Strategic Supplementation of Beef Cows to Correct for Nutritional Imbalances

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Introduction

The concept of strategic supplementation is the art and science of putting the appropriate supplemental feed in front of the cow at the right time. To understand the idea of strategic supplementation the word "strategic" needs to be defined. The online dictionary defines "strategic" as 1) "pertaining to, characterized by, or of the nature of strategy; 2) important in or essential to strategy; 3) forming an integral part of a stratagem."

What this concept forces us to ask is: when must cows be supplemented, what are the practical supplementation sources, for how long should cows be supplemented, and finally, what will supplementation cost. Strategic supplementation requires synthesizing 3 concepts: planning, biology, and economics. Let's address these concepts one at a time.

Planning

Nearly everything regarding cattle production operates on a seasonal cycle. Cattle production cycles, pasture growth, and environmental conditions all occur on semi-regular patterns. Anyone in the cattle business can recognize these cyclical patterns. Unfortunately the challenge in many production scenarios is to identify these production cycles for what they are and then implement management practices accordingly. Just as we know that grass will grow in the spring, we should also realize that grass will become dormant and lose quality in the fall and winter. Logic should tell us to be ready for that decline in quality and have management (supplement) procedures in place and ready to execute. Having resources and procedures in place is the strategic portion of "strategic supplementation." Several sources of information exist regarding the cyclic growth pattern of bahiagrass and other forages in Florida. Hughes et al. (2010) and Hughes and Hersom (2009a, b) have published reports on bahiagrass quality and forage mass in Florida. Likewise, Westway (Fields, personal communication) has an extensive bahiagrass and limpograss database. These sources can be utilized to establish pasture grazing plans, potential conserved forage resources, and supplement inputs.

Forage Cycle. The forage cycle is an important consideration for strategic supplementation. Bahiagrass is the primary component of grazing cattle diets (Chambliss and Sollenberger, 1991) in this region which conservatively comprises 10%

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of the total U.S. total cow herd. Bahiagrass has a primary seasonal production from April to October, but it can be grazed into the winter if managed properly (Ball et al., 2002; Brown and Mislevy, 1988; Mislevy and Everett, 1981). However, a consistently high-quality bahiagrass is rarely achieved (Gates et al., 2001), regardless of management or fertilization. Research has shown that ruminants will selectively graze when adequate forage is available (Bennett et al., 1999; Jung et al., 1989; Waterman et al., 2007). However, during the winter and spring months, bahiagrass forage mass can be limiting (Ball et al., 2002) and animal selection is limited. From a forage standpoint both the issue of quantity and quality are imperative considerations regarding strategic supplementation. Nominal forage quantities are presented in Hughes and Hersom (2009a, b) for different locations in all seasons in Florida, and graphically presented on a state-wide year-round basis in Figure 1. Obviously adequate forage for the cow to consume is a primary determinant to a supplementation scenario. Inadequate forage consumption in a forage-based production system is a harbinger to poor cow performance. Available forage allowances below 10 kg DM/100 kg of BW (Marsh et al, 1979) and 5 kg/100 kg BW (NRC, 2001) have been indicated as breakpoints at which cattle performance will suffer. Examining Figure 1, a limited forage allowance could conceivably be experienced from December through April depending upon stocking density of the pasture.

Likewise, forage quality is also a primary consideration regarding cattle supplementation scenarios. Figure 2 presents bahiagrass TDN and CP concentration from the Hughes et al. (2010) and Westway databases. Forage energy density during the year varied from 5% (University of Florida) to 2% (Westway). Similarly, forage CP concentration varied by 3.5 and 4 percentage units across months. Rumen degradable protein (RDP) as a % of CP in the Westway data set varied from a low of 63% in December and January to a high of 72% in May. Unfortunately the forage cycle conspires to result in greater quality forage but couples that quality with decreased availability. Deficiency of energy and RDP certainly limit cattle performance. The matrix of available energy and RDP to support rumen function, feed intake, and performance in many cases will respond favorably to strategic supplementation. In addition to energy and protein, forages supply minerals and vitamins. In some instances bahiagrass may be sufficient to meet mineral requirements during specific time frames; however, bahiagrass forage often is deficient in minerals and vitamins in relation to cow production requirements. Published analysis of bahiagrass mineral composition can be found in Tiffany et al. (2005). There are certainly time frames where bahiagrass alone will not meet many of the mineral requirements of grazing cattle. Specifically, intakes of P, Na, Cu, Zn, and Se from forage alone are generally less than predicated cow requirements during much of the year. In this case, strategic supplementation of minerals would be needed to support cattle performance. The ability of bahiagrass or any grazed forage to provide adequate nutrients for cattle production forms the basis for beef cattle production.

