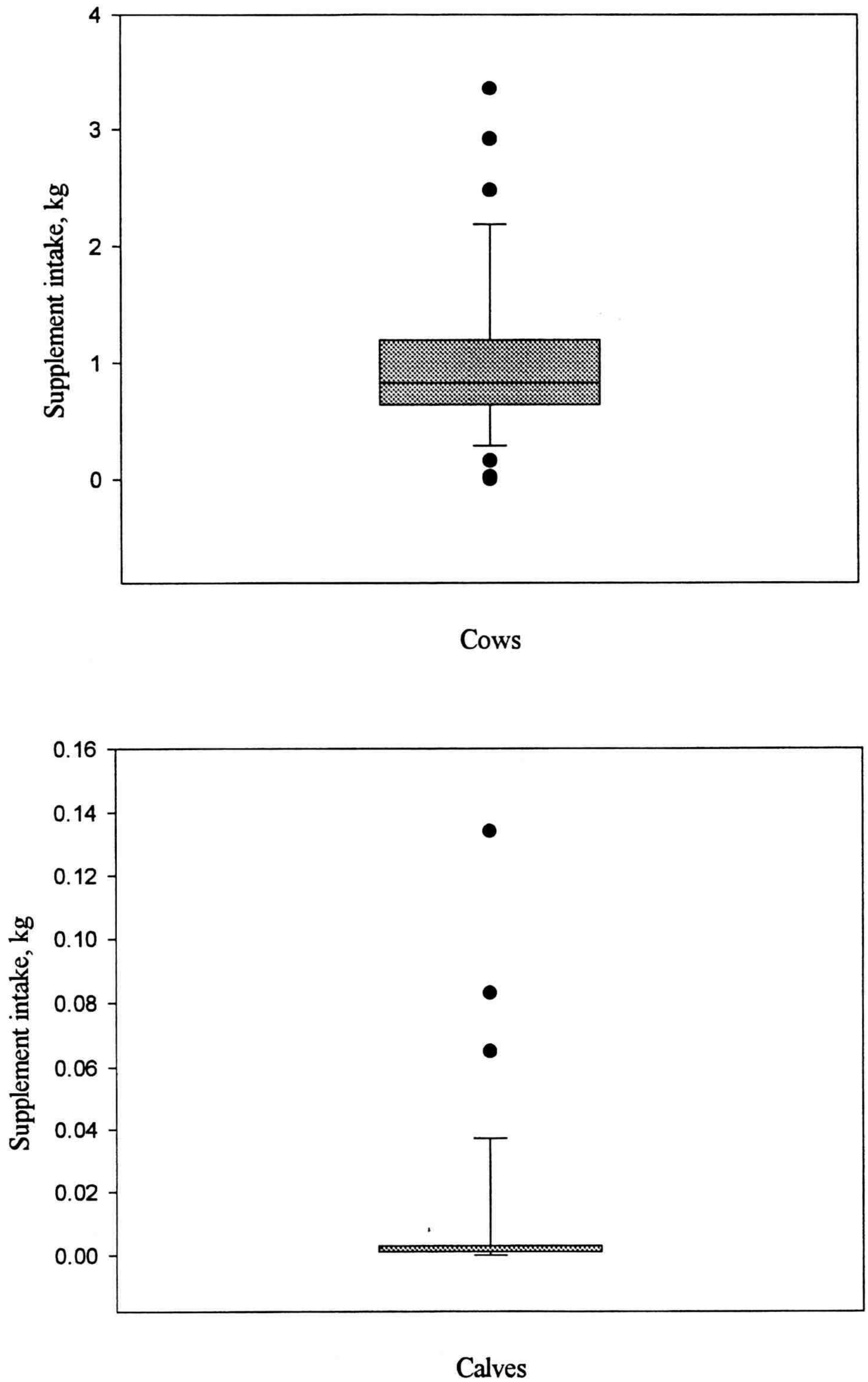

Figure 1. Box and scatter plot depicting variation of self-fed supplement intake of cows and calves with combined data from diets 1 and 2. Data represented by dots outside of the 95% confidence interval.

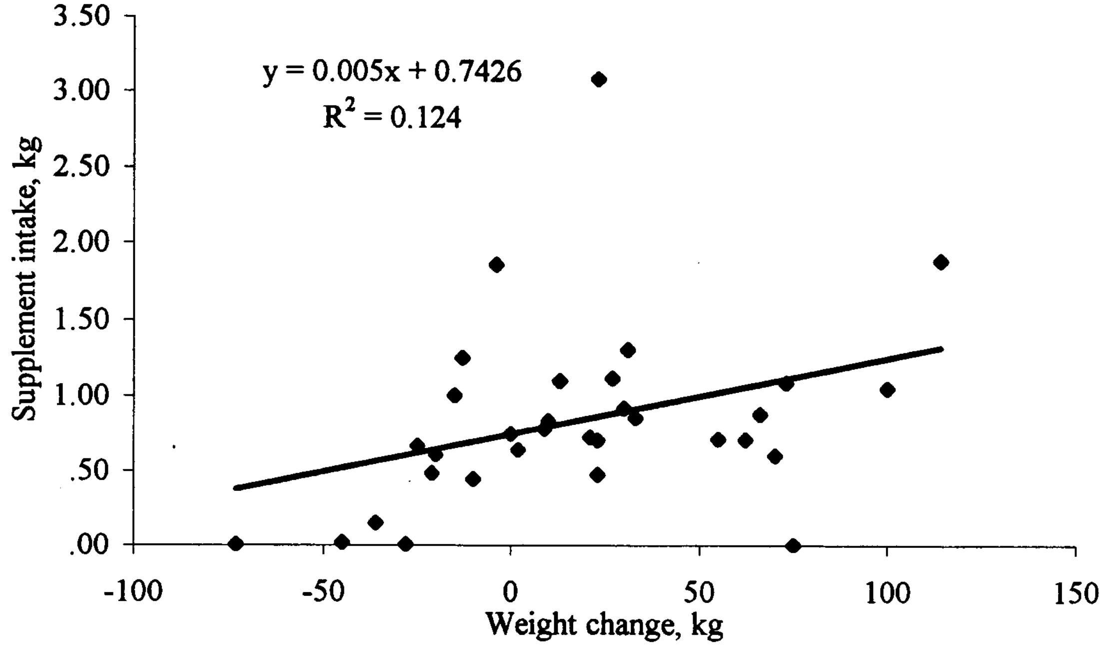

Figure 2. Relationship of cow supplement intake to cow body weight change from day 0 to 56 with data combined from diets 1 and 2.

than 8 gm per day) were observed in only three of the calves from both experiments (Figure 1). Therefore, self-fed supplement tubs do not seem to provide direct nutritional advantages to calves suckling dams consuming low-quality roughages. Total tract digestibility did not differ ($P > .10$) between calves of mid and late-lactating cows in either stockpiled or low-quality hay diets.

Implications

Non-lactating cows displayed the best response to self-fed supplementation of low-quality forages in terms of weight and condition score status due to lower nutritional requirements. Stage of lactation, did not seem to consistently influence response to self-fed protein supplementation with acceptable body weight and condition change over the study period. Self-fed supplement intake was appropriate for meeting cows nutritional requirements yet, displayed a high degree of variability not related to lactation and stage of lactation effects. Calf intake of the self-fed supplements was low and also displayed a high degree of variation.

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MANUSCRIPT 3

Influence of Cow Age on Consumption of Hand-Fed Supplements and Subsequent Performance of Beef Cows Winter Grazing Stockpiled Forage

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Abstract

Fifty mature British X Continental cows (average wt = 527.91 kg) were used to evaluate the variation in intake of a hand-fed oat/biuret supplement (20% CP) during two winters of grazing stockpiled forage. In the experiment, cows were allotted into five groups of ten cows representing the following cow age groups: 3, 5, 7, 9, and 11-yr cows for yr 1. Using the same cows for yr 2, age groups consisted of: 4, 6, 8, 10, and 12-yr cows. In yr 2, five cows from each age group were randomly selected and dosed with sustained release Cr_2O_3 boluses on d 28 of the trial to estimate fecal output (FO) and forage intake. The remaining five cows of each age group were fed Cr_2O_3 mixed within the ground oat/biuret supplement (20% CP) at a rate of 2.22 g/kg to determine supplement intake. In yr 1 of winter feeding, weight change at d 35 did not differ ($P > .10$) among the five age groups. Weight change at d 57 for 11-yr cows was greater ($P < .10$) than 5-yr cows. However, weight change at d 57 did not differ ($P > .10$) among ages 9-yrs and younger. Weight change at d 70 and calving did not differ ($P > .10$) among the age groups (Table 2). In yr 2, weight change at d 28 for 8-yr cows was less ($P < .10$) than 4, 6, and 10-yr cows yet, did not differ ($P > .10$) when compared to 12-yr cows. Weight change for 4-yr cows was greater ($P < .10$) than 6, 10, and 12-yr cows. At d 56, weight change for 4-yr cows was greater ($P < .10$) than 6, 8, 10 and 12-yr cows. Weight change for 12-yr cows at d 56 was less ($P < .10$) than 6 and 10-yr cows. Weight change at calving for 4-yr cows was greater ($P < .10$) than 6, 8, and 12-yr cows yet, did not differ ($P > .10$) when compared to 10-yr cows. Similarly, there was no difference ($P > .10$) in weight change at calving among ages 6-yrs and older. Forage intake of 10-yr cows was greater ($P < .10$) than 8 and 4-yr cows yet, there was no difference ($P > .10$) among 10,

12, and 6-yr cows. Supplement intake of 4-yr cows was greater (P > .10) than 10, 12, and 8-yr cows yet, did not differ (P > .10) when compared to cows 6-yr cows. Supplement intake of 6-yr cows was greater (P < .10) than 12 and 8-yr cows yet, did not differ (P > .10) when compared to 10-yr cows. There was no difference (P > .10) in supplement intake among cows 8-yrs and older. We conclude that 3 and 4-yr cows displayed the best response to hand-fed supplementation of stockpiled forages in terms of performance. Supplement intake was influenced by cow age with cows 6-yrs and younger consuming the highest amounts.

Key Words: Beef cattle, Hand-fed supplements, Intake, Low-quality forages, Cow age

Introduction

Energy supplementation is commonly practiced in the beef cattle industry, and can be beneficial when used in conjunction with the proper ration of protein to energy (DelCurto et al., 1990). Without the proper levels of protein, energy supplements have shown to lower the intake and utilization of low quality forages when fed at increasing levels (Sanson et al., 1990; Chase and Hibberd, 1987; Horn and McCollum, 1987). However, protein intake can be increased if low levels of non-protein nitrogen are added to energy supplements. On the other hand, forage intakes and ADG can decline when levels of NPN become too high (Clanton, 1978; Rush and Totusek, 1976).

