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REVIEWS

REVIEW: Factors Affecting Decisions on When to Calve Beef Females

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Abstract

The decision of when to calve beef females is critical to production efficiency and profitability in a cow and calf enterprise. Calf production and associated costs are affected by calving season because environmental conditions, stage of production, and season of the year interact to affect nutritional status and reproductive performance. Cow and calf producers typically choose to commence calving and breeding at times of the year when weather is least stressful and forage conditions are optimal. Choosing to do so can reduce the amount of supplemental feed needed to ensure acceptable pregnancy rates, resulting in reduced annual feed costs. However, the time of year when forage conditions are optimal varies across the United States because of not only environmental (ambient temperature, rainfall, day length) differences among latitudes and longitudes but also differences in soil types and topographies. Consequently, forage species and their growth characteristics differ among regions. Given such differences, feeding strategies and feed costs vary among regions. Additionally, summer heat stress, particularly in southern states, has negative consequences on reproductive performance in both the female and male and will reduce calf performance. Such a wide array of production environments, productivity levels, and associated costs will cause profitability to vary among regions of the United States, making it impossible to identify a universally acceptable date to commence calving and breeding. Consequently, the decision of when to calve beef females should be based on site-specific conditions.

(Key Words: Calving Season, Nutrition, Profitability.)

Introduction

Numerous studies indicate that production level and resulting costs are affected by when calving commences (1, 4, 6, 29, 41, 45, 57, 59, 60). Specifically, environmental conditions (ambient temperature, humidity, wind, day length) and season of the year directly affect the forage resource, thus indirectly affecting animal performance. Other data show that environmental conditions can directly affect various reproductive components in both the male and female as well as calf survival and performance (13, 45, 65). Traditionally, cow and calf producers choose calving periods that match lactation and subsequent breeding (periods of high nutrient demand) to the time of year when the forage resource is most abundant. This is a prudent approach, reducing the need for high levels of supplemental feed that would be needed in months and seasons when grazing conditions may be inadequate. However, the single goal of matching the female's periods of high nutrient demand to optimal forage conditions may not always provide enough information to make informed decisions about when females should be calved. Clearly, production environments and natural resources vary greatly within and between regions of the United States, adding to the complexity of choosing a calving season. Important considerations are seasonal temperature extremes, rainfall patterns, seasonal changes in feeder calf prices, production costs, and break-even prices as affected by when calving commences. The purpose of this paper is to address factors that should be considered in making informed management decisions associated with the timing of calving and breeding.

Review and Discussion

Nutrient Demand and Supply. An effective production management system includes many components

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designed to optimize the cow's chances of annually conceiving and weaning a calf. Successful producers try to time important production events such as calving and breeding to coincide with periods when weather conditions are least stressful and when grazing and supplemental feed resources are most abundant. An important component is supplying the correct types and amounts of supplements in response to potential nutrient deficits caused by temporary and extended periods of either weather-induced or seasonal changes in the forage resource. The types and amounts of supplements needed are influenced by the cow's production status (gravid or nongravid; lactating or nonlactating), age, BW, body condition (39), and the quality (nutrient content) and quantity of grazed and harvested forage. A robust body of literature exists that documents breed type × environment interactions on production efficiency, suggesting that breed differences for milk yield should also be considered when choosing supplements. High milk yield requires increased energy and protein intake (39), and there are breed differences for peak and total milk yield responses to increased levels of energy intake (26). These differential responses to increased energy intake suggest that feeding standards should be more dynamic (26) and based on breed character as well as seasonal changes in the forage resource.