Cow Production Cycle. Cattle nutrient requirements are not static and exhibit a great deal of variation during the productive cycle of any beef animal. Therefore, cow nutrient requirements and intake potential change with changing physiological state throughout the production cycle. Interestingly enough the NRC does not consider all maintenance equal. There exists two distinct phases of NE_M and protein requirements; namely, that during the lactation period and that during the dry period. About a 20% difference (NRC, 2001) exists between these two periods. This increased maintenance requirement associated with lactation is due to the increased metabolic demand upon body tissues, not the product (milk) of lactation. Additionally, the initial NE_M does not account for any energy expended for activity associated with grazing. The range in maintenance energy requirements for grazing cattle could be from 10 to 50% depending upon the grazing conditions and forage availability. Likewise the requirements associated with lactation changes; peak lactation and nutrient requirements occur during the second month postpartum. Identified differences between and within breeds that affect milk yield and milk composition also affect the lactation energy requirement. Unlike other requirements, lactation has a rapid onset of demand for energy and protein that is initiated by parturition. The energy requirement associated with pregnancy is an underlying energetic demand during the yearly production cycle. Whereas the energy required for gestation is initially very small, just 0.1% of the NE_M during the third month postpartum. In contrast, the gestation energy requirement one month prior to parturition is approximately 56% of the NE_M requirement during the same time. The post-weaning period is often referred to as a "maintenance period" for the grazing beef cow. Indeed, gestational requirements at weaning (3% of total energy required) do not equate to the greater energetic demand of lactation (17% of total energy demand), however this is an important energetic supply and demand period. This period is utilized for growth of the fetus in utero and uterine development.

Biology

Supplementation of cows makes little sense if it does not positively affect cow performance in some manner. Therefore, supplementation practices must have some positive biological function for the cow. In some cases the supplementation provided may only maintain the status quo of the cow and produce no discernable impact. However, removal of the supplement could ultimately result in a decrease in performance or production. Conversely, often supplementation may not be initiated until a noticeable change in cow appearance or performance becomes an issue. So therein lays the fundamental choice regarding supplementation; supplement to prevent a change in cow performance, or allow for oscillation in cow performance and fix issues once they become critical enough to warrant attention. Indeed, many recommendations indicate that cows should be kept in a mean body condition score of 5 (scale of 1 to 9) for optimal performance. However, we know in theory and practice that cows fluctuate in body condition score and body weight throughout the year and still have adequate performance (Freetly and Nienager, 1998). The NRC establishes the benchmarks for cattle nutrient requirements for important nutrients (energy, protein, Ca, P, etc.). Emerging work indicates that there are critical times in the cow productive cycle that the nutritional environment can have profound effects on fetal programming which can have direct impact on the calf during its subsequent life. As this field produces more evidence, the biological impact of strategic supplementation decisions will increase. Implementation of a supplement program has to have a measurable outcome to maintain its biological relevance and continued use.

