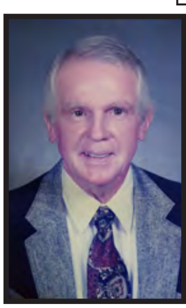
UF/IFAS Range Cattle Research and Education Center

Dr. W. Gordon Kirk
1941-1965

Dr. Herb L. Chapman
1965-1982

75th Anniversary Celebration & Field Day

October 27, 2016



Dr. Findlay M. Pate
1983-2005

Dr. John D. Arthington
2005-Present

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Schedule

Field Day opens 8:00 a.m.
(sponsor booths open, student posters displayed, and refreshments)

Program 9:05 a.m.
Welcome
John Arthington, UF/IFAS Range Cattle REC, Professor and Center Director

IFAS Remarks
Jack Payne, UF Sr. Vice President for Agriculture and Natural Resources

FCA Remarks
Ned Waters, President, Florida Cattlemen's Assoc.
Jim Handley, Executive Vice President, Florida Cattlemen's Assoc.

UF/IFAS Range Cattle REC Faculty Presentations
Raoul Boughton, Asst. Prof., Rangeland Ecosystems and Wildlife
Chris Prevatt, Regional Specialized Agent II, Livestock and Forage Economics
Philipe Moriel, Asst. Prof., Beef Cattle Nutrition and Management

Key Note Speaker – Erik Jacobsen, Deseret Cattle & Citrus

Historical Perspectives
Looking back on 75 years with Faculty, Staff, & Students

Lunch 12:15 p.m.

Sponsor Booths / Student Posters & Exhibits / Lab Tours 12:15 – 4:00 p.m.
Field Tour of Faculty Beef Enhancement Projects.
Departure options: 1:30 or 2:00 p.m.

John Arthington, Prof. and Center Dir., Beef Cattle Nutrition and Management
"Managing Free Choice Intake of Mineral among Grazing Beef Cows"

Brent Sellers, Assoc. Prof. and Assoc. Center Dir., Pasture and Rangeland Weed Mgmt. "Insight into Broomsedge Management in Bahiagrass Pastures"

Joao Vendramini, Assoc. Prof., Forage Management
"Fertilizer Efficiency of Limpograss Cultivars"

Maria Silveira, Assoc. Prof., Soil Fertility and Water Quality
"Biosolids Research and Demonstration Site"

Field Day Ends 4:00 p.m.

Welcome

Welcome to the UF/IFAS Range Cattle Research and Education Center's (RCREC) 75th Anniversary Celebration & Field Day! We are honored that you've joined us for this special occasion and hope that you enjoy the day. While you're here be sure to visit the sponsor's tent and the Extension Book Store's booth. You'll also have an opportunity to view the interesting work of our graduate students and we invite you to learn about the RCREC's programs through their exhibits and the lab tour, which will be available during lunch and afternoon program.

We value your support as our clients and partners and realize new challenges are on the horizon. It is our goal to continue to earn your trust as we work together to address these challenges and create a bright future for Florida's cattlemen and grazinglands.

We invite you to participate in our other activities. You can find information on upcoming events on our website, http://rcrec-ona.ifas.ufl.edu/ or follow us on Facebook, for timely updates on happenings.

Feel free to contact us anytime at ona@ifas.ufl.edu or 863-735-1314.

The RCREC Faculty

John Arthington
Brent Sellers
Raoul Boughton
Philipe Moriel
Chris Prevatt
Maria Silveira
Joao Vendramini

Factors Impacting Free-Choice Intake of Nutrient Supplements Offered to Grazing Cattle
Special Focus: Developing RFID Technologies to Understand Intake Variation

John Arthington, Professor and Center Director
Beef Cattle Nutrition and Management

In almost all production situations grazing cattle require supplemental nutrients to support optimal performance. Deficits can vary dramatically depending on many factors, most notably, region, season, and weather patterns. Around the World, almost all grazing cattle are deficient in sodium, thus supplemental salt has been recognized as vital to the health and performance of grazing livestock. Beyond salt, some macro-minerals can also be deficient, most notably, phosphorus. In many grazing situations, particularly those involving warm season grasses, phosphorus will be deficient at certain times of the season. This deficiency is almost always aligned with lactation, a period when the cow's phosphorus requirement is greatest. Micro-minerals are also often found to be deficient in grazed forage. The most commonly found micro-mineral deficiencies are copper, zinc, cobalt, and selenium.

In temperate climates, many cowherds are offered harvested forages with additional feed supplementation; however, in tropical and subtropical climates, where a large percentage of the World's beef is produced, cattle are typically enrolled in year-long grazing schedules. In these environments, supplementation strategies are critical to the productivity of these cowherds. Often, free-choice supplements are offered with the anticipation of adequate intake to offset nutrient deficiencies. Variation in free-choice intake, however, is a common problem impacting the efficacy of this management system. Although many contributing factors exist (Bowman and Sowell, 1997), variation due to changing seasons of the year is one common factor. Generally, as moisture content of forages increase, intake of free-choice supplements also increases. In one demonstration study, the voluntary intake of a salt-based free-choice supplement among grazing beef cows was surveyed over two consecutive years. Voluntary intake was correlated ($R^2 = 0.39$) with precipitation events in the 2 preceding months (Figure 1; courtesy of Vigortone Animal Nutrition; unpublished data). Similarly, we reported a large seasonally-impacted reduction in voluntary intake of salt-based, free-choice mineral supplements among grazing beef cows in southern Florida (Arthington and Swenson, 2004). In that study, cows were offered supplement in amounts to provide their targeted (assumed) intake on a weekly basis. All unconsumed supplement was measured weekly and the results were calculated as a percent refusal. During the dry season, when forage moisture was low, the percent refusal was high (i.e. voluntary intake was low); however, during the wet season, when forage moisture was high, voluntary intake was at or above the targeted amount (Figure 2).

Although clearly a considerable challenge, the need to understand the factors impacting variation in free-choice mineral supplement intake is evident. With an improved understanding of these factors, technologies and management systems may be devised to assist in this effort. This article will focus on four separate topics related to factors impacting free-choice mineral supplement intake, including; (1) salt limiter, (2) pH and/or cation/anion balance, (3) taste and/or "mouth feel", and (4) controlled mineral feeding.