The type, amount, and quality of the forage resource vary among years, seasons within a year, and across regions of the United States (24, 64, 67). Consequently, correct nutritional management and grazing strategies vary tremendously but are usually designed to take advantage of the fact that nutrient content is highest in range, pasture, and meadow forages before the onset of plant maturity (seed head emergence). The date at which forages mature varies among species and is affected by year differences in the onset and magnitude of change in ambient temperature, amount and timing of rainfall, and geographic latitude and longitude (24). Even within a given locale, topography (mountain *vs* plains *vs* desert *vs* forest) and proximity to the oceans may influence both weather and natural resource conditions. Such differences will affect the types and amounts of forages and their associated production characteristics. Warm season plant species generally germinate (tiller) and mature later in northern regions compared with southern regions of the United States. Cool season plants may germinate (tiller) earlier in northern regions but, because of extended cold periods, usually mature later than in southern regions. Such differences are advantageous because there is usually a variety of forage species that are adapted to specific production environments. Where warm season plant species predominate the forage resource, producers generally choose spring and summer calving; regions with abundant cool season plant production afford fall and winter calving as long as weather conditions are not so severe that animal performance and forage yield are negatively affected. In many regions, splitting the herd into two calving seasons (fall and spring) is possible. This option may provide moderate economic advantage because it allows for a reduction in the size of the bull battery. It also affords the opportunity to compare production and profitability, as affected by shifts in weather and market conditions, between two distinct calving seasons that occur at the same location.

Nutrient requirements for mature females are greatest at peak lactation and lowest at the middle third of gestation, increasing again as parturition approaches (39). As nutrient requirements for pregnancy and lactation increase, the quantity of forage intake necessary to meet those requirements increases, but the fibrous, bulky nature of low quality, mature forages usually limits intake (23, 24, 28, 44). Thus, an increase in forage quality will increase intake. Clearly, nutrient requirements are easier to meet when an increase in forage quality is concomitant with an increase in available forage. For these reasons, it is prudent to match the females' periods of high nutrient demand to the time when forage conditions are optimal, tending to simplify nutritional management and likely reduce the needed amount of supplemental feeds and associated costs. Studies of cows grazing warm season perennials in Nebraska (1), Montana (R. E. Short, 1999, USDA, Miles City, MT; personal communication), and South Dakota (45) demonstrated that shifting the start of calving from early spring (March) to early summer (May, June) for the purpose of more closely matching the female's nutrient needs to optimal grazing conditions resulted in reduced feed cost. Changes in production levels associated with the shift were inconsistent, but in the Nebraska (1) study, lower feed cost associated with the shift to summer calving contributed to a $0.17 reduction in cost/kg of weaned calf, which suggests that profitability can be improved in northern regions of the United States by shifting the start of calving to early summer for females maintained on warm season perennial grazing.

The decision on when calving should commence is further confounded by differences in nutrient requirements as determined by cow size. Troxel et al. (60) demonstrated an interaction between frame size in females and date of calving on productivity and net return per calf. All females in the study grazed native range and were fed hay and supplements in the winter. "Small" frame (<453 kg) cows calving in fall (September to December) produced heavier calves and had greater returns than the same size cows calving in spring (January to April), but the degree of improvement in productivity and returns associated with fall calving decreased as cow frame size increased to "medium" (453 to 544 kg). The trend was reversed in "large" frame dams (>544 kg), which had increased productivity and returns when calved in the spring compared with fall. Troxel et al. (60) suggested that meeting the nutrient requirements of large frame, fall-calving cows in a cost-effective manner is more difficult than in large frame, spring-calving cows when winter feeding strategies depend solely on hay and supplements.

Seasonal and Environmental Effects on Fertility. Seasonal differences in fertility have been reported (13) and were directly related to changes in ambient temperature and day length. Stress from high and low ambient temperatures can directly affect fertility in females and males. Some of the following citations are for trials that investigated the effect of heat stress on reproduction in dairy cows. The reproductive responses of beef cows to heat stress may differ slightly from dairy cows because of differences in housing, level of feed intake, and genetics. Numerous female reproductive functions are impacted by heat stress. During heat stress, blood is shunted from the inner organs to the outer extremities to help dissipate heat. This results in reduced blood flow to the uterus and, thus, less perfusion of hormones to the uterine tissues (52). Temporary heat stress near the time of estrus and ovulation can reduce oocyte quality by altering meiotic processes (19, 48), directly affecting conceptus quality and survival (9, 49). Heat stress from d 4 to 6 post-conception can reduce conceptus survival (68, 69), and abnormal conceptus development was noted in females that were stressed at d 1 to 16 of gestation (9, 47). Heat stress can increase the incidence of anovulatory estrus (42) and can reduce P_4 content in the corpus luteum (50). Catecholamine and glucocorticoid levels increase during heat stress (2, 14, 20, 66), and luteinizing hormone concentrations decrease (32), indicating that heat-induced alterations in ovarian, pituitary, and adrenal hormone levels will negatively influence certain physiological functions and will impair fertility (13). Estrus and the time of ovulation from the onset of estrus are shortened by heat stress (10, 21, 37, 71), suggesting that AI should be performed closer to the onset of estrus as opposed to waiting 12 h after the onset. Cows that calve in hot summer months may experience a longer period from parturition to subsequent pregnancy (37). This was directly attributed to an increased number of services (3.3 *vs* 1.1) required to become pregnant during hot, compared with cool temperatures. It has also been shown that heat stress in the middle to last third of gestation can reduce calf birth BW and subsequent milk production in the dam (15).