Energy supplements are commonly delivered in a hand-fed method. Although this method allows for tight control of how much feed is given to each animal, variation from the target amount can occur due to competition among the animals and limited trough space (Bowman and Sowell, 1997). In addition, physiological conditions (such as weight, age, growth, gestation, and lactation) can dictate dry matter intake (DMI) and nutrient requirements. Greater amounts of a self-fed protein supplement have been observed to be consumed by 5 and 6-yr-old cows when compared to younger 2-yr-old cows (Daniels et al., 1998).

Most of the research on hand-fed energy supplementation of beef cows has focused on strategies of supplementation such as timing, frequency, amounts, and sources. Despite this, little is known about how cow age influences animal response to hand-fed energy supplementation of low-quality roughages. Therefore, the objectives of these studies were to determine the effects of cow age on supplement intake, variation in supplement intake, and subsequent performance characteristics of beef cows and calves consuming stockpiled forage during the winter.

Material and Methods

Fifty British X Continental cows (average wt = 527.91 kg) were used to determine intake of hand-fed supplements and subsequent effects on performance. The study was conducted at the Eastern Oregon Agricultural Research Center in Union, OR during the 1997 to 1998 and 1998 to 1999 winter periods. Cows were allotted into five groups of ten cows representing the following age groups: 3, 5, 7, 9, and 11-yr cows for yr 1. Using the same cows for yr 2, age groups consisted of: 4, 6, 8, 10, and 12-yr cows. All age groups ran together in common on pastures of stockpiled forage (10.23% CP). Seven pastures had mixed management with prior use ranging from spring to early summer grazing to mid-summer hay harvest. Prior to being grazed, pastures were sampled to determine yield with .25m^2 clipped plots. Assuming cows would consume 2.30% of their avg BW, 12.27 kg hd^{-1} day^{-1}, grazing duration was calculated with a 60% utilization of the total pasture yield. Grazing and supplemental feeding began November

25 (yr 1) and December 2 (yr 2) and continued to mid-April. All treatment groups were group fed a oat/biuret supplement (20% CP) at 1.82 kg hd^{-1} day^{-1}.

Cows were weighed and body condition scored (1-9 scale; Momont and Pruitt, 1993) at the initiation of the study and at several intervals throughout the remainder of the year to determine change in performance. Body condition was recorded using the average of two scores that were measured for each cow. Weight and body condition measures were obtained during the feeding trial at d 35, 57, 70 and 24 h after calving for yr1, and d 28, 56, and 24 h after calving for yr 2. Subsequent measurements were obtained at intervals of breeding (20 to 84 d post-partum; yr 1 only), turn out to summer grazing (73 to 137 and 48 to 106 d post-partum yr 1 and 2, respectively), and at weaning. Weights and body condition scores were taken after a prior 16 h fast with the exception of the calving wt. Calf birth and weaning weights were also recorded to compare calf performance as influenced by dam's previous nutritional management. In yr 2, five cows from each treatment group were randomly selected and dosed with sustained release Cr_2O_3 boluses on d 28 of the trial in yr 2 to estimate fecal output (FO) and forage intake. The remaining five cows of the age groups were fed Cr_2O_3 mixed within the ground oat/biuret (4%) supplement at a rate of 2.22 g/kg to determine supplement intake. Each treatment group was assumed to have a supplement fecal output (FO_S) of .39 kg based on the known amount of supplement fed, supplement digestibility, and equations by Kartchner, (1981). Supplement fecal output was subtracted from total fecal output (FO_T) to determine forage fecal output (FO_F). Average FO_F of each age group was then applied to the corresponding age groups of the non-bolused cows to determine individual supplement intake (Kartchner, 1981).

Fecal grab samples were collected on d 38 to 44 and were dried in a forced-air oven (60°C), ground through a 1 mm screen, and analyzed for DM (AOAC, 1995), and Cr by atomic absorption spectrophotometry (Williams et al., 1962). Extrusa samples were collected on d 42 using four ruminally cannulated crossbred steers and were dried and ground to determine DM, Ash, CP (AOAC, 1995), NDF, ADF (Goering and Van Soest, 1970), and digestibility. Digestibility was estimated using TDN converted from the ADF of the basal diets. Digestibility was estimated also using a modified technique of IVDMD (Tilly and Terry, 1963).

Validation of the marker release rate was determined by administering Cr_2O_3 boluses to the four ruminally cannulated steers. Steers were fitted with fecal bags to determine actual FO. Three to five fecal grab samples were collected from each steer from d 49 to 55 and analyzed for Cr concentration to estimate FO. The actual FO avg was 3.09 kg. Estimated FO avg was 3.53 kg which overestimated the FO of the cows by 14.24%.

Data was analyzed by least squares ANOVA using the GLM procedure of SAS (1996) and individual animal as the experimental unit. Cow initial weight and condition score was included as a covariate in the model. Weight and condition score data were analyzed over time using repeated measures ANOVA. When time was significant, means were separated with LSD tests. Least square means and P-values are reported. Cr bolused cows were eliminated from the data set if Cr concentrations were outside a 95% confidence interval.

Results and Discussion

Forage of the seven pastures would be considered marginal quality that meets the CP requirement of mature gestating cows (7.8%; NRC, 1984) from the initiation of the study until calving yet, is deficient for lactating cows (11.9%; NRC, 1984) after calving. Forage is also deficient in meeting TDN requirements (53.2 and 65.2%; NRC, 1984) for gestating and lactating cows, respectively (Table 1).

During yr 1, weight change varied (P < .10) over time during the feeding trial yet, no time-treatment interaction was displayed. Weight change at d 35 of the feeding trial did not differ (P > .10) among the five age groups. Weight change at d 57 for 11-yr cows was 11.14 kg greater (P < .10) than 5-yr cows. However, weight change at d 57 did not differ (P > .10) among age 9-yrs and younger. Weight change at d 70 and calving did not differ (P > .10) among the age groups (Table 2).

Table 1. Chemical composition of stockpiled forage and oat supplement (year 2)[a]

Item, %	Stockpiled Forage	Oats
CP	10.23	10.29
ADF	45.05	16.80
NDF	71.14	34.69
Ash	.18	-
TDN	51.18	75.63

[a]Values expressed on a DM basis

Following the feeding trial, weight change at breeding (20 to 84 d post-partum) for 3-yr cows was greater (P<.10) than 5, 7, 9, and 11-yr cows. However, weight change at breeding did not differ (P > .10) among ages 5-yrs and older. Weight change at turn out (73 to 137 d post-partum) of 3-yr cows was greater (P < .10) than 5, 7, 9, and 11-yr cows. However, weight change at turn out did not differ (P > .10) among ages 5-yrs and older.

Table 2. Influence of age on hand-fed beef cow weight and body condition change throughout production cycle (Year 1)

Item	Age, years					SE[a]
	3	5	7	9	11	
Initial						
Wt, kg	449.23[d]	513.64[c]	552.41[b]	573.36[b]	571.73[b]	12.60
Condition, 1-9	4.23[c]	4.28[bc]	4.50[bc]	4.73[b]	4.65[b]	.11
Day 35						
Wt change, kg	48.82[b]	44.59[b]	49.09[b]	53.36[b]	50.45[b]	3.65
Cond change, 1-9	0.13[c]	-0.05[b]	0.13[c]	0.15[c]	0.15[c]	.06
Day 57						
Wt change, kg	57.18[bc]	51.5[b]	55.36[bc]	61.23[bc]	62.64[c]	3.93
Day 70						
Wt change, kg	45.68[b]	41.48[b]	45.09[b]	47.95[b]	41.26[b]	4.93
Cond change, 1-9	-.08[b]	-.13[b]	0[bc]	0.05[bc]	0.14[c]	.09
Calving						
Wt change, kg	26.00[b]	-1.00[b]	7.89[b]	18.40[b]	1.70[b]	19.18
Cond change, 1-9	-.03[bc]	-.25[b]	-.10[bc]	-.03[bc]	.13[c]	.12
Breeding(20-84 d post-partum)						
Wt change, kg	-16.64[b]	-36.73[c]	-45.91[c]	-36.91[c]	-38.77[c]	6.14
Cond change, 1-9	-.23[b]	-.30[b]	-.15[b]	-.28[b]	.13[b]	.11
Turn Out (73-137 d post-partum)						
Wt change, kg	46.36[b]	-1.87[c]	-9.43[c]	-8.99[c]	-14.20[c]	8.30
Cond change, 1-9	.67[b]	.38[b]	.29[b]	.44[b]	.21[b]	.16
Weaning						
Wt change, kg	67.88[b]	61.87[bc]	54.49[bc]	42.25[cd]	33.54[d]	7.40
Cond change, 1-9	.39[b]	.39[b]	.56[b]	.61[b]	.56[b]	.12
Calf						
Birth wt, kg	38.32[c]	40.00[bc]	41.45[bc]	42.27[b]	39.45[bc]	1.32
Weaning wt, kg	197.77[d]	263.86[b]	280.14[b]	260.41[b]	232.82[c]	9.11
Calving %	90	90	90	90	90	-

[a]Pooled standard error with n=10

[b,c,d]Means within a row lacking a common superscript differ (P<.10)

Weight change at weaning did not differ (P > .10) among 3, 5, and 7-yr cows yet, the 3 and 5-yr cows were greater (P < .10) than the 9 and 11-yr cows (Table 2).

Body condition change during the feeding trial also varied (P < .10) over time yet, with no time-age interaction. Body condition change at d 35 for 5-yr cows was .18, .18, .20, and .20 points less (P < .10) than 3, 7, 9, and 11-yr cows, respectively. Body condition change did not differ (P > .10) among the other ages. Body condition at d 70 for 11-yr cows was .22 and .28 points greater (P < .10) than 3 and 5-yr cows. Body condition change did not differ (P > .10) among the other age groups. Body condition changes at calving for 5-yr cows were .38 points less than 11-yr cows. Body condition change at calving did not differ (P > .10) among the other ages. Following the feeding trial, BC did not differ (P > .10) among ages at breeding, turnout, and weaning (Table 2). With the exception of one treatment difference, age did not appear to be influential in weight change during winter feeding. Weight changes of all age treatments changed over time yet, appeared to parallel each other in their patterns. Significant differences in weight change that occurred following winter feeding was not influenced by age due to irregular patterns among the age group comparisons.