(1) Salt Limiter

Cattle have a nutritional need for sodium and chlorine. This requirement has been realized for centuries due to a natural craving for common salt. In fact, salt is the only nutrient that cattle display a nutritional wisdom for consumption. When given adequate access, cattle will consume salt in amounts that meet or exceed their nutritional requirement for sodium and chlorine. Collectively, these two elements function as electrolytes in body fluids and are essential for nutrient metabolism. Signs of sodium and chlorine deficiency result in pica, which is an abnormal appetite or craving for non-nutritional substances, presumably to obtain salt. This condition results in behaviors such as licking of wood, rocks, soil, sweat, or bones from other animals. A prolonged deficiency results in a loss of appetite, decreased growth, unthrifty appearance, reduced milk production, and loss of body weight (Underwood and Suttle, 1999). Sodium is the most limiting of the two minerals in typical cattle diets, so supplementation is almost always required. Common salt is the most widely utilized source for sodium supplementation. The sodium requirement of beef cattle is not well understood; however, it is reasonable to assume that it will be impacted by level of milk production, environmental conditions, and growth status. The Beef NRC (1996) suggests a maximum sodium requirement of 0.08% for dry cows and 0.10% for lactating cows. These guidelines were derived from Morris (1980) and still serve as a functional guideline for grazing beef cattle today.

Annual variations in salt-based, free choice mineral supplements are widely observed across the globe. These fluctuations are often seasonal in nature and associated with changes in precipitation (i.e. Figures 1 and 2) among many other factors (McDowell, 1996). A common misconception is that cattle will consume free-choice mineral at the amount needed to meet their requirements, thus if cattle are consuming more mineral than usual, it must be due to an increased need. This is not true. With the possible exception of phosphorus under severe deficiency states (Denton et al., 1986), cattle only have a nutritional wisdom to consume salt at or above their nutritional requirement. Because salt is used as a carrier for most of our free-choice mineral supplements, seasonally-impacted increases in intake are only a reflection of an increased craving for salt. This seasonal change in mineral intake pattern is likely related to both an increased sodium requirement, but also an unexplained craving for salt. If allowed free choice access, grazing cows will often consume mineral supplement in excess of their requirement during certain seasons of the year when their craving for salt is increased. This increased intake will typically not harm the cowherd; however, it is also will not improve production. It is a costly waste that can be lessened by using salt as an intake limiter during periods of excessive intake. For example, if a product is formulated for a 100 g/d intake and the cowherd is consuming an average of 200 g or more daily (typical seasonal variation), then consider mixing the supplement with straight white stock salt at a 50:50 ratio. Thus, a 200 g/cow daily intake of the blended mixture will result in the originally targeted consumption rate of 100 g/cow daily of the complete mineral premix supplement. This management option can greatly reduce your annual cowherd mineral costs without impacting production. Remember, when using this management strategy; do not feed the white stock salt and mineral supplement separately - instead, hand-mix the two together. Also, it is important to continually monitor intake. As the natural seasonally-influenced salt craving changes and voluntary intake declines, reduce in the inclusion of white stock salt with the goal of regulating the intake of the mineral supplement as close as possible to the formulation's feeding instructions. By monitoring and recording mineral intake each week, a record can be obtained that will be fairly repeatable on an annual basis with the same mineral supplement, pastures, and herd of cows.

Salt has also long been recognized as an effective intake limiter for free-choice energy and protein supplements for mature cattle (Riggs et al., 1953), but particularly for pre-weaned calves and young growing (stocker) cattle. These supplementation systems are intended to provide a small amount of supplemental nutrition targeted to fill gaps in protein and/or energy deficiencies. In Florida, on-farm field studies have been conducted to investigate the effects of providing cottonseed meal to pre-weaned calves. Intake was limited by the inclusion of salt which was gradually increased in the formula (up to 8%) to limit intake to approximately 1.7 kg/d. A summary of 6 experiments revealed that calves experienced 0.30 kg/d of added gain while consuming an average of 1.43 kg of cottonseed meal daily. Each kg of added gain required approximately 4.85 kg of cottonseed meal. Although these experiments revealed significant variation among studies, they collectively suggest that pre-weaned beef calves can experience efficient, cost-effective added gains when provided limit-fed creep supplements. It is important to continually monitor actual intake when salt is used as a limiter in free-choice supplements. Cattle, particularly young cattle, can gradually become accustomed to the salt inclusion and begin tolerating larger daily intakes, thus resulting in a gradual increase in the voluntary intake of the free-choice supplement beyond the targeted amount. As an illustration, Schauer et al. (2004) used salt to limit free-choice supplement intake among weaned steers grazing native pasture. In that study, the supplement contained 16% salt to target a daily intake of 0.50% of calf body weight. In the first two months of supplementation, the formulation met the targeted intake (Figure 3); however, in the final two months, calves became accustomed to the 16% salt inclusion and free-choice intakes increased to nearly 1.0% of body weight.

(2) <u>Cation/anion balance (DCAD) and pH</u>

The dietary cation/anion difference (DCAD) is often manipulated in attempt to impact the physiology of periparturient dairy cows to protect them from complications associated with milk fever. As the inclusion of anionic salts drives the DCAD into a negative balance, voluntary dry matter intake also declines (Block, 1984). This response may also be effective in beef cattle. In one study, the inclusion of 5.25% anionic salts (ammonium chloride and ammonium sulfate) to a free-choice supplement was initially effective in limiting intake of a free-choice supplement offered to weaned grazing steers (Figure 3; Schauer et al., 2004). However, this response appeared short-lived and ultimately was inferior to salt limiter over the 4 month evaluation period (Figure 3). The logic of using negative DCAD balance as an intake limiter for free-choice supplements is questionable; particularly if the reduction in physiological pH results in an overall reduction in voluntary forage dry matter intake. In another study, beef cows consuming a negative vs. positive DCAD diet (-0.9 vs. 25.0 mEQ/100 g DM) had less voluntary forage dry matter intake and reduced urine, blood, and uterine pH (Hersom et al., 2010).