Similar stress-related physiological responses and lower fertility have been observed in females during cold stress in northern states and Canada, but this has also been attributed to, and is potentially confounded by, day length (34, 35). There is evidence that decreasing day length, compared with increasing day length, results in reduced conception rates (38) and increased frequency of an ovulatory estrus (30, 43, 58). These data suggest that breeding should commence during periods of increasing day length. To the contrary, fertility in fall and early winter months (decreasing day length) may be acceptable in southern states as long as cows are adequately nourished. In two Texas herds with lactating females with body condition scores (8) of ≥ 5 (1 = thin to 9 = fat) that were exposed for 75 d of natural breeding beginning in late November through January, pregnancy rates were 93 and 94% (57). It is interesting to note that 69% of these females conceived in the first 30 d of breeding, coinciding with the period of decreasing day length.

As the period of increasing day length progresses, so does ambient temperature. If temperature reaches a stressful level, the potential benefits in fertility attributed to increasing day length can be negated. Of equal importance is the incidence and degree of nighttime cooling. Data from Monty and Wolff (37) showed that a decrease in late summer, nighttime temperatures (from 22ºC down to 12ºC) was accompanied by an increase in pregnancy rates even though average daytime temperature was 30ºC.

The degree of stress associated with high and low ambient temperatures is compounded by high humidity. Ingraham et al. (25) calculated a temperature-humidity index (THI) that increases as dry bulb temperature and humidity rise. Index values are categorized as in three zones: "comfort" (THI ≤78), "danger" (THI 79 to 83), or "emergency" (THI ≥84). Ingraham et al. (25) noted that conception rate declined from 55 to 10% as THI increased from 70 (comfort zone) to 84 (emergency zone).

Given the high humidity and long duration of potential heat stress in southern and southeastern states, THI becomes an important consideration in determining when breeding should commence and end in the southern United States. Data from Louisiana (29) and Texas (57) suggest that pregnancy rates will be low for females in spring-breeding seasons that progress beyond the month of May when THI begins to increase. When breeding occurred in April through June, pregnancy rates in Louisiana fell 38 points compared with breeding during December through February (29). However, if breeding occurred in April through mid May, Bagley et al. (4) reported pregnancy rates in Louisiana that were equal to rates achieved in January to mid February.

Two trials in Texas demonstrated a dramatic drop in pregnancy rates for females displaying estrus during June through September compared with earlier months (57). In Central Texas, pregnancy rates in 285 spring calving cows that were artificially inseminated during May, June, and July were 81.8, 58.4, and 16.4%, respectively. All females in this herd had body condition score of ≥5 during the breeding season, suggesting that nutrition was adequate and that heat stress likely accounted for reduced fertility as the breeding season progressed into the hotter months. In a similar trial that included 111 naturally mated females grazing Gulf Coast native range (57), pregnancy rates in April, May, June, and July through September were 75.7, 44.8, 45.4, and 15.8%, respectively. These data suggest that, except under extraordinary circumstances, southern and southeastern producers should avoid breeding during summer months. This may also apply to states in the south central plains and midwest. Data from Kentucky (J. T. Johns, 1999, University of Kentucky, Lexington, KY; personal communication), Illinois (D. B. Faulkner, 1999, University of Illinois, Urbana, IL; personal communication), Arkansas (60), Missouri (D. J. Patterson, 1999, University of Missouri, Columbia, MO; personal communication), and Kansas (55) also show a decline in pregnancy rate for females exposed for breeding from June through August compared with April and May. For southern herds grazed on tall fescue (*Festuca arundinacea* Schreb.), summer calving and breeding are usually undesirable because endophyte-infested fescue combined with heat stress results in summer toxicosis characterized by numerous symptoms, including reduced fertility and agalactia in dams as well as reduced growth in calves (22, 63).