Calf birth weight of 9-yr cows was 3.95 kg greater (P < .10) than calves of 3-yr cows yet, calf birth weight did not differ (P > .10) among calves of 7, 5, and 11-yr cows. Weaning wt of calves from 3-yr cows was 35.05 kg less (P < .10) than calves of 11-yr cows. Weaning weight did not differ (P > .10) among calves of 5, 7, and 9-yr cows yet, the 5 to 9-yr cows were greater (P < .10) than calves of 3 and 11-yr cows (Table 2).

In yr 2, weight change varied (P < .10) over time during the feeding trial yet, there was no display of a time-age interaction. Weight change at d 28 for 8-yr cows was 21.41, 10, and 9.05 kg less (P < .10) than 4, 6, and 10-yr cows, respectively yet, did not differ (P > .10) when compared to 12-yr cows. Weight change for 4-yr cows was 11.41, 12.37, and 20.09 kg greater (P < .10) than 6, 10, and 12-yr cows, respectively. Weight change did not differ (P > .10) among 6 and 10-yr cows. Weight change at d 56 for 4-yr cows was 17.04, 24.54, 18.91, and 32.22 kg greater (P < .10) than 6, 8, 10, and 12-yr cows, respectively. Weight change for 12-yr cows at d 56 was 15.18 and 13.31 kg less (P < .10) than 6 and 10-yr cows, respectively. Weight change at calving for 4-yr cows was 36.05, 38.52, and 28.97 kg greater (P < .10) than 6, 8, and 12-yr cows, respectively yet, did not differ (P > .10) when compared to 10-yr cows. Similarly, there was no difference (P > .10) in weight change at calving among ages 6-yrs and older (Table 3).

Following the feeding trial in yr 2, weight change at turn out (48 to 106 d post-partum) for 4-yr cows was greater (P < .10) than 8, 10, 12-yr cows yet, did not differ (P >.10) when compared to 6-yr cows. Weight change at turn out for 6-yr cows was also greater (P < .10) than 8 and 10-yr cows yet, did not differ (P > .10) when compared to 12-yr cows. Similarly, there was no difference (P > .10) in weight change at turn out among ages of 8-yrs and older. Weight change at weaning of 12-yr cows was less (P <. 10) than 8, 6, and 4-yr cows yet, did not differ (P > .10) when compared to 10-yr cows. Similarly, there was no difference (P > .10) in weight change at weaning among cows 8-yrs and younger (Table 3).In yr 2, BC change during the feeding trial varied (P < .10) over time with no time-age interaction. Body condition change at d 28 for 8-yr cows was .33 points greater (P < .10) than 12-yr cows. However, BC change did not differ (P > .10) among the remaining age groups. At d 56, BC change for 12-yr cows was .70, .78, .67, and .65 points lower (P < .10) than 4, 6, 8, and 10-yr cows, respectively. However, BC change

Table 3. Influence of age on hand-fed beef cow weight and body condition change throughout production cycle (Year 2)

Item	Age, years					SE[a]
	4	6	8	10	12	
Initial						
Wt, kg	506.95^{d}	569.45^{c}	617.00^{b}	612.27^{b}	599.32^{bc}	14.27
Cond change, 1-9	4.43^{d}	4.58^{cd}	4.93^{bc}	5.15^{b}	5.18^{b}	.18
Day 28						
Wt change, kg	23.41^{d}	12.00^{c}	2.00^{b}	11.05^{c}	3.32^{b}	2.84
Cond change, 1-9	.05^{bc}	.05^{bc}	.20^{c}	.03^{bc}	-.13^{b}	.10
Day 56						
Wt change, kg	16.27^{d}	-.77^{c}	-8.27^{bc}	-2.64^{c}	-15.95^{b}	4.63
Cond change, 1-9	-.05^{c}	.03^{c}	-.08^{c}	-.10^{c}	-.75^{b}	.20
Calving						
Wt change, kg	-36.18^{c}	-72.23^{b}	-74.70^{b}	-52.59^{bc}	-65.15^{b}	11.33
Cond change, 1-9	-.48^{c}	-.68^{bc}	-.68^{bc}	-.55^{bc}	-.93^{b}	.16
Turn-out (48-106 d post-partum)						
Wt change, kg	-29.70^{d}	-48.98^{cd}	-76.25^{b}	-76.48^{b}	-72.01^{bc}	10.03
Cond change, 1-9	-.21^{d}	-.28^{cd}	-.59^{bc}	-.81^{b}	-.64^{bc}	.19
Weaning						
Wt change, kg	10.96^{bc}	2.16^{c}	-22.55^{c}	-23.52^{bc}	-54.66^{b}	13.62
Cond change, 1-9	.13^{d}	.13^{d}	-.05^{cd}	-.41^{bc}	-.53^{b}	.17
Calf						
Birth wt, kg	38.55^{c}	42.95^{b}	41.98^{b}	41.55^{bc}	42.55^{b}	1.62
Weaning wt, kg	234.01^{c}	252.27^{c}	278.11^{b}	-	230.17^{c}	9.68

[a]Pooled standard error with n=10

[b,c,d]Means within a row lacking a common superscript differ ($P < .10$)

did not differ ($P > .10$) among cows 10-yrs and younger. For 4-yr cows, BC change at calving was .45 points greater ($P < .10$) than 12-yr cows, yet there was difference ($P > .10$) when compared to 6, 8, and 10-yr cows. Likewise, there was no difference ($P > .10$) in BC change at calving among 6, 8, and 10-yr cows (Table 3).

Following the feeding trial, BC change at turn out for 4-yr cows was greater (P < .10) than 8, 10, and 13-yr cows. Body condition change at turn out for 6-yr cows was .53 points greater (P < .10) than 10-yr cows. There was no difference (P > .10) among 6, 8, and 12-yr cows and 8, 10, and 12-yr cows. Body condition change at weaning for 12-yr cows was .48, .66, and .66 points less (P < .10) than 8, 6, and 4-yr cows, respectively. Likewise, BC change at weaning for 10-yr cows was .54 points less (P < .10) than both 6 and 4-yr cows. There was no difference (P > .10) among cows 4, 6, and 8-yrs old (Table 3).

Year 2 displayed age group differences more frequently than the previous year, particularly during winter feeding. The younger age groups, 4 and 6-yr cows, displayed the greatest change in weight with the 4-yr cows consistently having the greatest weight changes and 6-yr cows frequently being greater than the older age groups. Following winter feeding, weight changes were similar to the results of yr 1 by displaying more variability and less of an influence by cow age.

Calf birth weight of 4-yr cows was 4.4, 3.43, and 4.00 kg less (P < .10) than 6, 8, and 12-yr cows, respectively yet, there was no difference (P > .10) between birth weight of calves of 4 and 10-yr cows. Likewise, there was no difference (P >.10) among cows 6-yrs and older. Calf weaning weight for 8-yr cows was 44.10, 25.84, and 47.94 kg greater (P < .10) than 4, 6, and 12-yr cows, respectively. There was no difference (P > .10) in calf weaning weight among 4, 6, and 12-yr cows (Table 3).

Although limited research data is available, cow age did not display differences in weight and body condition change in a study conducted by Daniels et al. (1998). The authors reported similar results to this study with initial weight and body condition being the lowest for younger, 2-yr-old cows and increasing with cow age.

Forage intake of 10-yr cows was greater ($P < .10$) than 8 and 4-yr cows yet, there was no difference ($P > .10$) among 10, 12, and 6-yr cows. Likewise, there was no difference ($P > .10$) in forage intake among 4, 6, 8, and 12-yr cows (Table 4). Variation of forage intake was greatest for 8 and 10-yr cows based upon their CV values (Table 4). Supplement intake of 4 year old cows was .47, .70, and .84 kg greater ($P<.10$) than 10, 12, and 8 year old cows respectively yet, did not differ ($P>.10$) when compared to 6 year old cows. Supplement intake of 6 year old cows was .42 and .56 kg higher ($P<.10$) than 12 and 8 year old cows respectively yet, did not differ ($P>.10$) when compared to 10 year

Table 4. Influence of cow age on daily forage and supplement intake of hand-fed supplement, %BW, %BW$^{.75}$, and fecal chromium concentration

	Age, years					
Item	4	6	8	10	12	SE
Forage intake, kg	7.08^{d}	8.31^{cd}	7.77^{d}	12.38^{c}	8.44^{cd}	1.47^{a}
CV	22.03	27.00	46.95	44.55	13.70	-
Supplement intake, kg	1.58^{c}	1.30^{cd}	.74^{e}	1.11^{de}	.88^{e}	0.14^{b}
CV	32.43	39.12	13.78	13.64	27.3	-
%BW	.13^{c}	.11^{cd}	.05^{e}	.08de	.07de	0.01^{b}
CV	54.21	44.46	16.43	23.87	27.25	-
%BW$^{.75}$	.75^{c}	.62^{cd}	.33^{e}	.49de	.41de	0.08^{b}
CV	50.82	43.03	15.67	21.04	27.26	-
Fecal Cr concentration^{f}	372.83^{cd}	370.89^{cd}	296.00^{de}	385.53^{c}	256.08^{e}	32.31^{b}
CV	32.43	28.58	13.78	13.64	15.97	-

[a]Standard error with n=3,4 and 6 year olds; n=4, 8-12 year olds

[b]Standard error with n=5

[c,d,e]Means within same row with different superscripts differ ($P<.10$)

[f]Concentrations of non-bolused cows

old cows. Likewise, there was difference ($P > .10$) in supplement intake among cows 8 years and older (Table 4). Based on their CV values, variation of supplement intake was greatest for 4 and 6-yr cows (Table 4). Data from Daniels et al., (1998) displayed that older 5 and 6-yr cows consumed greater amounts of forage than 2, 3, and 4-yr cows when supplemented with a self-fed protein supplement. Additional observations displayed greater supplement intakes for the older 5 and 6-yr cows when compared to 2, 3 and 4-yr cows.

Supplement intake, expressed on a body weight basis (%BW), for 4-yr cows was 160.00, 62.50, and 85.71% greater ($P < .10$) than 8, 10, and 12-yr cows, respectively yet, did not differ ($P > .10$) when compared to 6-yr cows. Percentage of BW for 6-yr old cows was 120.00% greater ($P < .10$) than 8-yr cows yet, did not differ ($P > .10$) when compared to 10 and 12-yr cows. Likewise, there was no difference ($P > .10$) in %BW among cows 8-yrs and older (Table 4). Similarly, 4 and 6-yr cows displayed the greatest amount of variation in %BW based upon their CV values (Table 4). Different results from Daniels et al. (1998) reported that cow age did not affect DMI levels when expressed on a body weight basis.