The DCAD technology cannot necessarily be removed from the direct impact of supplement pH on voluntary intake. The two should be considered together. Multiple field demonstration studies (unpublished data; courtesy of Dr. Larry Caswell, Vigortone Animal Nutrition, Cargill Inc.) have demonstrated differences in free-choice intake of mineral supplements formulated with differing forms of feed phosphorus. In their studies, the preferential intake of 50:50 mixtures of salt and feed-phosphorus increases as the pH of the source of feed phosphorus increases (Table 1). Additionally, phosphorus source also impacted preferential intake of block supplements offered to grazing beef cattle, whereas cattle preferentially consumed blocks formulated with increasing amounts of tri-calcium phosphate (increasing pH) as a source of feed phosphorus (Table 2). These field observations provide interesting insight into the effects of feed phosphorus source on voluntary intake of free-choice supplements. It is unclear whether these responses are the result of supplement pH or rather simply source of phosphorus. Currently, little consideration is placed on this potential impact when formulating free-choice supplements and the published literature is lacking in supporting evidence. Further research in this field is warranted.

(3) <u>Taste or "Mouth Feel"</u>

The influence of pH on taste or "mouth feel" is certainly linked. Anionic salt supplements clearly impact the taste of a diet. This is likely due to the highly acidic result of the anionic-salt formulated supplement. Additionally, soluble sources of trace metals may also create a taste or "mouth feel" effect. In our studies, we have experienced this impact in models involving young calves, which are known to have approximately 2.5X the number of taste buds compared to humans. This allows for a larger range in flavors and thus potential taste aversions (unpublished data; Yale University, College of Nursing).

Related to this phenomena, our research team has attempted to devise management technologies to improve the trace mineral nutrition of pre-weaned calves with the central aim of improving post-weaning health and performance. As an alternative to traditional creep feeding systems, we have illustrated that limited creep, in amounts < 0.5 kg/d, result in a behavioral association of humans and feed, acclimation to concentrated feedstuffs, and improved trace mineral status. In our initial studies, we discovered that calves provided creep-feed without trace mineral fortification had greater voluntary supplement intake compared to calves provided the same creep supplement but fortified with trace minerals. In this experiment, calves provided mineral-fortified supplements never reached their maximum targeted supplement intake of 110 g/calf daily (Figure 4; Moriel and Arthington, 2013). Following these initial experiences, we sought to examine various sources of trace minerals that might improve voluntary supplement consumption. Visually, calves consuming these mineral-fortified supplements appeared to exhibit 'taste-aversion' to the feed. We questioned the possibility that the highly-soluble trace mineral sources used in the formulation (primarily sulfate sources) were creating a “metallic taste” in the calves’ mouth, thus reducing voluntary intake. To address this question, we sought to examine different trace mineral sources with lesser solubility. One source of Cu, Zn, and Mn, called hydroxychlorides (trade name IntelliBond), is offered by Micronutrients Inc. (Indianapolis, IN). Compared to the sulfate and organic counterparts used in our initial study, the hydroxychloride sources of Cu, Zn, and Mn are less soluble. We hypothesized that the low solubility of these ingredients would improve preferential intake. In our first experiment, weaned calves, offered supplements fortified with hydroxychloride-sources of Cu, Zn, and Mn had much greater preferential intake compared to supplements fortified with equivalent amounts of Cu, Zn, and Mn from organic and sulfate sources (Figure 5).

We have also examined the influence of trace mineral source on measures of voluntary intake of mineral supplements provided to grazing cows and calves. Two experiments were conducted using commercially manufactured, free-choice, salt-based mineral supplements. The supplements were formulated to be nutritionally identical with the inclusion level of Ca carbonate adjusted to account for differences in metal content among the different sources of Cu, Zn, and Mn examined in these studies (i.e. sulfate, hydroxychloride, and organic). The 3 formulations were offered simultaneously to pre-weaned beef calves (4 pastures; 17 calves/pasture) within separate stainless steel bowls inside covered cow-exclusion areas. Therefore, all pastures received the same access to each treatment formulation to allow measurement of preferential intake. Preferential intake was evaluated weekly for 18 weeks prior to weaning and calves were approximately 6 mo old at the start of the study. Fresh supplements, in amounts to ensure free-choice intake, were provided weekly. Overall, consumption of mineral averaged 21 ± 2.4 g/d (sum of all 3 sources). Averaged over all 18 weeks, there was a greater ($P < 0.001$) percentage of the total intake of the formulation containing hydroxychloride- vs. organic- or sulfate-sources of Cu, Zn, and Mn (42.8, 30.2, and 27.0% of total intake, respectively; SEM = 1.03).

Another experiment was conducted using the same pasture groups and cowherd. The objective of this experiment was to evaluate intake and mineral status among cows and pre-weaned calves provided free-choice, salt-based mineral supplement containing either hydroxychloride or sulfate sources of Cu, Zn, and Mn. The two mineral treatments were randomly assigned to pastures (n = 4 pastures/treatment) containing 18 to 20 cow-calf pairs/pasture. Treatments were delivered to pastures within covered cow and calf exclusion areas which were designed to allow intake measures separately. Voluntary intake was evaluated weekly for 20 weeks prior to weaning and calves were approximately 6 mo old at the start of the study. Fresh supplement, in amounts to ensure free-choice intake, was provided weekly. When provided only a single treatment with no option for preferential selection, there was no effect of Cu, Zn, and Mn source (hydroxychloride or sulfate; $P = 0.44$) on voluntary mineral intake among calves; however, cows had a numerical tendency ($P = 0.14$) to consume more mineral containing hydroxychloride- vs. sulfate-sources of Cu, Zn, and Mn (Table 3). In addition, calves consuming mineral containing hydroxychloride-sources of Cu, Zn, and Mn tended ($P = 0.06$) to have greater

ADG over the 20-wk period compared to calves consuming sulfate-sources of the same elements (1.09 vs. 1.06 kg/d; SEM = 0.013).

(4) Controlled Mineral Feeding

This management strategy involves the formulation of a palatable, grain-based supplement fortified with essential minerals. This method of mineral feeding can be particularly useful when cattle are not attracted to supplemental salt, which can be observed in areas with saltwater intrusion or otherwise high-salt content of drinking water. Under these situations, cattle may not adequately consume salt-based, free-choice mineral supplements, and thus, lack essential minerals such as copper, cobalt, selenium, and zinc. When offered at a minimum of once or twice weekly, this mineral-fortified supplement can be an effective, efficient tool for delivering supplemental minerals to the cowherd. For best results, the supplement should be formulated into a range cube or pellet and fed on the ground. Loose mix supplement offered in feed bunks can also be effective, but attention to adequate bunk space to ensure intake opportunities for all cattle is essential. Molasses-based liquid formulations are also available. To limit the costs associated with handling and storage, these mineral supplements should be concentrated such that maximum intake can be limited to < 200 g/cow at each feeding for the dry supplements and less than 500 g/day for liquid supplements. The mineral specifications can vary greatly depending on the amount of product being consumed and the frequency of feeding. Free choice white stock salt should be offered to the cowherd at all times.