Contrary to the data from south and southeastern states, pregnancy rates were not different during July through September compared with April through June in southwestern states [(New Mexico (5)] and northern states [(R. E. Short, 1999, USDA, Miles City, MT; personal communication); Nebraska (1); South Dakota (45)]. In the region where the New Mexico study (5) was conducted, 63% of the annual rainfall occurs in the months of June through September, which are coincident with the months of breeding for the "summer" herd. Similar rainfall patterns exist in the Trans Pecos region of West Texas (12). Such late summer rains suggest that cows in these southwest regions may be more well nourished in mid to late summer than are cows in the southern and southeastern states where rainfall occurs primarily in spring and early summer followed immediately by periods of high temperatures, low rainfall, and low forage quality. Whether a result of later onset and shorter duration of heat stress, different rainfall patterns, less humidity, greater incidence of nighttime cooling, or a combination of these conditions, beef females in northern and southwestern states may not experience a dramatic reduction in pregnancy rates during summer compared with early spring as is seen in females in the southern plains and southeastern states.

In the male, heat stress reduces sperm quality and numbers. Even stress lasting no more than 12 h impairs spermatogenesis (53) and is attributed to an increase in temperature of testicular tissues (16, 46). After cessation of stress, it is unfortunate that recovery time to normal sperm production lasts ca. 6 to 8 wk, the period required for sperm cell maturation in the testicle (36).

Male libido and serving capacity are lower during hot weather, possibly reducing pregnancy rates because of failure of the bulls to seek and service estrual females (31). Similarly, cold stress may have similar effects on reproductive performance in the bull. During cold stress in northern climates, the chance of scrotal frostbite and associated testicular damage is a common concern because it reduces sperm cell quality (17). The degree of reproductive impairment in bulls as a result of either heat or cold stress increases in direct relation to the duration of stress (17). These results suggest an interaction of season and location on the magnitude of reproductive impairment attributed to extreme environmental conditions.

Seasonal and Environmental Effects on Calf Performance. There appears to be a similar interaction of season and location on calf performance. Calves born in Montana at the same site during three distinct periods (January to February; March to April; May to June) had different adjusted weaning weights (R. E. Short, 1999, USDA, Miles City, MT; personal communication), and adjusted weaning weights were least for calves born in May and June, indicating an effect of season on growth. Research in Nebraska (1) shows a similar reduction in growth of calves born in June compared with calves born in March. To the contrary, Pruitt et al. (45) concluded that preweaning growth rate of South Dakota calves (same site) born in May to June was greater than the preweaning growth rate of calves born in March to April. Studies in Colorado (J. Whittier, 1999, Colorado State University, Ft. Collins, CO; personal communication) show site-specific differences in calf performance. Southeastern, northeastern, and northwestern Colorado calves born in April to June had weaning weights that were 11 to 34 kg greater than those of calves born in February to March, whereas south central and southwestern Colorado calves born in April to June had adjusted weaning weights that were 7 to 22 kg less than those of calves born in February to March. A New Mexico study (8) revealed no difference in preweaning growth rate of calves born in January through April compared with calves born in March through June.

Pate et al. (41) demonstrated that Florida calves born in winter (mid December to mid March) and spring (late February to late May) and subsequently reared on warm season perennials had different weaning weights. Calves born in winter had greater weaning BW than calves born in spring. This difference was attributed to the asynchronous timing of the highest nutrient requirement period of the spring calving cow (peak lactation) and the period when forage quality was lowest (mid to late summer). To the contrary, the timing of the highest nutrient requirement period of the winter calving cow was more coincident with the period when forage quality was highest (late spring to early summer).