Supplement intake, expressed on a metabolic body weight basis (%$BW^{.75}$), for 4-yr cows was 127.00, 53.00, and 82.92% ($P < .10$) greater than 8, 10, and 12-yr cows, respectively yet, did not differ ($P > .10$) when compared to 6-yr cows. Percentage $BW^{.75}$ for 6-yr cows was 87.88% greater ($P < .10$) than 8-yr cows yet, did not differ ($P > .10$) when compared to 10 and 12-yr cows. Likewise, there was no difference ($P > .10$) in %$BW^{.75}$ among cows 8-yrs and older (Table 4). Variation was again greatest for 4 and 6-yr cows' %$BW^{.75}$ (Table 4).

Fecal Cr concentrations of the non-bolused 10-yr cows were greater ($P < .10$) than non-bolused 8 and 12-yr cows yet, did not differ ($P > .10$) when compared to non-bolused 4 and 6-yr cows. Likewise, there was no difference ($P > .10$) in fecal Cr concentration among 4, 6, and 8-yr cows and when comparing among 8 and 12-yr cows. The variation of Cr concentration, based upon their CV values, was greatest for 4 and 6-yr cows. This follows the same pattern of variability as displayed by supplement intakes (Table 4). Variability of supplement intake appears to be explained by animal and(or) by the delivery in a hand-fed method (Bowman and Sowell, 1997). The variability of the forage intake appears to be explained by inherit variability of the Cr_20_3 boluses.

Although there is limited data available, the greater forage and supplement intakes of younger aged cows are contrary to data of Daniels et al (1998). However, the latter study reported data concerning consumption of self-fed supplements, which allow for greater trough space and fewer non-feeders. The greater consumption of the younger cows could also be explained by biological differences that occur between fat and protein deposition. Younger, faster growing cattle acquire most of their weight in the form of protein whereas weight gain of older cattle is typically explained by fat deposition. A younger animal, in the growth stage, has a greater caloric requirement to sustain protein turnover and tissue growth.

Implications

Three and four-year-old cows displayed the best response to hand-fed supplementation of stockpiled forages in terms of weight gain and body condition maintenance throughout production stages of years 1 and 2, respectively. Cows 5-years and older did not consistently influence performance throughout both years of the study.

Cow age, based on the dam's winter nutritional management, did not consistently influence calf performance. Cows 6-years and younger consumed the greatest amount of hand-fed supplement while utilizing stockpiled forages during the winter yet, with the greatest amount of variation. Older cows, greater than 6 years, consumed the least amount of supplement with the least variation. The supplement did meet the minimum requirements of the lactating cows and helped maintain performance to prepare for breeding.

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CONCLUSIONS

In the first study we conclude that abstinence from grazing of western Oregon spring forages displayed the best response in terms of stockpiled forage yield yet, had the lowest quality. The implementation of a rotational grazing system significantly reduced the amount of stockpiled forage available for late-summer use. Grazing did not influence the quality of stockpiled forage in a great magnitude and the forage quality was considered low regardless of grazing treatment. Use of these forages would require supplementation to meet the demands of lactating cattle. However, even small increases in CP content are advantageous when low-quality forages are provided as the basal diet. Accumulated precipitation and temperature would be the best parameters to gauge a timing point in order to terminate grazing since producers are likely to utilize spring forage growth.

In the second study, non-lactating cows displayed the best response to self-fed supplementation of low-quality forages in terms of weight and condition score status. Stage of lactation (mid vs late), did not seem to consistently influence response to self-fed protein supplementation with acceptable body weight and condition change over the study period. Self-fed supplement intake was appropriate for meeting cows nutritional requirements, yet displayed a high degree of variability not related to lactation and stage of lactation effects. Calf intake of the self-fed supplements was low and also displayed a high degree of variation.

In the third study, 3 and 4-year-old cows displayed the best response to hand-fed supplementation of stockpiled forages in terms of weight gain and body condition maintenance throughout production stages of years 1 and 2, respectively. Cows 5-years and older did not consistently influence performance throughout both years of the study. Cow age, based on the dam's winter nutritional management, did not consistently influence calf performance. Cows 6-years and younger consumed the highest amount of hand-fed supplement while utilizing stockpiled forages during the winter yet, with the greatest amount of variation. Older cows, greater than 6 years, consumed the least amount of supplement with the least variation. The supplement did meet the minimum requirements of the lactating cows and helped maintain performance to prepare for breeding.

With an improved understanding of what influences dry matter intake and supplement variability, a producer can adjust management accordingly to minimize variation. This, in turn, can ultimately lead to optimal use of low-quality forages. If we can increase intake of low-quality forages, then it could be advantageous stockpile the forage resource through manipulative grazing. No matter what management strategy is implemented, the ultimate goal of the producer is to lower input costs and match cattle requirements to the forage resource.

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APPENDIX

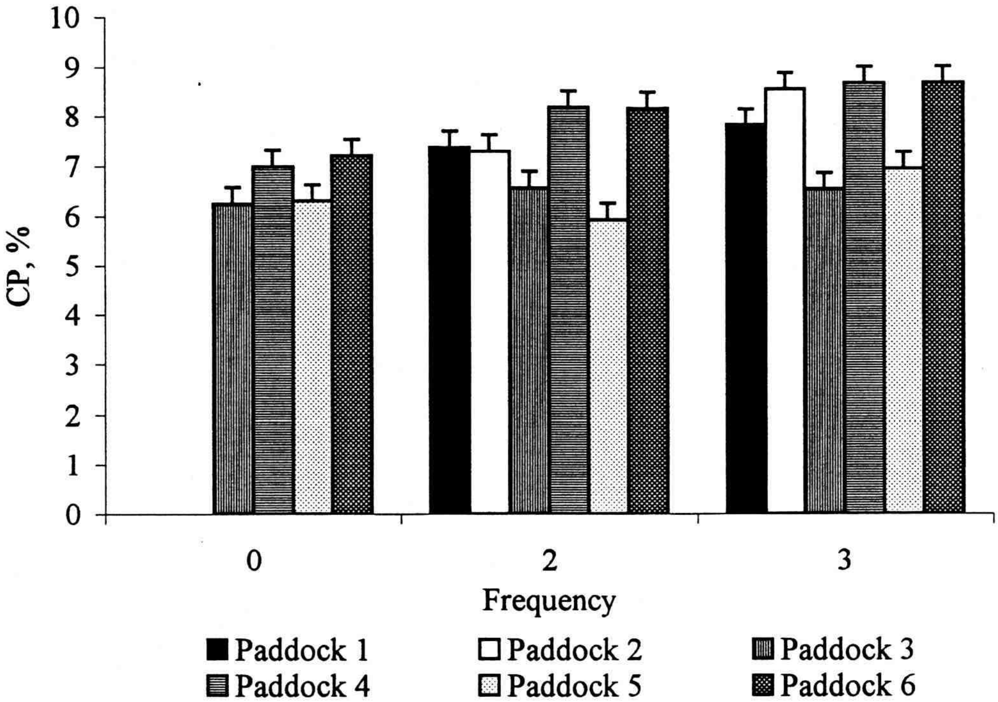

Figure 1. Effects of grazing frequency on crude protein levels of stockpiled forage

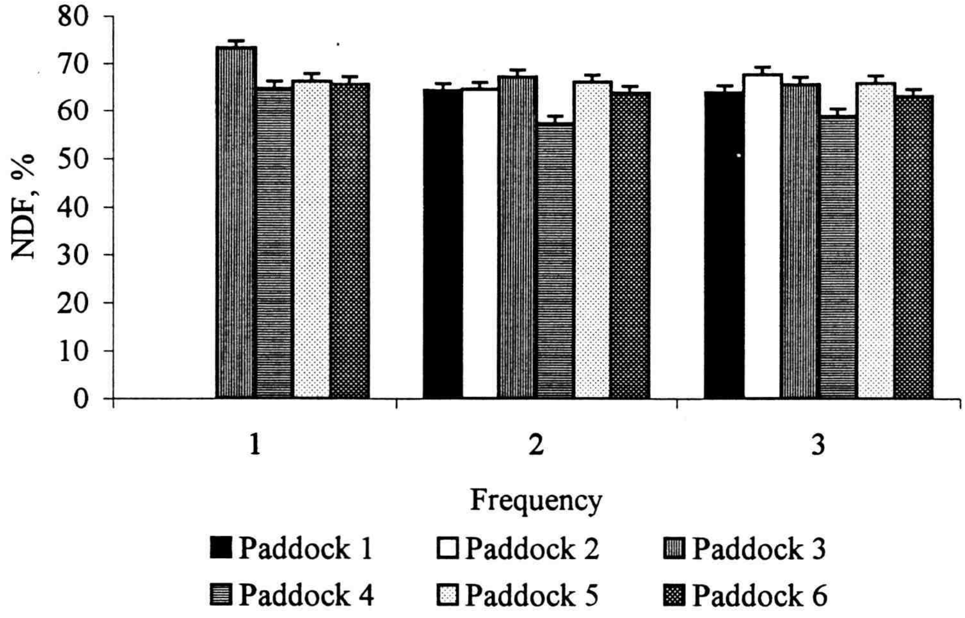

Figure 2. Effects of grazing frequency on neutral detergent fiber levels of stockpiled forage

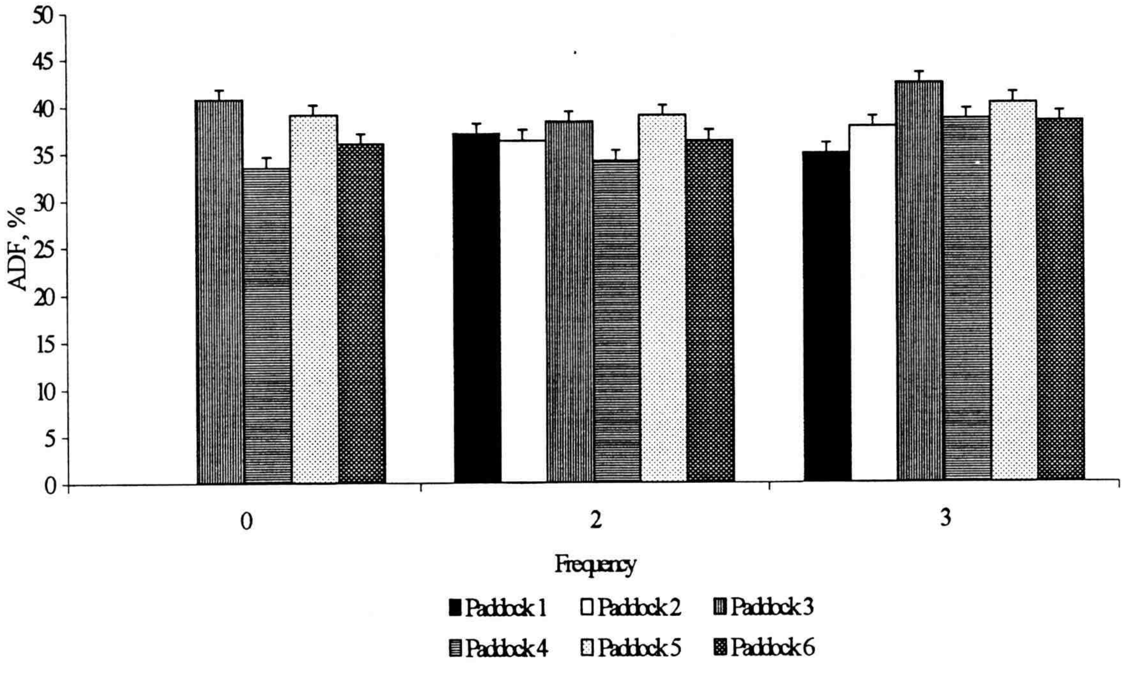

Figure 3. Effects of grazing frequency on acid detergent fiber levels of stockpiled forage