Current Research

Using RFID Technology to Assess Factors Impacting Variation in Free-Choice Mineral Intake among Grazing Cattle

Overview:

The need to understand the factors impacting variation in free-choice, salt-based supplement intake is evident. Through FY2016 funding support by FCA/FDACS, our team developed field-ready RFID (radio-frequency identification) technology to accurately assess the frequency of individual animal visits to a mineral feeder. Six portable units were constructed (photo). Each mineral feeder was equipped with a tag reader, which allowed every animal's visit to the feeder to be recorded. In addition, funds were provided to perform initial testing with the central aim of evaluating breed differences on behavioral measures of voluntary free-choice intake of a salt-based mineral supplement. Interesting new information has been revealed implying that Brahman cattle make more frequent visits to the mineral feeder with a larger percentage of visits during the hottest hours of the day compared to Braford or Angus cattle. Using this new research tool, we will seek additional funding in FY2017 to begin to address how these behavior differences relate to the mineral status of Brahman vs. Angus cattle and how recommended management systems may differ when addressing the mineral nutrition requirements of these two breed types.

Material and Methods:

An observational study was conducted at the Range Cattle Research and Education Center (Ona, FL) to evaluate behavior differences due to breed on the consumption of salt-based, free-choice mineral supplements.

Sixteen heifers representing 3 breeds were utilized (4/breed; Brahman, Braford, and Ona White Angus). Heifers were allocated to a single "Jiggs" Bermudagrass [*Cynodon dactylon* (L.) Pers.] pasture with access to a single RFID-equipped mineral feeder containing a salt-based mineral supplement in amounts to ensure free-choice consumption (9.1, 4.0, and 62.5% Ca, P, and NaCl, and 1,750, 60.0, and 5,000 mg/kg Cu, Se, and Zn, respectively). Distribution of daily visits were reported in 8 h intervals; morning = 05:00 to 12:59, afternoon = 13:00 to 20:59, and night = 21:00 to 04:59. Supplement intake was evaluated throughout the study by calculation of disappearance rate. Individual heifer visits to the mineral feeder were recorded from May to July of 2016. A total of 47 d of data resulted in 1400 readings were achieved.

Readings were evaluated in cycles of 24 h. Recorded data were sometimes impacted by the capacity of the battery and infrequent software errors. If the reader stopped recording data, the next reading to be added to the file was the first reading of the same period in the following day and in-between readings deleted. Data were analyzed using the MIXED procedure of SAS. (SAS Inst. Inc., Cary, NC; version 9.4). The dependent variable was the number of individual visits and the model statement included the effects of week, period, breed and their interactions. Results are reported as least squares means; Significance was set at $P \leq 0.05$, and tendencies were determined if $P > 0.05$ and $P \leq 0.11$.

Results:

Individual visits to the mineral feeder were reported as a total and percentage of total for each breed group throughout the individual daily segments (Table 4).

During the evaluation period, visits were consistently distributed throughout the day. The afternoon period (13:00 to 20:59) had a numerically greater number of visits (562 visits; 40.1% of total) when compared to the other two periods. The number of morning visits (05:00 to 12:59; 554 visits; 39.6% of total) followed the afternoon visits with the night period (21:00 to 4:59) having the least frequent visits (284 visits; 20.3% of total). There were no differences ($P =$ 0.85) for the number of visits when comparing morning and afternoon periods; however, both periods had a greater ($P \leq .001$) number of visits when compared to the night period.

When assessing mineral feeder visits by breed, there was a tendency for Brahman heifers to visit the mineral feeder more often than the Ona White Angus ($P = 0.08$) and Braford heifers (P = 0.11). There were no differences in the frequency of mineral feeder visits between Braford and Ona White Angus heifers ($P = 0.90$). As a total of visits, the Brahman heifers visited the feeder 516 times, while the Braford and Ona White Angus heifers made 445 and 439 visits, respectively (36.9, 31.8, and 31.4% of the total of visits for Brahman, Braford and Ona White Angus heifers, respectively).

When assessing mineral feeder visits by breed and period, Brahman and Braford heifers had a greater ($P \leq 0.05$) number of visits to the feeder in the mornings when compared to Ona White Angus heifers. There were 223, 197, and 134 visits, respectively, for Brahman, Braford, and Ona White Angus heifers, representing 43.2, 44.3, and 30.5% of the morning visits, respectively.

For the afternoon period, Brahman heifers had the greatest ($P \leq 0.01$) number of visits when compared to the other two breeds. There were no differences ($P = 0.55$) for the number of afternoon visits between Braford and Ona White Angus heifers. There were 233, 172, and 152 visits, respectively, for the Brahman, White Angus and Braford heifers, representing 45.2, 39.2, and 35.3% of the afternoon visits, respectively.

For the night period, Ona White Angus heifers had a greater ($P \leq 0.01$) number of visits compared to Brahman heifers, and tended ($P = 0.10$) to have a greater number of visits compared to Braford heifers. There were no differences ($P = 0.22$) among Brahman and Braford heifers for the number of night visits to the mineral feeder. There were 133, 91, and 60 visits, respectively, for White Angus, Braford and Brahman, representing 30.3, 20.4, and 11.6% of the night visits, respectively.

Within breed comparisons for each period were also evaluated. Braford heifers tended ($P = 0.11$) to have a greater number of visits during the morning vs. afternoon and night periods (197, 157 and 91 visits for morning, afternoon and night, respectively). Brahman heifers had fewer ($P < 0.01$) visits to the mineral feeder in the evening vs. morning and afternoon periods. Unlike Braford and Brahman heifers, there were no differences ($P = 0.13$) among periods for the number of visits that Ona White Angus heifers made to the mineral feeder (134, 172 and 133 visits in the morning, afternoon and night, respectively).