Summer calving in southern and southeastern herds is questionable because of the potential for reduced calf performance. A trial in Arkansas (60) indicates that calves born in May through August had adjusted weaning BW that were 23 to 37 kg less than calves born in other months. Similar studies in Texas (57, 59) indicate that calves born in May through August, and even in September and October, had adjusted weaning BW that were 16 to 31 kg less than the BW of calves born in other months. These studies suggest an effect of heat stress on performance in southern calves because of either direct effects (reduced appetite, physiological and metabolic changes) on the calf and its dam or from indirect effects of potentially lowered milk yield in dams that would be grazing late summer, low quality forages during periods of peak lactation. Sprinkle et al. (54) noted that demand for energy intake appears to increase during late summer (September 12 to 22) compared with early summer (July 18 to 28) for both lactating and nonlactating *Bos taurus* females. These females had originated from an indigenous south Texas herd that had been established for 50 yr and were presumably adapted to the arid conditions in the study area. If heat stress is concomitant with late summer, low quality grazing, the chances that a female could consume enough forage to meet her energy requirements could be seriously reduced. Furthermore, the month of birth dictates the month at which calves reach an age when acquired grazing habits begin to impact nutrient supply. Southern calves born in May through August and reared on native forage would have low quality grazing by the time they reached 5 to 7 mo of age, thus potentially reducing their preweaning growth rate compared with calves born in other months. This adds another consideration in the choice of when calving should commence.

Bagley et al. (4) compared growth rate in Louisiana calves born in a 75-d period either during late summer or early fall (September, October, November) or winter or early spring (January, February, March). In this 5-yr study, both calving groups had access to cool season annual and legume pastures during winter followed by identical warm season perennial (coastal bermudagrass) pasture. Environmental conditions (ambient temperatures, humidity) were not reported, but given the normally high temperatures and humidity during late summer and early fall in Louisiana, reduced performance might be expected in calves born during that period compared with those born in winter or early spring. Such a reduction did not occur. Bagley et al. (4) attributed this directly to higher quality grazing conditions (ample cool season forages) prior to 205 d of age for late summer and early fall calves compared with grazing conditions (lower quality, warm season perennials) prior to 205 d of age for calves born in winter and early spring. The ability to overcome reduced performance in southern calves born in the summer may depend on the quality and quantity of forage during the period when calves begin to consume forages as a greater part of their diets. The advantages of using cool season annual and legume mixtures in southern herds are well known and were previously demonstrated for cow and calf (11) and growing steer enterprises (3, 62).

An alternative that may overcome reduced performance in calves born during summer is to retain ownership past a traditional weaning age (7 to 9 mo) to take advantage of the potential for compensatory gain at a later age. Unfortunately, many cow and calf operators cannot retain ownership and must market calves at or near the time of weaning. For these operations, the choice of when to calve may have more impact on income and profit compared with other operations that have the opportunity to retain ownership. Furthermore, as with any retained ownership enterprise, major concerns are the cost and availability of forage and supplemental feed resources and the degree of potential change in feeder calf prices during the ensuing months. These factors will differ between locations and years.

Season and environment also affect neonatal calf health and survival (40, 70). Calves may experience hypothermia if born in cold months, particularly in northern climates (51). Bellows et al. (7) reported that death from exposure chilling accounted for 5.6% of calf losses during a 15-yr period in Montana. The effect of exposure is compounded when there is >25% *Bos indicus* breeding in the offspring (27).

Differences in Seasonal Market Prices and Potential Profit. Although a number of factors influence feeder calf prices, supply and demand account for much of the price difference between spring and fall and winter markets (33). The traditional increase in spring prices, compared with fall and early winter (18, 61), is attributed to a lower supply of calves born in fall, which are then subsequently available for spring marketing, and to a higher demand by buyers who want to utilize the oncoming abundance of spring and early summer forages (33). If supply and demand were the only factors to consider in choosing when to commence calving, then potential income (and presumably profit) could be increased by simply choosing to calve the herd in the fall so that marketing would coincide with the high spring prices.