Table 1. Manufacturer's nutrient and ingredient list for self-fed baked molasses supplement

Nutrients

Crude protein	Minimum 18%
Crude fiber	Minimum 3%, maximum 5%
Calcium	Minimum 2.5%, maximum 3.5%
Phosphorus	Minimum 2%
Magnesium	Minimum 2%
Iodine	Minimum .002%
Selenium	Minimum 3mg/lb
Vitamin A	Minimum 50,000 IU/lb
Vitamin B_3	Minimum 30,000 IU/lb
Vitamin E	Minimum 30 IU/lb

Ingredients

Condensed fermented corn extractives, condensed beet molasses by-product, corn molasses, soybean meal, canola meal, animal fat, calcium carbonate, magnesium oxide, phosphoric acid, vitamin A acetate, D-activated sterol (Vit D), α1-alpha tocopherol (Vit E), zinc oxide, manganese oxide, iron carbonate copper sulfate, copper oxide, cobalt carbonate, ethylene diamine dihydrate, sodium selenite

Table 2. Chemical composition and yield of rotationaly grazed spring forage[a]

Paddock	Rotation	CP%	NDF%	ADF%
1	1	20.90	48.67	24.99
2	1	14.90	47.25	25.88
3	1	13.87	47.54	26.91
4	1	15.82	50.79	26.63
5	1	11.56	52.08	28.96
6	1	11.81	50.18	26.97
1	2	13.88	56.46	30.91
2	2	11.33	60.64	34.52
3	2	13.38	59.77	34.35
4	2	11.84	61.83	35.72
5	2	12.85	58.70	32.67
6	2	10.74	55.20	32.38
1	3	11.44	63.60	37.38
2	3	9.45	64.17	39.20
3	3	11.20	62.04	38.06
4	3	12.46	51.27	30.72
5	3	9.04	59.09	34.00
6	3	8.34	61.52	36.71

[a]Forage samples were clipped two days prior to the beginning of grazing of each paddock with .25m^2 areas

Table 3. Yield, DM, and CP harvested from rotationally grazed spring forage[a]

Paddock	Rotation	Yield available, kg/hg	DM harvested, kg/ha	CP harvested, kg/ha
1	1	1840.45	704.09	147.15
2	1	1748.41	202.5	30.17
3	1	1472.28	335.92	46.59
4	1	2560.23	1423.87	225.26
5	1	1773.07	636.71	73.6
6	1	1732.5	596.14	70.4
1	2	3558.3	2421.94	336.17
2	2	4032.95	2896.59	328.18
3	2	2668.52	1532.16	205
4	2	2130.11	993.75	117.66
5	2	1395.69	259.33	33.32
6	2	2209.24	1072.88	115.23
1	3	3708.41	2572.05	294.24
2	3	2401.93	1265.57	119.6
3	3	1963.75	827.39	92.67
4	3	1379.55	243.19	30.3
5	3	1407.84	271.48	24.54
6	3	1444.43	308.07	25.69

[a]Forage samples were clipped two days prior to the beginning of each grazing bout with .25m^2 areas

Table 4. Effect of timing and grazing frequency on quality and yield of stockpiled forage[a]

Paddock	Treatment	Date last grazed	CP, %	NDF, %	ADF, %	Yield, kg/ha
3	0X	14-Apr	6.24	65.62	42.37	8987.05
4	0X	18-Apr	6.98	58.84	38.56	6787.95
5	0X	22-Apr	6.30	65.88	40.27	3915.35
6	0X	26-Apr	7.20	63.01	38.29	5420.58
1	2X	6-May	7.37	64.24	36.97	3826.03
2	2X	10-May	7.29	64.47	36.30	2929.43
3	2X	14-May	6.56	73.23	40.71	2069.10
4	2X	18-May	8.19	64.68	33.46	2389.78
5	2X	22-May	5.92	66.24	39.03	2166.60
6	2X	26-May	8.16	65.59	35.90	2377.63
1	3X	29-May	7.82	63.82	34.92	2353.28
2	3X	3-Jun	8.56	67.76	37.70	2487.15
3	3X	7-Jun	6.53	67.12	38.27	1740.58
4	3X	11-Jun	8.68	57.27	34.13	1651.38
5	3X	15-Jun	6.94	66.06	38.94	1225.35
6	3X	19-Jun	8.70	63.67	36.29	1428.20

[a]Forage samples were clipped on d 122 with .25m^2 areas

Table 5. Influence of lactation and stage of lactation on cow performance[a] (Exp.1)

		Cow weights (lbs)		Cow condition score	
Cow ID #	Treatment[b]	Wt1	Wt2	CS1	CS2
2110	Late-lact	1677	1655	7	6.75
3026	Late-lact	1285	1303	6.25	6.25
3101	Late-lact	1463	1390	6.75	5.25
3171	Late-lact	1320	1292	5.5	5.5
4023	Late-lact	1400	1387	5.75	5.75
4081	Late-lact	1233	1180	5	6
4596	Late-lact	1395	1426	5	5
5110	Late-lact	1415	1394	6.25	5.5
1056	Mid-lact	1375	1405	6.5	6.5
2043	Mid-lact	1455	1440	8	7.5
2056	Mid-lact	1515	1577	7	7
3016	Mid-lact	1137	1133	3	3
3029	Mid-lact	1408	1431	5.25	5
4019	Mid-lact	1355	1373	5.5	5
4084	Mid-lact	1330	1357	4	4
4151	Mid-lact	1200	1273	7	7
33	Non-lact	1435	1521	6.25	7
162	Non-lact	1347	1447	6.25	6.25
1032	Non-lact	1500	1510	7.25	7.25
1085	Non-lact	1590	1606	6.75	6.5
1100	Non-lact	1540	1565	7.25	7.25
1117	Non-lact	1300	1323	6.75	6.75
2002	Non-lact	1314	1380	6	6.5
8185	Non-lact	1418	1461	5	6.5

[a]Beef cow weights and condition scores were determined after 16 h overnight fast on Aug. 5 (Wt1, CS1) and Sept. 23 (Wt2, CS2)
[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) late-lactation weaned (non-lactating cows, calves removed from late-lactating cows just prior to study); and 3) mid-lactation lactating (109 to 131 days post-partum)

Table 6. Influence of lactation and stage of lactation on cow performance[a] (Exp. 2)

		Cow weights		Cow condition scores	
Cow ID #	Treatment	Wt1	Wt2	CS1	CS2
2143	Late-lact	1605	1585	7.5	7
3086	Late-lact	1603	1567	6.5	7
3146	Late-lact	1389	1422	5.75	6.75
4053	Late-lact	1443	1424	7	6
4127	Late-lact	1330	1327	6	6
4154	Late-lact	1317	1330	6.25	6
4175	Late-lact	1510	1512	7	6.25
5164	Late-lact	1346	1321	5.75	4.5
1087	Mid-lact	1685	1680	7.75	7
2051	Mid-lact	1710	1670	5.75	5.5
2085	Mid-lact	1590	1590	7	6.75
3019	Mid-lact	1480	1413	6.25	6
4032	Mid-lact	1140	1210	5.5	5.25
4150	Mid-lact	1360	1315	6.25	5.25
4159	Mid-lact	1142	1169	5	4.75
6107	Mid-lact	1417	1438	5.75	5.25
68	Non-lact	1380	1374	6.75	6.75
1048	Non-lact	1772	1781	7.25	7
1091	Non-lact	1265	1340	7	6.5
1108	Non-lact	1575	1565	5.5	5.5
1158	Non-lact	1238	1352	5.25	5.75
2059	Non-lact	1245	1354	4.75	4.75
2125	Non-lact	1600	1750	7.5	7.75
8188	Non-lact	1395	1450	6.5	6.5

[a]Beef cow weights and condition scores were determined after 16 h overnight fast on Aug. 5 (Wt1, CS1) and Sept. 23 (Wt2, CS2)
[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) late-lactation weaned (non-lactating cows, calves removed from late-lactating cows just prior to study); and 3) mid-lactation lactating (109 to 131 days post-partum)

Table 7. Influence of lactation and stage of lactation on calf performance[a] (Exp. 1)

Calf ID #	Treatment[b]	Calf weights	
		Wt1	Wt2
8011	Late-lact	584	700
8001	Late-lact	575	670
8016	Late-lact	469	569
8025	Late-lact	549	656
8038	Late-lact	532	654
8039	Late-lact	420	453
8042	Late-lact	543	651
8043	Late-lact	411	530
8084	Mid-lact	358	461
8085	Mid-lact	420	524
8086	Mid-lact	305	361
8088	Mid-lact	366	462
8089	Mid-lact	380	490
8091	Mid-lact	333	416
8093	Mid-lact	313	421
8095	Mid-lact	316	407
8003	Weaned	490	525
8018	Weaned	475	562
8021	Weaned	445	475
8024	Weaned	427	472
8030	Weaned	445	484
8033	Weaned	481	506
8036	Weaned	437	485
8040	Weaned	415	471

[a]Calf weights were determined after 16 h overnight fast on Aug. 5 (Wt1) and Sept. 23 (Wt2)
[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) late-lactation weaned (non-lactating cows, calves removed from late-lactating cows just prior to study); and 3) mid-lactation lactating (109 to 131 days post-partum)

Table 8. Influence of lactation and stage of lactation on calf performance[a] (Exp. 2)