Mineral supplement intake was recorded and calculated by the disappearance rate. During the evaluation period, mineral supplement intake ranged from 38 to 130 g/head daily, which resulted in an average of 79 g/head daily. These data illustrate the expected variation in free-choice mineral intake. Heifers experienced periods when daily consumption was below and above the targeted rate of 50 g/head daily. This variation is impacted by many factors, including soil fertility, forage type, season of the year, sodium content of drinking water, and precipitation.

Summary

In summary, it is important to understand the seasonal fluctuations in free-choice supplement intake among grazing beef cattle. These changes are regional and can be impacted by precipitation (forage moisture), salt content of drinking water, and presence of supplemental feeds, environmental conditions, and stage of production. Provided adequate access, cattle will consistently consume supplemental salt at levels that meet and exceed their requirement for sodium. Therefore, salt can be used to dilute free-choice mineral mixtures during times of excessive salt craving. Salt can also be effective as a limiter for free-choice energy and protein supplements offered to grazing cattle. However, acclimation and increased tolerance limit the effectiveness of salt-limiter over extended periods of time. Inclusion of anionic salts to alter DCAD will impact supplement intake but may negatively impact overall forage intake. Lastly, dietary pH and source of phosphorus and trace minerals will also influence voluntary intake of free choice supplements. When cattle lack an attraction to salt-based mineral supplements or technologies to effectively limit overconsumption are ineffective, beef producers can control-feed supplements through a low-intake, mineral-fortified feedstuff offered once or twice weekly. Recent research efforts supported by the Florida Cattlemen's Association Beef Enhancement Fund have found breed differences related to mineral intake behavior among grazing beef cattle. Future approaches, considering season of the year, source of supplements, and location of feeder should be considered. These research efforts will help better explain this variation and allow for the implementation of management systems that seek to optimize the mineral nutrition of grazing beef cattle.

Literature Cited

Arthington, J.D., and C.K. Swenson. 2004. Effects of trace mineral source and feeding method on the productivity of grazing Braford cows. Prof. Anim. Sci. 20:155-161.

Block, E. 1984. Manipulating dietary anions and cations for prepartum dairy cows to reduce incidence of milk fever. J. Dairy Sci. 67:2939-2946.

Bowman, J. G. P. and B. F. Sowell. 1997. Delivery method and supplement consumption by grazing ruminants: A Review. J. Anim. Sci. 75:543-550.

Denton, D. A., J. R. Blair-West, M. J. McKinley, and J. F. Nelson. 1986. Problems and paradigms: Physiological analysis of bone appetite (Osteophagia). BioEssays. 4:40-43.

Hersom, M. J., G. R. Hansen, and J. D. Arthington. 2010. Effect of dietary cation-anion difference on measures of acid-base physiology and performance in beef cattle. J. Anim. Sci. 88:374-382.

McDowell, L. R. 1986. Feeding minerals to cattle on pasture. Anim. Feed Sci. Tech. 60:247-271.

Moriel, P., and J.D. Arthington. 2013. Effects of trace mineral-fortified supplements on performance of pre- and post-weaned beef calves. J. Anim. Sci. 91:1371-1380.

Morris, J. G. 1980. Assessment of sodium requirements of grazing beef cattle: A review. J. Anim. Sci. 50:145-152.

NRC. 2014. Nutrient Requirements of Beef Cattle. 7th ed. Natl. Acad. Press, Washington, DC.

Riggs, J. K. R. W. Colby, and L. V. Sells. 1953. The effects of self-feeding salt-cottonseed meal mixtures to beef cows. J. Anim. Sci. 12:379-393.

Schauer, C. S., G. P. Lardy, W. D. Slanger, M. L. Bauer, and K. K. Sedivec. 2004. Self-limiting supplements fed to cattle grazing native mixed-grass prairie in the northern Great Plains. J. Anim. Sci. 82:298-306.

Underwood, E. J., and N. F. Suttle. 1999. The Mineral Nutrition of Livestock. 3rd Ed. CABI Publishing, New York, NY.

Tables and Figures

Table 1. Effect of phosphorus source on preferential intake of 50:50 mixtures of salt and feed phosphorus.[1]

Phosphorus source	pH	Intake, % of total
Monocalcium	3.6	26.4
Dicalcium	4.2	32.2
Tricalcium	8.8	41.4

[1]Research conducted on 10 herds in Wyoming. Unpublished data courtesy of Dr. Larry Caswell, Vigortone Animal Nutrition, Cargill Inc.

Table 2. Effect of phosphorus source on preferential intake of block supplements.[1]

Phosphorus source	Intake, % of total
MCP (100)	7.1
MCP : DCP (67:33)	17.5
MCP : DCP (33:67)	29.8
TCP (100)	45.6

[1]Research conducted on 4 herds in Kansas and Missouri. Unpublished data courtesy of Dr. Larry Caswell, Vigortone Animal Nutrition, Cargill Inc.

Table 3. Free-choice, salt-based mineral intake among cows and calves (Exp 2).[1]

	Treatment			
Group	Hydroxy	Sulfate	SEM	P =
	--------------- g/d ---------------			
Cows	69.5	60.7	3.64	0.14
Calves	15.0	16.6	1.31	0.44

[1]Values are lsmeans. Intake measured over 20 consecutive weeks. Cows and calves were provided free-choice, salt-based mineral supplements containing either hydroxy or sulfate sources of Cu, Zn, and Mn. Treatments were delivered to pastures within covered cow and calf exclusion areas which were designed to allow intake measures separately.

Table 4. Effect of yearling heifer breed on the frequency of visits to a RFID-equipped feeder containing salt-based, free-choice mineral supplement[1]

Breed[2]	Total of Visits by Breed	Morning[3]	Afternoon[3]	Night[3]
Braford	445 (31.8)^{a}	197 (44.3)^{a,d}	157 (35.3)^{a,d}	91 (20.4)^{a,e}
Brahman	516 (36.9)^{a†}	223 (43.2)^{a,d}	233 (45.2)^{b,d}	60 (11.6)^{a,e}
White Angus	439 (31.4)^{a}	134 (30.5)^{b}	172 (39.2)^{a}	133 (30.3)^{b}
Total[4]	1400	554^{d}	562^{d}	284^{f}

[1]Data collected over 47 days in May/July, 2016. Heifers were grazing fertilized 'Jiggs' Bermudagrass pasture. Supplement was a salt-based mineral supplement in amounts to ensure free-choice consumption (9.1, 4.0, and 62.5% Ca, P, and NaCl, and 1,750, 60.0, and 5,000 mg/kg Cu, Se, and Zn, respectively).
[2]Breeds consisted of Braford (n = 4) and Brahman (n = 4), and Ona White Angus (n = 4). The pooled Breed x Period SEM = 3.6.
[3]Distribution of daily visits reported in 8 h intervals; Morning = 05:00 to 12:59, Afternoon = 13:00 to 20:59, and Night = 21:00 to 04:59.
^{a,b} Number of visits in a column with different superscript differ ($P < 0.05$).
^{d,f} Number of visits in a row with different superscript differs ($P < 0.05$).