Body Weight-Condition Score. Body condition can be used as in indirect indicator of nutritional status as it estimates the amount of fat that an animal contains. In fact, body condition score (BCS) or shifts in body condition is a more reliable guide to evaluate the nutritional status of a cow when compared to live weight due to factors such as gut fill and pregnancy influencing what is read on the scale (Herd and Sprott, 1986). Body condition score when taken regularly along with other major factors such as lactation status and forage quality, can be an important tool to a producer when determining the management of supplementation for the cow herd. In Tables 1 and 2 (adapted from Herd and Sprott, 1986) the effect that forage quality and BCS has on pounds of feed needed for supplementation of a 1,000 pound cow during the last 1/3 of gestation (Table 1) and during lactation (Table 2). Need for supplemental energy is impacted greater by BCS when compared with supplemental protein. However, in environments such as Florida where low quality forage is abundant, cattle must be supplemented with protein in order to utilize the forage effectively regardless of BCS or lactation status. In a situation with low quality forage, animal response to protein supplementation is typically greater than that to energy supplementation.

Reproduction. Body condition score and nutritional status at calving tends to be the most influential factor on the resumption of estrous. Additionally, body energy reserves are related to reproductive function of postpartum cows (Dziuk and Bellows, 1983). Most studies suggests a minimum BCS of 5 at calving is needed to ensure adequate body stores so peak reproductive performance can be attained during the subsequent breeding season (Dziuk and Bellows, 1983; Richards et al., 1986). Cows calving at a BCS of 7 to 9 (Scale 1-9) were capable of returning to estrus within 60 d after calving. Dietary restrictions of cows during the late pre-partum period resulted in weight loss and decreased body fat, which led to a decrease in the number of cows returning to estrus early in the breeding season (Whitman, 1975; Wettemann et al., 1982). Wiltbank et al. (1964) reported that cows fed the recommended amount of TDN averaged 49 d from calving to first estrus as compared with 73 and 72 d for cows receiving 75% and 150% of the recommended amount, respectively.

In a study completed in Florida, Bos indicus × Bos taurus cows were synchronized with progestin-based estrous synchronization protocols. Their BCS clearly affected the post-partum reproductive capacity. Cows which possessed a BCS ≤ 4.5 had significantly reduced estrous response, conception rate, synchronized pregnancy rate, and thirty day-pregnancy rate compared to cows having a BCS of ≥ 5. Even cows which displayed the average or "target" BCS of 5 tended to have a decreased estrous response and conception rate and significantly lower synchronized pregnancy rate and thirty day-pregnancy rate compared to cows with ≥ 5 BCS (McKinniss, 2008; Table 3).

Supplementation

Feed resources cost money. Whether that money is invested in the pasture to produce grazable forage, spent to conserve forage for times of decreased pasture availability, or as a supplement outlay to address nutritional deficiencies, a financial decision is made. The strategy to apply financial resources toward feeding and supplementing the cow herd is an enterprise-specific decision. Regardless, approximately 45 to 55% of the annual maintenance cost for a cow is consumed by feed (Strohbehn, 1990). Lardy (2011) correctly reminds us of "the principle of diminishing returns." The principle is that for every additional unit of input an incrementally lower amount of output can be expected. In essence, the second pound of supplement does not affect performance as much as the first, the third pound not as much as the second, and so-on. So the key is to find the point at which cattle performance and cost outlays are optimized. These curves will be affected by many variables including expected cow performance, previous cow condition, forage conditions, supplement type, and environmental conditions.

Energy. Energy is one of the primary drivers of cattle performance. However, a consistent supply of energy for grazing cattle is often not achievable. In several studies the viability of cyclic energy supply for cows has been examined (Freetly and Nienabler, 1998, Freetly et al., 2000; Freetly et al., 2005). Provision of supplemental energy after 27 days of lactation to cows that had incurred an energy restriction prior to calving and early lactation allowed cows to regain BW, BCS, and calf BW by 58 days post-partum (Freetly et al., 2000). In this situation, energy supply was increased 3.33X from the restriction period to the initiation of breeding. The timing of the additional energy corresponded to the critical production period for cows. Similarly, heifers and young cows were capable of weaning similar BW calves, stay in the herd, and become pregnant when strategically supplemented with energy 27 d after parturition after an energy restriction from day 112 of gestation to day 27 of lactation (Freetly et al., 2005). The energy increase, 7 times the metabolizable energy for gain than non-restricted females, was significant and the increase occurred over a 6-day period and maintained to the initiation of the breeding season. Deferment of energy intake is successful for non-pregnant and non-lactating mature cows, mature pregnant and lactating cows, and pregnant and lactating heifers and young cows. In each case the cattle were in adequate body condition and remained in adequate body condition during the energy deferment period. However, energy deferment and maintaining cows at lower BW over time is viable, if at critical (strategic) periods of the production cycle, additional (supplemental) feed energy is provided.