Even though high market prices result in increased income, other factors, such as level of production, cash costs (interest, feed, medicine, death loss, depreciation, breeding, taxes, land, etc.), opportunity costs, and investment per cow also interact to determine profitability. In a study of east Texas cow and calf operations (56) that had either positive or negative return on assets (**ROA**), 94% of the variability in ROA was explained by four factors: production per cow, total operating expenses plus opportunity costs, cash interest expense, and feeder calf prices. Among these four factors, their individual impact on ROA in order of magnitude from greatest to least was feeder calf price = production per cow > total operating expense > cash interest expense. A 1% increase in feeder calf price (only $0.02 on a $1.91/kg feeder calf market) and a 1% increase in kilogram of calf produced per cow (2- to 2.6-kg increase) had equal impact on ROA and improved it by 0.55 percentage points. Compared with these changes, a 1% decrease in total operating expenses had 3.3 times less impact on ROA; a 1% decrease in cash interest expense had 13.7 times less impact on ROA. These data demonstrate the need to closely monitor potential changes in profitability, as impacted by the degree of change in production level and costs that may result from shifting the breeding and calving seasons. If the projected outcome on profitability is negative, there is no assurance that market prices at any time of the year would be high enough to overcome such a change.

Because managers have relatively little control over feeder calf prices compared with the degree of control over productivity and given that the impact of production level on ROA is almost equal to the impact of feeder calf prices (56), it seems prudent that management strategies be directed at maintaining production while simultaneously finding ways to keep production costs at a minimum. Any reduction in the level of productivity as a result of changes in management strategies must necessarily be of lesser value than any cost savings that may result from new management strategies. Any increase in productivity is acceptable as long as the value of the increase exceeds the value of any cost that is directly associated with achieving greater productivity.

Interactions Among Environment, Resources, Productivity, Costs, and Income. The complex interactions among environment, grazing resources, production costs, and resulting income as influenced by when calving commences across regions of the United States are documented (1, 4, 6, 29, 41, 45, 57, 59, 60) but are well demonstrated in trials by Adams et al. (1) in Nebraska and Bagley et al. (4) in Louisiana. Both studies reported higher income from calves born in warm months (June to July—Nebraska; September to mid November—Louisiana) compared with calves born in cool or cold months (March to April—Nebraska; January to March—Louisiana). However, the reason for higher income from calves born in warm months differed dramatically between these locations. Even though Nebraska calves born from June to July had reduced performance (30 kg less weaning BW) compared with calves born during March to April, feed cost for the June-to-July dams was $47 per cow lower than in the March-to-April dams because of fewer required supplements. The net effect was that the value of reduced feed costs for the June-to-July cows was greater than the value of reduced performance in calves (1). To the contrary, calves born in Louisiana (4) during warm months (September to November), compared with those born during cool months (January to March), had greater weaning BW (28 kg per calf), and warm month dams had higher feed costs than dams calving in cool months because of more required supplements. The net effect was that the value of increased performance in the September to November calves was greater than the value of increased feed cost in their dams (4).

The impact of grazing resource on calf performance was also evident in studies by Adams et al. (1) and Bagley et al. (4). Cows in Nebraska were grazed on native range (warm season perennials) and subirrigated meadow; cows in Louisiana were grazed on warm season, improved pasture (coastal bermudagrass) and cool season annuals and legumes. The nutrient content of the grazing diet for cows and their offspring during winter and early spring would obviously differ between the locations, i.e., less in Nebraska than in Louisiana. Bagley et al. (4) attributed the increased performance of calves born from September to November to the high quality, cool season forages and grazing diet during the preweaning period compared with an equivalent stage of growth in calves born from January to March that would have a relatively lower quality diet of coastal bermudagrass.

Such grazing resource differences also required different winter feeding strategies for lactating and nonlactating dams in studies by Adams et al. (1) and Bagley et al. (4). Lactating dams during winter months in Nebraska (1) had an adequate quantity of grazing, but the forage contained 5 to 6% CP, which is approximately one-half of the nutrient needs (39). Because the volume of purchased protein and energy supplements required to meet a nutrient deficit under these conditions could have been economically prohibitive, hay was fed ad libitum so as to essentially substitute for the low quality grazing diet. Protein supplements were given as needed based on weather conditions and hay quality. Nonlactating cows (calving in June to July) had access to an adequate amount of grazing on winter meadow and, because of its CP content, which approached or slightly exceeded requirements for nonlactating cows, were given a moderate level of supplement and allowed to graze without hay. A lesser amount of hay was needed during winter for nonlactating dams, which explains the $47 reduction in annual feed costs for cows calving June to July compared with cows calving in March to April.