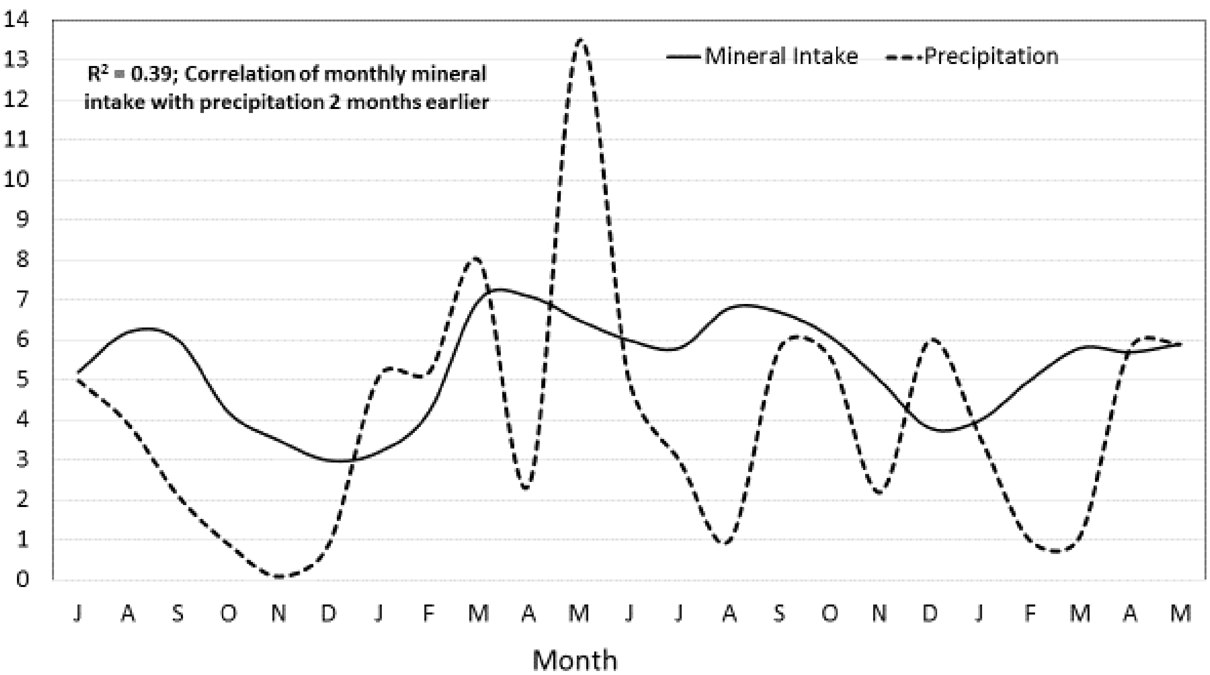


Figure 1. Correlation of free-choice mineral intake with monthly precipitation in grazing beef cows. Curtesey of Vigortone Animal Nutrition, Cargill Inc; Unpublished data.

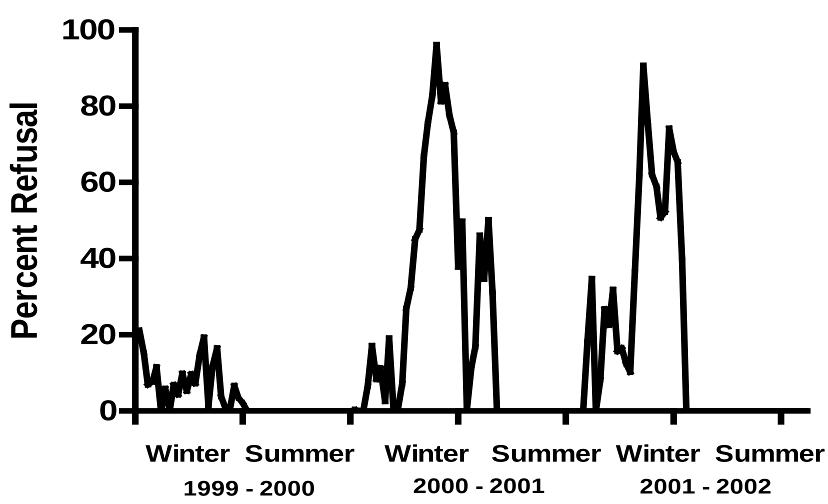


Figure 2. Annual variation in free-choice, salt-based mineral intake among grazing beef cows in Florida. Cowherds (n = 8; 20 cow/herd) were provided the product's recommended intake of 57 g/d in a single weekly feeding. Refusal was measured weekly over a 3-year period (Arthington and Swenson, 2004).