Protein. Protein is an important component to support cattle production. The method of supplying protein to cattle can take several options. Supplementation of crude protein (CP) is the most basic premise for protein supplementation. Cow BW loss and cow calving interval was less for protein supplemented cows in the winter (Spears et al., 1986). Patterson et al. (2003) supplemented heifers to meet CP requirements or metabolizable protein (MP) requirements. Meeting the CP requirement generally resulted in numerically lower BW and BCS compared to meeting the MP requirement Formulation to meet CP requirements resulted in similar NE_M balance, decreased MP balance, but greater RDP balance compared to supplementing cattle to meet the MP requirement. In another experiment, Patterson et al. (2003) supplemented 2-year old cows to meet MP or RDP requirements. Cow BW, BCS, hay intake, milk production, and calf performance was not affected by protein supplement type. However, cow postpartum BW gain was greater for MP-supplemented cows compared to RDP-supplemented cows. Likewise, Wiley et al (1991) demonstrated greater postpartum BW gain in lactating cows supplemented with rumen undegradable protein (RUP) compared to RDP supplements. Studies have suggested that RUP supplementation to postpartum cattle may increase milk production, but high amounts of RUP supplementation may simulate BW gain at the expense of milk production. Triplett et al. (1995) demonstrated that excessive RUP (75.6% RUP) in heifers decreased milk production compared to moderate (56.3%) and low RUP supplementation (38.1%). The strategic supplementation of protein to stimulate performance, milk production, and reproductive performance is paramount to sustainable and viable beef cattle herds.

Summary

The task of meeting cow requirements and correcting deficiencies is complicated by changing cow requirements, changing forage conditions, and changing environmental conditions. The least variable aspect of this scenario may be the supplemental feedstuffs. However, the ongoing interactions between cattle and their environment imply that strategic supplementation is a moving target for beef cattle production.

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Table 1. Pounds of feed needed daily by a pregnant 1,000 pound cow (last 1/3 of gestation) or the same cow with varying body condition score (BCS), when fed forage of varying quality, assuming fleshy cows will be allowed to lose weight (1.33 lb/day) and condition and then cows will be fed to increase weight (+1.33 lb/day) and condition. [a, b]

	Pasture, Range or Hay Quality								
	Excellent 13% Crude Protein 52% TDN[c] 0.51 Mcal NE_M[d]			Average 7.5% Crude Protein 47% TDN 0.43 Mcal NE_M			Poor 4% Crude Protein 42% TDN 0.35 Mcal NE_M		
BCS of cows Cow weight, lb	3 860	5 1,000	7 1167	3 860	5 1,000	7 1167	3 860	5 1,000	7 1167
Required by cow Crude Protein, lb/d NE_M, Mcal/d	 1.9 13.4	 1.5 9.5	 1.2 6.2	 1.9 13.4	 1.5 9.5	 1.2 6.2	 1.9 13.4	 1.5 9.5	 1.2 6.2
Hay, lb Cottonseed meal, lb Milo or corn, lb	24.7 - 1	18.7 - -	12.2 - -	20.2 - 5.5	22.0 - -	16.0 - -	16.7 1.5 7.5	18.3 1.5 2.5	15 1.5 -

[a] Adapted from Herd and Sprott, 1986.
[b] At 1.33 pounds per day change in body weight, 105 days would be required for the thin cow (BSC=3) to reach a BCS of 5; 125 days would pass before the fleshy cow (BSC=7)would drop down to a BCS of 5. When feed is available and reasonably priced, it may be desirable to save some of the condition on the BCS 7 cow for a later time, e.g. a drought when feed will be scarce and expensive.
[c] Total Digestible Nutrients.
[d] Megacalories of Net Energy for Maintenance (used as basis for calculations).