		Calf weights	
Calf ID#	Treatment[b]	Wt1	Wt2
8002	Late-lact	490	590
8004	Late-lact	590	688
8005	Late-lact	558	678
8013	Late-lact	523	622
8022	Late-lact	428	519
8028	Late-lact	439	543
8037	Late-lact	360	445
8041	Late-lact	426	538
8076	Mid-lact	385	475
8077	Mid-lact	385	513
8078	Mid-lact	419	532
8079	Mid-lact	420	528
8082	Mid-lact	364	455
8090	Mid-lact	426	538
8092	Mid-lact	365	475
8094	Mid-lact	348	470
8006	Weaned	441	515
8007	Weaned	505	575
8008	Weaned	610	646
8010	Weaned	570	620
8023	Weaned	432	460
8026	Weaned	444	486
8029	Weaned	555	625
8034	Weaned	515	553

[a]Calf weights were determined after 16 h overnight fast on Aug. 5 (Wt1) and Sept. 23 (Wt2)

[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) late-lactation weaned (non-lactating cows, calves removed from late-lactating cows just prior to study); and 3) mid-lactation lactating (109 to 131 days post-partum)

Table 9. Influence of stage of lactation on dam milk production[a] (Exp. 1)

Calf ID #	Treatment[b]	Pre-suckle wt	Post-suckle wt	Milk production (lbs)
8001	Late-lact	661	675	14
8011	Late-lact	662	672	10
8016	Late-lact	548	555	7
8025	Late-lact	616	622	6
8038	Late-lact	603	609	6
8039	Late-lact	491	480	-11
8042	Late-lact	530	530	0
8043	Late-lact	478	494	16
8084	Mid-lact	404	412	8
8085	Mid-lact	484	500	16
8086	Mid-lact	313	327	14
8088	Mid-lact	408	421	13
8089	Mid-lact	429	444	15
8091	Mid-lact	371	383	12
8093	Mid-lact	362	369	7
8095	Mid-lact	369	374	5

[a]Milk production was determined on d 17 with weigh-suckle-weight technique (Williams et al., 1979). Wt1 taken after 8 hour separation of dam and calf. Wt2 taken immediately after 30 min suckling period.

[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) mid-lactation lactating (109 to 131 days post-partum)

Table 10. Influence of stage of lactation on dam milk production[a] (Exp. 2)

Calf ID#	Treatment[b]	Pre-suckle wt	Post-suckle wt	Milk production (lbs)
8002	Late-lact	518	525	7
8004	Late-lact	629	634	5
8005	Late-lact	602	615	13
8013	Late-lact	558	565	7
8022	Late-lact	468	470	2
8028	Late-lact	462	471	9
8037	Late-lact	394	399	5
8041	Late-lact	468	477	9
8076	Mid-lact	408	415	7
8077	Mid-lact	404	415	11
8078	Mid-lact	450	465	15
8079	Mid-lact	443	455	12
8082	Mid-lact	397	400	3
8090	Mid-lact	461	465	4
8092	Mid-lact	394	411	17
8094	Mid-lact	381	396	15

[a]Milk production was determined on d 17 with weigh-suckle-weight technique (Williams et al., 1979). Wt1 taken after 8 hour separation of dam and calf. Wt2 taken immediately after 30 min suckling
[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) mid-lactation lactating (109 to 131 days post-

Table 11. Effects of lactation and stage of lactation on cow forage and self-fed supplement intake[a] (Exp. 1)

Cow ID #	Treatment[b]	Forage intake, kg	Supplement intake, kg
3026	Late-lact	12.80	.52
3101	Late-lact	14.38	.00
3171	Late-lact	14.40	.00
4023	Late-lact	23.13	1.36
4596	Late-lact	15.02	1.42
5110	Late-lact	14.04	.52
1056	Mid-lact	14.60	1.00
2043	Mid-lact	13.51	1.09
2056	Mid-lact	15.90	.77
3016	Mid-lact	17.17	2.02
3029	Mid-lact	40.16	3.36
4084	Mid-lact	17.01	1.21
4151	Mid-lact	14.45	1.18
162	Non-lact	14.05	1.14
1032	Non-lact	14.77	.91
1117	Non-lact	15.57	.76
2002	Non-lact	13.29	.95

[a]Forage and supplement intakes were estimated with the use of a dual marker technique usin Cr_2O_3 boluses and Ytterbium

[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) mid-lactation lactating (109 to 131 days post-partum); 3) Non-lactating

Table 12. Effects of lactation and stage of lactation on cow forage and self-fed supplement intake[a] (Exp. 2)

Sample #	Treatment[b]	Forage intake, kg	Supplement intake, kg
2143	Late-lact	12.29	0.66
3086	Late-lact	14.89	0.16
3146	Late-lact	13.69	0.93
4154	Late-lact	14.91	0.62
4175	Late-lact	13.79	0.70
5164	Late-lact	15.13	0.72
2085	Mid-lact	14.47	0.81
4032	Mid-lact	14.00	0.34
4150	Mid-lact	13.37	0.02
6107	Mid-lact	13.61	0.79
1048	Non-lact	13.94	0.85
1091	Non-lact	13.12	0.002
1108	Non-lact	11.45	0.48
1158	Non-lact	13.22	2.06
8188	Non-lact	14.16	0.77

[a]Forage and supplement intakes were estimated with the use of a dual marker technique usin Cr_2O_3 boluses and Ytterbium

[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) mid-lactation lactating (109 to 131 days post-partum); 3) non-lactating

Table 13. Effects of lactation and stage of lactation on calf forage and self-fed supplement intake[a] (Exp. 1)

Calf ID #	Treatment[b]	Forage intake, kg	Supplement intake, kg
8001	Late-lact	6.23	.01
8011	Late-lact	6.42	.13
8016	Late-lact	5.19	.003
8025	Late-lact	6.03	.003
8038	Late-lact	5.93	.001
8039	Late-lact	4.37	.002
8042	Late-lact	5.97	.001
8043	Late-lact	4.71	.08
8084	Mid-lact	3.07	.003
8085	Mid-lact	3.54	.001
8086	Mid-lact	2.50	.01
8088	Mid-lact	3.11	.001
8089	Mid-lact	3.26	.001
8091	Mid-lact	2.81	.001
8093	Mid-lact	2.75	.06
8095	Mid-lact	2.71	.002

[a]Forage intakes were estimated assuming late-lactation calves consumed 1.0%BW ans mid-lactation consumed .75%BW. Supplement intakes were estimated with Ytterbium.

[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) mid-lactation lactating (109 to 131 days post-partum)

Table 14. Effects of lactation and stage of lactation on calf forage and self-fed supplement intake[a] (Exp. 2)

Calf ID #	Treatment[b]	Forage intake, kg	Supplement intake, kg
8005	Late-lact	6.18	.001
8004	Late-lact	6.39	.003
8002	Late-lact	5.40	.001
8022	Late-lact	4.74	.000
8094	Late-lact	4.09	.000
8028	Late-lact	4.91	.001
8037	Late-lact	4.03	.000
8041	Late-lact	4.82	.001
8013	Mid-lact	4.29	.001
8077	Mid-lact	3.37	.02
8079	Mid-lact	3.56	.001
8082	Mid-lact	3.07	.001
8076	Mid-lact	3.23	.000
8090	Mid-lact	3.62	.001
8078	Mid-lact	3.57	.001
8092	Mid-lact	3.15	.001

[a]Forage intakes were estimated assuming late-lactation calves consumed 1.0%BW ans mid-lactation consumed .75%BW. Supplement intakes were estimated with Ytterbium.

[b]Treatments consisted of: 1) late-lactation lactating (149 to 175 days postpartum); 2) mid-lactation lactating (109 to 131 days post-partum)

Table 15. Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1)[a]

		Initial, Nov. 25		Dec. 30	
Cow ID #	Age	Wt	BC	Wt	BC
5011	3	973	4.25	1073	4.25
5019	3	-	-	-	-
5027	3	978	4	1039	4
5121	3	1032	4.5	1142	5
5132	3	936	4	1033	4.25
5162	3	1074	4.25	1205	4.5
5180	3	974	4	1086	4
5189	3	1030	4.5	1132	4.25
5223	3	971	4.25	1085	4.5
5226	3	912	4	1041	4
5240	3	1003	4.5	1121	4.75
3001	5	1181	4.75	1279	4.75
3007	5	1280	4.75	1398	4.75
3025	5	1026	4	1143	4
3041	5	1096	4	1187	4
3080	5	1043	4	1137	4
3091	5	-	-	-	-
3123	5	1204	4.25	1321	4
3125	5	1053	4	1147	4
3151	5	1136	4.5	1183	4.25
3154	5	1290	4.5	1406	4.5
3191	5	991	4	1080	4
1062	7	1253	5.5	1359	5.5
1063	7	1210	4.5	1267	4.25
1066	7	1287	4	1455	4.25
1067	7	1242	4	1380	4.5
1073	7	-	-	-	-
1075	7	1168	4	1301	4.25
1116	7	1310	4	1473	4.5
1159	7	-	-	-	-
1167	7	1017	4.5	1077	4.5
1172	7	1143	5	1223	5
1176	7	1277	4.75	1393	5
1190	7	1246	4.75	1313	4.5

[a]Beef cow weights and body condition were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1)[a]

		Jan. 21	Pre-calving, Feb.03	
Cow ID #	Age	Wt	Wt	BC
5011	3	1076	1059	4
5019	3	-	-	-
5027	3	1090	1067	4
5121	3	1128	1109	4.5
5132	3	1044	1030	4.25
5162	3	1212	1164	4
5180	3	1140	1102	4
5189	3	1151	1112	4.25
5223	3	1084	1069	4
5226	3	1081	1059	4
5240	3	1135	1117	4.5
3001	5	1296	1268	4.25
3007	5	1398	1354	4.5
3025	5	1154	-	-
3041	5	1208	1192	4.25
3080	5	1168	1159	4
3091	5	-	-	-
3123	5	1318	1339	4
3125	5	1161	1104	4
3151	5	1231	1194	4.25
3154	5	1406	1403	4.5
3191	5	1093	-	-
1062	7	1362	1317	5.25
1063	7	1276	-	-
1066	7	1469	1436	4.25
1067	7	1398	-	-
1073	7	-	-	-
1075	7	1352	1308	4.58
1116	7	1487	-	-
1159	7	-	-	-
1167	7	1092	-	-
1172	7	1233	-	-
1176	7	1363	1356	4.5
1190	7	1339	1310	4.5

[a]Beef cows weights and body condition were determined after a 16 j overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1=extremely emaciated, 9=extremely obese)

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1) [a]