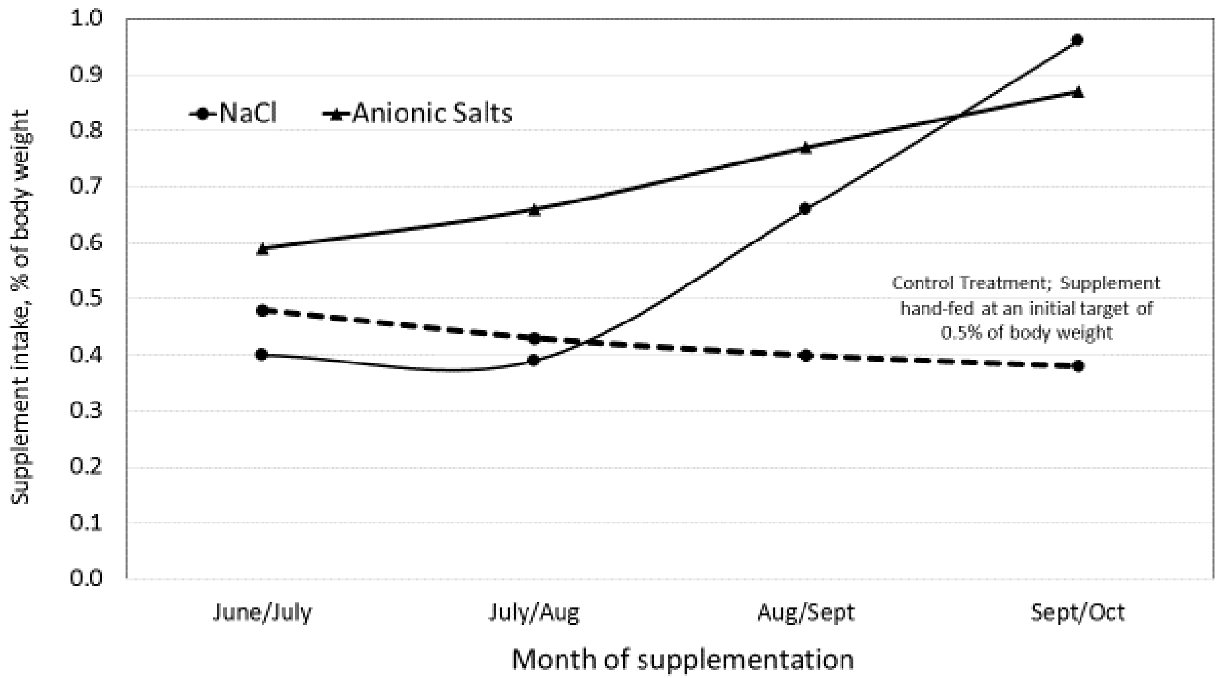


Figure 3. Effects of NaCl and anionic salts (16 and 5.25% inclusion, respectively) as intake limiters for free-choice supplements offered to steers grazing native pastures. Adapted from Schauer et al., 2004.

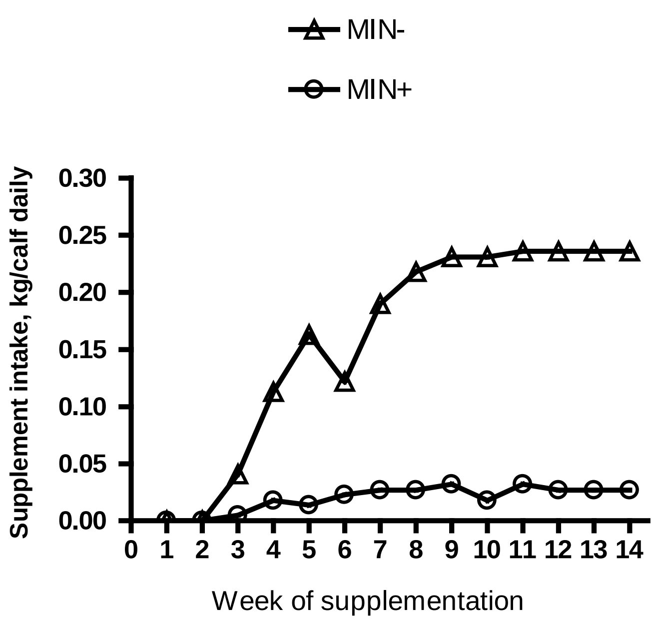


Figure 4. Intake of limit-fed creep supplements fortified (MIN+) or not (MIN-) with trace minerals. Calves were provided supplements 3 times weekly (M, W, and F) in amounts equivalent to 0.5 lb (0.23 kg) daily (Moriel and Arthington, 2013).

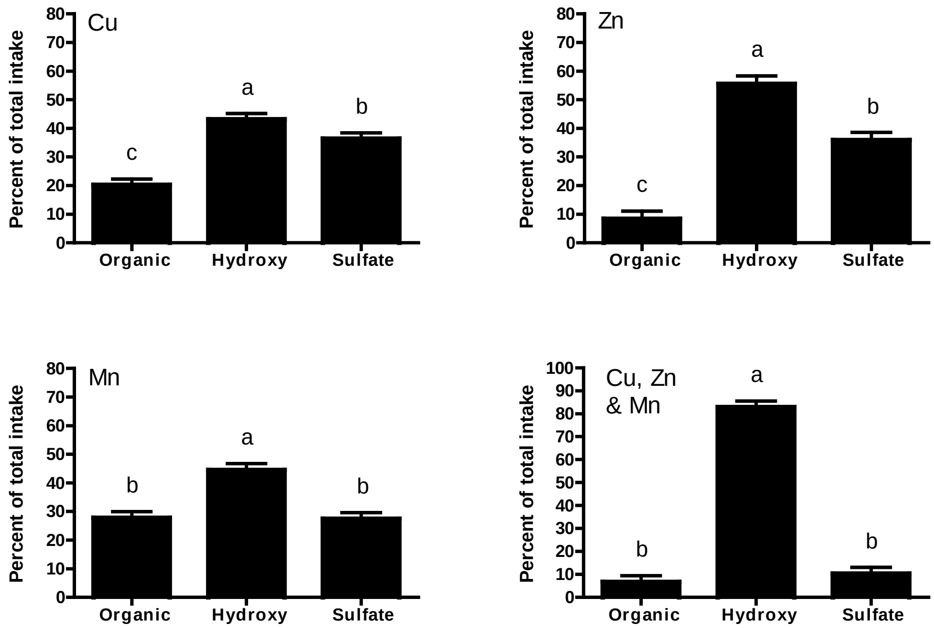


Figure 5. Preferential intake of supplements fortified with Cu, Zn, and Mn, individually or combined together, from 3 sources (organic, hydroxy or sulfate) by weaned beef calves. Calves were provided a complete ration over a 7-day evaluation periods. At 10:00 daily, all feed was removed and calves were offered each of the three supplements simultaneously in amounts to ensure free-choice intake. Preferential intake, as a percent of offer, was calculated 4 hour later.