Table 2. Pounds of feed needed daily by a 1,000 pound lactating cow (14 lbs milk/day) or the same cow with varying body condition score (BCS), when fed forage of varying quality, assuming the fleshy cows will be allowed to lose weight (-1.33 lb./day) and condition and the thin cows will be fed to increase weight (+1.33 lb./day) and condition. [a, b]

	Pasture, Range or Hay Quality								
	Excellent 13% Crude Protein 52% TDN[c] 0.51 Mcal NE_M[d]			Average 7.5% Crude Protein 47% TDN 0.43 Mcal NE_M			Poor 4% Crude Protein 42% TDN 0.35 Mcal NE_M		
BCS of cows	3	5	7	3	5	7	3	5	7
Cow weight, lb	860	1,000	1167	860	1,000	1167	860	1,000	1167
Required by cow									
Crude Protein, lb/d	2.6	2.2	1.9	2.6	2.2	1.9	2.6	2.2	1.9
NE_M, Mcal/d	17.5	13.5	10.2	17.5	13.5	10.2	17.5	13.5	10.2
Hay, lb	26.0	26.5	20.0	21.9	23.7	23.0	17.5	19.0	19.5
Cotton seed meal, lb	-	-	-	1.0	1.0	1.0	2.5	2.5	2.0
Milo or corn, lb	5.0	-	-	8.0	3.0	-	11.0	6.0	2.5

[a] Adapted from Herd and Sprott, 1986.
[b] At 1.33 pounds per day, 105 days would be required for the thin cow (BCS=3) to reach a BCS of 5; 125 days would pass before the fleshy cow (BCS=7)would drop down to a BCS of 5. When feed is available and reasonably priced, it may be desirable to save some of the condition on the BCS 7 cow for a later time, e.g. a drought when feed will be scarce and expensive.
[c] Total Digestible Nutrients.
[d] Megacalories of Net Energy for Maintenance (used as basis for calculations).

Table 3. Effect of body condition score (BCS) on post-partum reproductive traits in *Bos indicus* × *Bos taurus* cows synchronized with progestogen-based estrous synchronization protocols. (Adapted from McKinniss, 2008)

Variable	BCS[a]		
	≤ 4.5	5	≥ 5
Estrous response, %[b]	48.8 (59/121)	54.4 (75/138)	66.2 (43/65)
P-value	0.02	0.10	Referent
Conception rate, %[c]	35.6 (21/59)	60.0 (45/75)	72.1 (31/43)
P-value	0.0003	0.10	Referent
Synchronized pregnancy rate, %[d]	26.5 (32/121)	40.6 (56/138)	56.9 (37/69)
P-value	0.0002	0.04	Referent
Thirty day pregnancy rate, %[e]	72.7 (88/121)	77.5 (107/138)	89.2 (58/65)
P-value	0.01	0.05	Referent

[b] BCS: 1 = emaciated, 5 = moderate, 9 = very fat. BCS evaluated at start of synchronization.

[c] Percentage of cows displaying estrus 72 h after $PGF_{2\alpha}$ of the total cows treated.

[d] Percentage of cows pregnant to AI of the total cows that exhibited estrus and were AI.

[e] Percentage of cows pregnant during the synchronized breeding of the total cows treated.

[f] Percentage of cows pregnant during the first 30 d of breeding season of the total cows treated.