		Calving[b]				Pre-breeding, Apr. 20	
Cow ID #	Age	Calving date	Wt	BC	Calf wt	Wt	BC
5011	3	7-Feb	1002	4.5	83	922	4.25
5019	3	-	-	-	-	-	-
5027	3	27-Mar	1012	4	94	991	4.25
5121	3	11-Feb	969	4	99	955	4.25
5132	3	18-Mar	915	3.5	73	889	3.75
5162	3	5-Mar	1138	4.5	80	1053	4
5180	3	13-Mar	-	-	81	907	3.5
5189	3	5-Mar	1064	4.5	87	1010	4
5223	3	11-Mar	1011	4	95	899	3.75
5226	3	20-Mar	1022	4.5	74	955	4.25
5240	3	10-Feb	1010	4.5	77	936	4
3001	5	25-Feb	1236	4.5	89	1095	4.25
3007	5	6-Feb	1260	4	92	1158	4.5
3025	5	30-Jan	1043	4	88	905	3.25
3041	5	5-Feb	1135	4.25	85	1011	4
3080	5	30-Mar	1032	4	107	1035	3.75
3091	5	-	-	-	-	-	-
3123	5	19-Feb	1265	4	71	1165	4.25
3125	5	11-Feb	880	2.5	79	898	2.75
3151	5	11-Feb	1095	4.5	102	1021	4.5
3154	5	27-Mar	1336	4.5	88	1283	4.5
3191	5	2-Feb	1008	4	79	921	4
1062	7	27-Mar	-	5	76	1124	5
1063	7	2-Feb	1198	4	93	1061	4
1066	7	14-Feb	1399	4	99	1181	3.75
1067	7	2-Feb	1325	4.25	86	1194	4
1073	7	-	-	-	-	-	-
1075	7	5-Feb	1218	4.5	85	1132	4.25
1116	7	26-Jan	1373	4	94	1227	4
1159	7	-	-	-	-	-	-
1167	7	3-Feb	938	4.25	96	916	4.25
1172	7	30-Jan	1100	5	81	1011	4.75
1176	7	17-Mar	1245	4.5	93	1196	5
1190	7	4-Feb	1175	4.5	109	1101	4.5

[a]Beef cow weights and body condition were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)
[b]Calf weights were recorded within 24 h after calving

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1) [a]

		Turn-out, June 12		Weaning, Oct. 16-18		
Cow ID #	Age	Wt	BC	Wt	BC	Calf weaning wt
5011	3	-	-	-	-	-
5019	3	847	4.5	897	4.5	447
5027	3	1112	4.5	1112	4.25	503
5121	3	1103	5.5	1182	5.25	484
5132	3	1037	4.5	1119	4.75	402
5162	3	-	-	1265	4.75	458
5180	3	-	-	1127	4.5	480
5189	3	-	-	1167	4.75	364
5223	3	-	-	1091	4.25	407
5226	3	-	-	1058	4.25	336
5240	3	-	-	1133	4.75	470
3001	5	1187	5	1311	4.5	619
3007	5	1251	5.5	1396	5.25	593
3025	5	995	3.5	1194	4.5	597
3041	5	1115	4.5	1259	4.75	620
3080	5	-	-	-	-	-
3091	5	1180	5	1280	4.5	588
3123	5	1256	4.5	1430	5	613
3125	5	1006	4	1219	4.5	464
3151	5	1101	5	1198	4.75	592
3154	5	1357	5	1361	4.25	550
3191	5	952	5	1114	4.75	569
1062	7	1243	6	1363	5.5	441
1063	7	1129	4.5	1297	5	702
1066	7	1295	3.5	1423	4.25	649
1067	7	1288	4.5	1447	5	671
1073	7	1213	5	1408	5	626
1075	7	1193	4.5	1290	4.5	700
1116	7	1268	4.5	1516	5.25	688
1159	7	1404	5.5	1524	5	607
1167	7	-	-	-	-	-
1172	7	1074	5	1192	5.75	512
1176	7	1234	5.5	1321	5	567
1190	7	-	-	-	-	-

[a]Beef cow weights and body conditions were determined after a 16 h overnight fast. Beef cow body condition was determined using a 9-point scale (1=extremely emaciated, 9=extremely obese)

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1) [a]

		Initial, Nov. 25		Dec. 30	
Cow ID #	Age	Wt	BC	Wt	BC
9049	9	1150	4.5	1283	4.5
9073	9	1093	4.5	1223	4.5
9078	9	1257	4.75	1339	4.75
9116	9	1377	5.25	1471	5.5
9128	9	1276	4.75	1358	5
9132	9	-	-	-	-
9136	9	1258	4.75	1371	5
9146	9	1513	5.25	1628	5.5
9153	9	1250	4.5	1365	4.75
9189	9	1370	4.75	1543	5
7082	11	1305	4.25	1419	4.25
7130	11	1258	4.25	1381	4.25
7132	11	1147	4.5	1265	4.75
7140	11	1300	5	1414	5
7151	11	1240	5	1360	5
7158	11	1355	5	1459	5
7177	11	1305	4.75	1392	5
7200	11	1185	4.5	1280	5
6061	11	1245	5	1386	5
6153	11	1238	4.5	1332	5
6160	11	-	-	-	-
6161	11	-	-	-	-

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1) [a]

		Jan. 21	Pre-Calving, Feb. 03	
Cow ID #	Age	Wt	Wt	BC
9073	9	1271	1230	4.25
9078	9	1416	1353	4.5
9116	9	1503	1463	5.25
9128	9	1371	1323	4.75
9132	9	-	-	-
9136	9	1382	1408	5.25
9146	9	1604	1591	5.25
9153	9	1364	1360	4.75
9189	9	1547	1496	5
7082	11	1408	1409	4.25
7130	11	1384	-	-
7132	11	1297	1257	5
7140	11	1435	1382	5
7151	11	1368	1291	4.75
7158	11	1524	1460	5.25
7177	11	1423	1399	4.75
7200	11	1327	1260	4.75
6061	11	1424	1377	5.25
6153	11	1366	1302	4.75
6160	11	-	-	-
6161	11	-	-	-

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1) [a]

		Calving[b]				Pre-breeding, Apr. 20	
Cow ID #	Age	Calving date	Wt	BC	Calf wt	Wt	BC
9049	9	21-Feb	1252	5	85	1112	4.25
9073	9	24-Feb	1143	4	90	1016	3.25
9078	9	11-Mar	1285	5	91	1197	4.75
9116	9	9-Feb	1350	5.5	96	1277	5.75
9128	9	23-Feb	1238	4.5	95	1147	4.25
9132	9	-	-	-	-	-	-
9136	9	5-Mar	1270	4.5	112	1202	4.75
9146	9	6-Feb	1465	5	105	1382	4.75
9153	9	10-Mar	1231	4.5	83	1122	4.5
9189	9	4-Mar	1424	5	98	1305	4.5
7082	11	6-Feb	1313	4	87	1199	3.5
7130	11	3-Feb	1220	4	81	1147	4
7132	11	16-Mar	1187	5	85	1134	4.75
7140	11	6-Feb	1245	5	92	1183	5
7151	11	4-Feb	1144	5	91	1123	5
7158	11	10-Mar	1395	5	98	1298	4.75
7177	11	21-Feb	1354	5	88	1253	4.75
7200	11	31-Mar	1160	5	85	1090	4.25
6061	11	4-Mar	1325	5	82	1222	5
6153	11	20-Feb	1252	5	79	1076	4.5
6160	11	-	-	-	-	-	-
6161	11	-	-	-	-	-	-

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9
[b]Calf weights were recorded within 24 h after calving

Table 15 (continued). Effects of cow age on hand-fed supplement cow weight and condition change, and calf performance (Year 1) [a]

		Turn out, June 12		Weaning, Oct. 16-18		Calf
Cow ID	Age	Wt	BC	Wt	BC	weaning wt
9049	9	-	-	-	-	-
9073	9	1063	3.5	1171	4.75	632
9078	9	1304	5.5	1405	5.5	580
9116	9	1315	6	1428	6	501
9128	9	1140	4.5	1287	4.75	523
9132	9	1336	5.5	1336	5.5	576
9136	9	1237	5	1368	5.25	581
9146	9	1462	6.5	1565	6.5	641
9153	9	1195	5.5	1356	5.5	476
9189	9	1407	5	1524	5.25	634
7082	11	-	-	-	-	-
7130	11	1230	4	1307	5	658
7132	11	1163	5	1279	5.25	455
7140	11	1244	5	1363	5	417
7151	11	1156	5	1315	6	463
7158	11	1350	5.5	1453	5.5	531
7177	11	-	-	-	-	-
7200	11	1191	4.5	1299	5	503
6061	11	1280	5.5	1364	6	466
6153	11	1104	5	1252	5	559
6160	11	1287	4.5	1450	4.5	452
6161	11	1230	4	1350	4.75	618

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)

Table 16. Effects of cow age on hand-supplment cow weight and body condition change, and calf performance (Year 2)[a]

		Initial, Dec. 20		Dec. 30		Pre-calving, Jan. 27	
Cow ID #	Age	Wt	BC	Wt	BC	Wt	BC
5019	4	894	4.5	942	4.75	923	4
5027	4	1066	4.25	1151	4.25	1146	4.5
5121	4	1168	5.5	1202	5	1180	4.75
5132	4	1328	4.75	1328	5	1301	4.5
5162	4	1278	4.5	1322	4.75	1289	4.75
5180	4	1089	4.5	1150	4.5	1140	4.5
5189	4	1134	4.25	1187	4.25	1150	4.25
5223	4	1083	4	1152	4.5	1157	4.25
5226	4	1003	3.5	1089	3.5	1121	3.75
5240	4	1110	4.5	1145	4.25	1104	4.5
3001	6	1288	4.25	1323	4.75	1283	4.5
3007	6	1374	5.5	1393	5.25	1345	5.25
3025	6	1167	4.25	1201	4.5	1170	4.5
3041	6	1253	4.75	1286	5	1269	5
3091	6	1245	4.25	1239	4	1216	4.25
3123	6	1398	5	1431	4.75	1390	5
3125	6	1186	4.5	1216	4.5	1140	4.25
3151	6	1197	5.25	1224	4.75	1207	4.25
3154	6	1349	4	1383	4	1375	4.25
3191	6	1071	4	1096	4.75	1116	4.75
1062	8	1320	5.75	1325	5.75	1268	5.25
1063	8	1277	4.5	1266	4.75	1280	4.5
1066	8	1403	4.5	1426	5	1408	5
1067	8	1386	5	1381	5	1368	5
1073	8	1400	5	1397	5	1381	4
1075	8	1305	4.25	1293	4.5	1284	4.5
1116	8	1489	5	1517	5.25	1480	5.25
1159	8	1486	5	1487	5	1440	5
1172	8	1196	5	1216	5.5	1173	5.25
1176	8	1312	5.25	1310	5.5	1310	4.75