Dams in Louisiana (4) had access to high quality winter grazing that met CP requirements for both lactating and nonlactating dams but, because of different stocking rates and variable growing conditions throughout the winter months, became limited in quantity at various times during the study. Consequently, lactating and nonlactating cows required moderate levels of protein supplement and hay during the winter to correct deficiencies resulting from lesser intake. Regardless of stocking rates ("low" or "high"), cows that calved in January to March consumed less hay than did cows that calved in September to November (4).

The work by Adams et al. (1) and Bagley et al. (4) shows examples of different winter feeding strategies that were correctly designed to meet the first limiting criterion. For females grazing Nebraska Sandhills native range during winter, CP was limited to the extent that hay was required as a diet substitute for lactating females; nonlactating females had less nutrient demand and only required moderate levels of protein supplements. To the contrary, females grazing winter annuals in Louisiana had adequate CP in the grazing diet, but quantity became limited to the extent that DMI was reduced. This necessitated dietary hay in both lactating and nonlactating females. Although the quality of the hay was described by Bagley et al. (4) as "good," both groups of females also required protein supplements, but as expected, nonlactating females required fewer supplements than did lactating females while consuming hay.

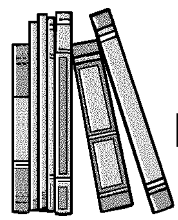
Deciding to Shift the Start of Calving. In some environments, there may be economic merit in shifting the calving season to alternative times of the year especially when calving occurs during stressful weather conditions or when the periods of highest nutrient demand by the dam (suckling and breeding) are not coincident with the seasonal periods of adequate grazing [(1, 450; R. E. Short, 1999, Miles City, MT; personal communication]. The periods of adequate grazing conditions do not necessarily occur at similar times of the year between locations and are also affected by the species of forages available, resulting in feeding strategies that differ by region. The net effect is that profitability of the enterprise, as affected by when calving commences, will be influenced by factors that are not common among regions.

Some producers cannot shift the start of calving to alternative seasons. However, these considerations are not necessarily site-specific. This is especially true for many seedstock breeders who must time their calving season so that offspring reach a marketable age during periods of peak demand for replacement animals. Some club calf producers must time the calving season so that birth dates are desirable for regional livestock shows. Additionally, producers who utilize federal grazing lands may have fewer choices of when to calve because of rules in the lease agreement associated with the timing and duration of grazing, which may not be coincident with a desirable calving period. Clearly, there are production and economic circumstances that impact different management scenarios in conflicting ways.

Perhaps Dr. Robert Short (1999, USDA, Miles City, MT; personal communication) stated the situation best, "The choice of when calving should commence should be based on site-specific information." A requirement for making informed decisions is an understanding of production differences among breeds, growth pattern and quality of the forage resource, nutritional requirements for the dam and her offspring, extremes in environmental conditions, cost differences in production systems, and market conditions.

Implications

Environmental and natural resource conditions differ across the United States, causing cow and calf management strategies to necessarily vary. Supplemental feeding should be designed to overcome potential nutrient deficits caused by temporary and extended periods of either seasonal or environmental induced changes in the forage resource. Calving and breeding during periods of adequate, high quality grazing can reduce the amount of needed supplements and annual feed costs. However, the periods when such grazing conditions exist differ among regions, making it difficult to identify a universally acceptable time to commence breeding and calving. Furthermore, ambient temperature and humidity combine to create potential stress that reduces calf performance and fertility in females and males, even when grazing is adequate. Thus, productivity and resulting profitability are unpredictable among regions. Producers should base their decision on when to calve and breed according to site-specific conditions that can affect production and associated costs in a manner that is not necessarily identical to an effect seen in nearby or distant production environments.



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