Figure 1. Monthly available bahiagrass DM forage mass

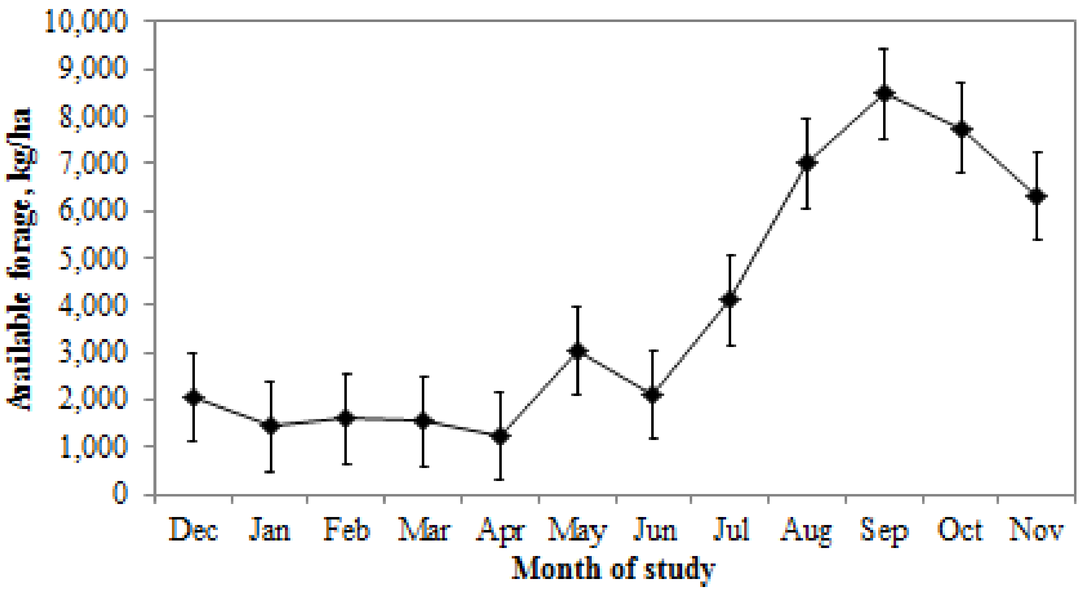
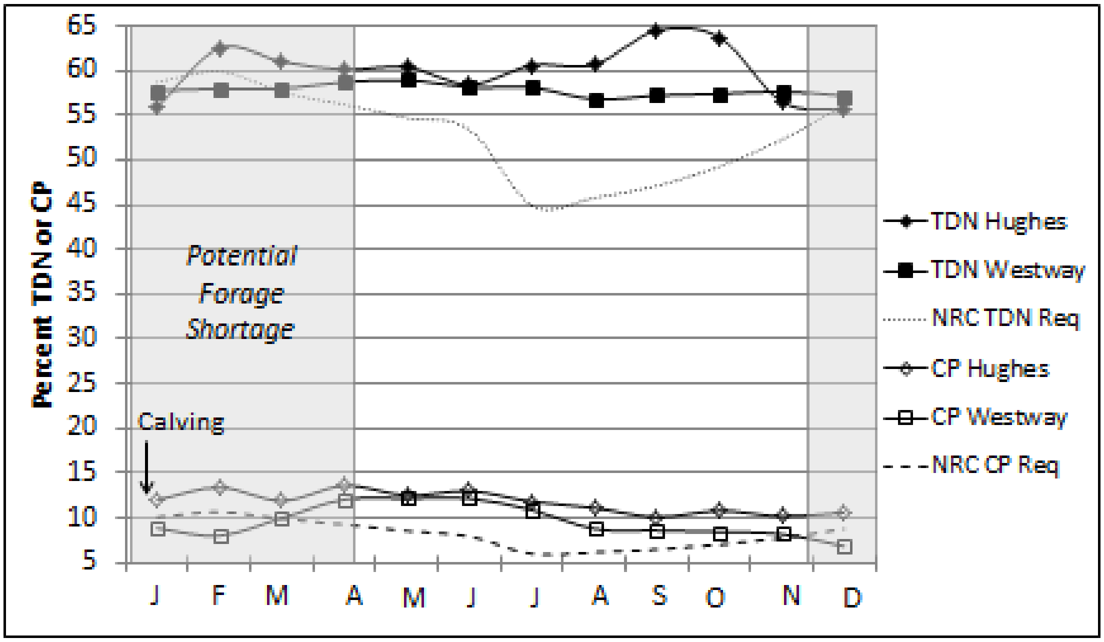


Figure 2. Inter-relationship of forage quality and cow requirements



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