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)

Table 16 (continued). Effects of cow age on hand-supplement cow weight and body condition change, and calf performance (Year 2)[a]

		Calving[b]				Turn-out, June 14	
Cow ID	Age	Calving date	Wt	BC	Calf wt	Wt	BC
5019	4	4-Mar	833	3.5	66	-	-
5027	4	24-Mar	1090	4	90	1135	4
5121	4	15-Feb	900	4	94	1109	4.75
5132	4	2-Feb	1200	4.5	65	1017	4.25
5162	4	11-Feb	1086	4	94	1205	4.5
5180	4	11-Mar	1086	4	101	1031	4
5189	4	11-Mar	1085	4	90	-	-
5223	4	22-Mar	1058	4	78	1123	4.5
5226	4	8-Feb	989	3.5	83	-	-
5240	4	2-Mar	1030	4	87	-	-
3001	6	23-Feb	1063	4	107	1218	4
3007	6	8-Feb	1227	5	100	1215	4.5
3025	6	6-Feb	1052	3.5	84	-	-
3041	6	11-Feb	1035	4	104	1096	4
3091	6	1-Feb	1075	4.5	89	1157	4.5
3123	6	10-Mar	1138	3	113	-	-
3125	6	5-Mar	1019	3	82	1048	4.25
3151	6	9-Feb	969	4	91	1082	4.5
3154	6	11-Mar	1346	4	87	1285	4.5
3191	6	9-Mar	1015	4	88	1000	4.25
1062	8	31-Mar	-	4.5	108	1073	-
1063	8	8-Feb	1122	4	103	1104	4
1066	8	7-Mar	1283	4	108	1206	4
1067	8	8-Feb	1227	4.5	94	1215	4
1073	8	31-Jan	1195	4	75/70	-	-
1075	8	6-Feb	1188	4	100	1132	4
1116	8	15-Mar	1297	4	75	126	4.25
1159	8	3-Feb	1230	4	103	1323	4.25
1172	8	13-Feb	985	4.5	88	1046	4.75
1176	8	4-Mar	1248	5	92	1160	4.5

[a]Beef cow weights and body condition were determined after a 16 h overnight fast weith the exception at calving. Beef cow body condition was determined using a 9-point scale (1=extremely emaciated, 9=extremely obese)

[b]Calf weights were recorded within 24 h after calving

Table 16 (continued). Effects of cow age on hand-supplement cow weight and body condition change, and calf performance (Year 2)[a]

		Weaning, Oct. 16-18		
Cow ID #	Age	Wt	BC	Calf weaning wt
5019	4	-	-	-
5027	4	1158	4.25	506
5121	4	1242	5.5	507
5132	4	1081	4.75	570
5162	4	1411	5.25	594
5180	4	1111	4	477
5189	4	-	-	-
5223	4	1155	4.5	435
5226	4	-	-	-
5240	4	-	-	-
3001	6	1281	4.75	640
3007	6	1321	5.25	579
3025	6	-	-	-
3041	6	1159	4.5	616
3091	6	1283	4.5	548
3123	6	-	-	-
3125	6	1191	4.75	474
3151	6	1254	5	504
3154	6	1446	4.5	568
3191	6	1066	4.25	511
1062	8	1157	5	568
1063	8	1269	4.5	615
1066	8	1297	4	631
1067	8	1371	4.75	656
1073	8	1450	5.75	646.5
1075	8	1304	4.75	667
1116	8	1400	5	555
1159	8	1447	5	688
1172	8	1146	5	473
1176	8	1237	5	619

[a]Beef cow weights and body conditions were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1=extremely emaciated, 9=extremely obese)

Table 16 (continued). Effects of cow age on hand-supplment cow weight and body condition change, and calf performance (Year 2)[a]

		Initial, Dec. 20		Dec. 30		Pre-calving, Jan. 27	
Cow ID #	Age	Wt	BC	Wt	BC	Wt	BC
9031	10	1208	5	1240	4.75	1218	4.5
9073	10	1180	3.5	1177	4	1174	4
9078	10	1366	5.5	1403	5.5	1363	5
9116	10	1417	6.5	1437	6	1419	6
9128	10	1231	4.5	1276	4.5	1178	5
9132	10	1320	5	1327	5	1287	4.75
9136	10	1350	5.75	1384	5.25	1335	5.5
9146	10	1555	6.25	1588	6.5	1548	6.25
9153	10	1355	5	1341	5	1363	4.5
9189	10	1488	4.5	1540	5.25	1527	5
7130	12	1295	4.5	1342	4.75	1306	
7132	12	1283	5	1258	5.25	1200	4.75
7140	12	1315	6	1320	5.5	1312	5.5
7151	12	1291	5.75	1288	5.5	1280	5.75
7158	12	1443	5.25	1467	5.25	1312	5.25
7200	12	1264	4.5	1262	4.25	1250	5
6061	12	1344	5.5	1361	5.75	1330	4.75
6153	12	1279	5.25	1265	4.5	1237	4.5
6160	12	1387	5	1369	4.75	1323	4
6161	12	1284	5	1326	5	1284	4.75

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9 point scale (1 = extremely emaciated, 9 = extremely obese)

Table 16 (continued). Effects of cow age on hand-supplment cow weight and body condition change, and calf performance (Year 2)[a]

		Calving[b]				Turn-out, June 14	
Cow ID #	Age	Calving date	Wt	BC	Calf wt	Wt	BC
9031	10	9-Mar	1137	4	97	1079	4
9073	10	7-Feb	1133	4	84	994	3.5
9078	10	9-Mar	1228	4.5	100	1229	4.5
9116	10	12-Apr	1380	5.5	75	1293	5.25
9128	10	28-Mar	1100	3.5	70	-	-
9132	10	26-Feb	1128	5	101	1118	4.25
9136	10	8-Feb	1197	4.5	96	1137	4.5
9146	10	2-Mar	1490	5.5	89	1404	5.5
9153	10	10-Feb	1100	4.5	104	-	-
9189	10	28-Feb	1420	5	98	1284	4
7130	12	23-Mar	1210	4	98	1189	4
7132	12	2-Mar	1127	4	85	1150	4.5
7140	12	3-Mar	-	5.5	86	-	-
7151	12	11-Mar	1178	4.5	101	-	-
7158	12	14-Feb	1181	4	106	1337	5
7200	12	5-Mar	1186	4	82	1095	4
6061	12	3-Mar	1219	4.5	82	1210	4.75
6153	12	8-Feb	1087	4	103	995	3.75
6160	12	25-Feb	1124	3.5	102	-	-
6161	12	21-Mar	1268	4.5	91	1107	4.5

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)
[b]Calf weights were recorded within 24 h after calving

Table 16 (continued). Effects of cow age on hand-supplment cow weight and body condition change, and calf performance (Year 2)[a]

		Weaning, Oct. 16-18		
Cow ID #	Age	Wt	BC	Calf weaning wt
9031	10	1181	4.25	-
9073	10	1125	4	-
9078	10	1331	4.75	-
9116	10	1414	6	-
9128	10	-	-	-
9132	10	1267	4.75	-
9136	10	1254	4	-
9146	10	1496	6.25	-
9153	10	-	-	-
9189	10	1402	4.75	-
7130	12	1247	4.5	521
7132	12	1174	4.5	494
7140	12	934	4.75	494
7151	12	-	-	-
7158	12	1380	5.25	591
7200	12	1222	4.25	475
6061	12	1279	5	394
6153	12	1070	4	557
6160	12	-	-	-
6161	12	1239	4.5	525

[a]Beef cow weights and body condition were were determined after a 16 h overnight fast with the exception at calving. Beef cow body condition was determined using a 9-point scale (1 = extremely emaciated, 9 = extremely obese)

Table 17. Effects of cow age on cow hand-fed supplement intake, %BW, %BW$^{.75}$, and forage intake[a]

			Supplement intake		
Cow ID #	Age	Forage Intake, kg	kg	%BW	%BW$^{.75}$
5019	4	5.52	-	-	-
5027	4	-	1.20	11.27	64.39
5121	4	8.64	-	-	-
5132	4	-	1.10	8.28	49.99
5180	4	-	1.33	12.25	70.38
5189	4	7.08	-	-	-
5223	4	-	.87	7.99	45.86
5240	4	-	.51	0.97	8.25
3001	6	9.67	-	-	-
3007	6	-	1.02	7.39	45.00
3025	6	9.54	-	-	-
3041	6	-	1.00	8.00	47.59
3123	6	-	.64	4.59	28.10
3125	6	5.72	-	-	-
3151	6	-	1.38	11.53	67.84
3191	6	-	.80	7.49	42.83
1062	8	7.75	-	-	-
1063	8	-	.69	5.26	31.73
1066	8	5.97	-	-	-
1067	8	-	.74	5.37	32.77
1075	8	-	.67	5.13	30.86
1116	8	4.50	-	-	-
1159	8	-	.69	4.64	28.78
1172	8	12.87	-	-	-
1176	8	-	.92	7.02	42.22

[a]Forage intakes were estimated with use of Cr_2O_3 boluses. Supplement intakes were estimated by feeding 2.22 g of Cr_2O_3 per kg of oats.

Table 17(continued). Effects of cow age on cow hand-fed supplement intake, %BW, %BW$^{.75}$, and forage intake[a]

			Supplement intake		
Cow ID #	Age	Forage Intake, kg	kg	%BW	%BW$^{.75}$
9031	10	9.52	-	-	-
9073	10	-	1.35	11.41	66.86
9078	10	12.54	-	-	-
9116	10	-	.92	6.52	40.03
9128	10	7.42	-	-	-
9132	10	-	1.07	8.14	49.08
9146	10	-	1.10	7.06	44.36
9153	10	20.02	-	-	-
9189	10	-	1.10	7.41	46.00
6061	12	7.07	-	-	-
6153	12	-	.61	4.80	28.69
6161	12	-	.77	6.02	36.02
7130	12	9.17	-	-	-
7132	12	-	.57	4.42	26.47
7140	12	7.93	-	-	-
7151	12	-	.81	6.30	37.74
7158	12	9.60	-	-	-
7200	12	-	.82	6.47	38.60

[a]Forage intakes were estimated with use of Cr_2O_3 boluses. Supplement intakes were estimated by feeding 2.22 g of Cr_2O_3 per kg of oats.