Photo Caption: RFID Mineral Feeder Validation Experiment (April, 2016).
Motion sensor camera used to validate system by pairing computer RFID data with visual presence.
UF/IFAS, Range Cattle Research and Education Center, Ona

Broomsedge Management in Bahiagrass Pastures

Brent A. Sellers

Ona 75th Anniversary

October 27, 2016

UF | IFAS Extension
UNIVERSITY of FLORIDA

Broomsedge

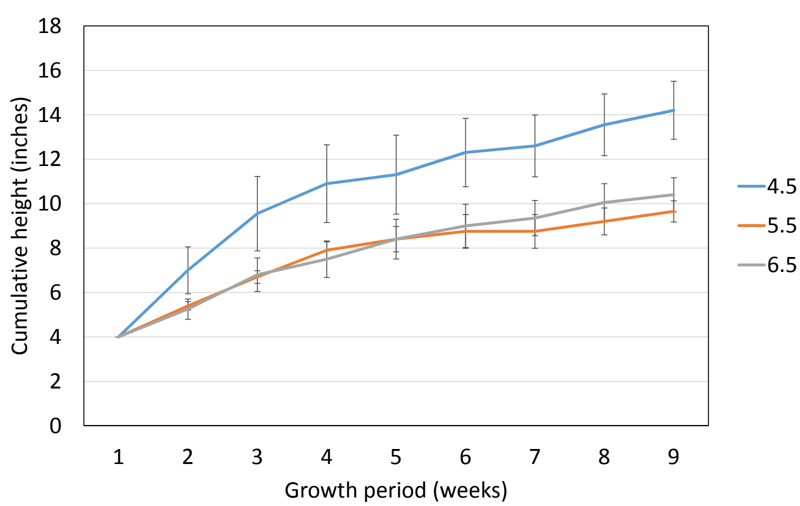
- Tufted perennials
- 3 to 5 yrs
- ~18 species present
- Extremely evident this time of year

Broomsedge

- Soil pH is not necessarily the reason

Location	pH	P	Cu	Zn
		-----------ppm--------------		
Hardee	5.9	42	0	1.46
Polk	5.1	1	0	0.74
Polk**	6.0	105	1.37	19.39
Polk	4.5	3	0	7.34
Okeechobee	5.4	0	0	3.38
Highlands	4.1	2	0	3.97
Manatee	5.6	0	0	0.43
Ona	4.3	2	0	0.95
Glades	5.8	0	0	6.55
DeSoto	7.8	40	0	0.54

Cumulative Purple Bluestem Height



Circumstantial Evidence

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- Optimize soil pH
- Does P have a role?
- Does Cu have a role?
- Does something else have a role?

Location	pH	P	Cu	Zn
		-----------ppm-------------		
Hardee	5.9	42	0	1.46
Polk	5.1	1	0	0.74
Polk**	6.0	105	1.37	19.39
Polk	4.5	3	0	7.34
Okeechobee	5.4	0	0	3.38
Highlands	4.1	2	0	3.97
Manatee	5.6	0	0	0.43
Ona	4.3	2	0	0.95
Glades	5.8	0	0	6.55
DeSoto	7.8	40	0	0.54

Methods

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- 3 locations
  - Ona (2012)
  - Arcadia (2012)
  - St. Cloud (2013)
- Annual application
  - 10-5-10
  - Frit 503-G (micros)
- Broomsedge counts annually
- Soil and tissue samples - fall

Rep 4	0Lime 0 NPK Micro	Lime 0 NPK 0 Micro	0 Lime NPK Micro	Lime NPK 0 Micro	Lime 0 NPK Micro	0 Lime 0 NPK 0 Micro	Lime NPK Micro	0 Lime NPK 0 Micro
Rep 3	0 Lime NPK 0 Micro	Lime 0 NPK Micro	Lime NPK Micro	0 Lime 0 NPK 0 Micro	0 Lime NPK Micro	0 Lime) NPK Micro	Lime 0 NPK 0 Micro	Lime NPK 0 Micro
Rep 2	0 Lime NPK Micro	0Lime 0 NPK Micro	0 Lime NPK 0 Micro	0 Lime 0 NPK 0 Micro	Lime NPK Micro	Lime 0 NPK 0 Micro	Lime NPK 0 Micro	Lime 0 NPK Micro
Rep 1	Lime NPK Micro	0 Lime NPK Micro	Lime 0 NPK Micro	0Lime 0 NPK Micro	Lime NPK 0 Micro	0 Lime NPK 0 Micro	0 Lime 0 NPK 0 Micro	Lime 0 NPK 0 Micro

Methods – Location Information

Location	Soil pH	P	K	Mg	Ca	Cu	Mn	Zn	Species	Density
		——————PPM——————								plants/m^2
Arcadia	7.7	13	10	69	1879	0	2	2	Bushy bluestem	5.0
Ona	4.3	2	19	24	116	0	0	0	Purple bluestem	2.8
St. Cloud	5.5	2	22	44	281	0	0	0	Broomsedg e bluestem	4.4

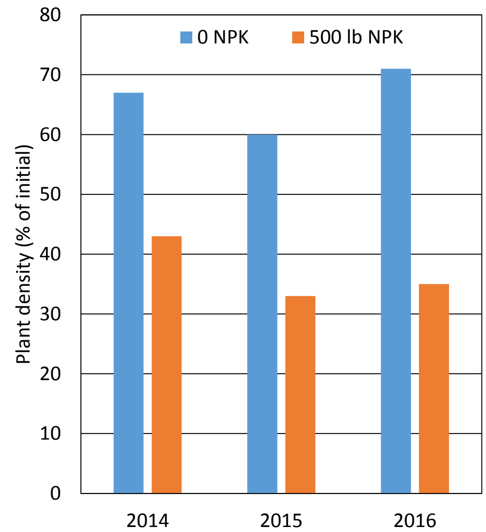
Plot Layout

Rep 4	0Lime 0 NPK Micro	Lime 0 NPK 0 Micro	0 Lime NPK Micro	Lime NPK 0 Micro	Lime 0 NPK Micro	0 Lime 0 NPK 0 Micro	Lime NPK Micro	0 Lime NPK 0 Micro
Rep 3	0 Lime NPK 0 Micro	Lime 0 NPK Micro	Lime NPK Micro	0 Lime 0 NPK 0 Micro	0 Lime NPK Micro	0 Lime) NPK Micro	Lime 0 NPK 0 Micro	Lime NPK 0 Micro
Rep 2	0 Lime NPK Micro	0Lime 0 NPK Micro	0 Lime NPK 0 Micro	0 Lime 0 NPK 0 Micro	Lime NPK Micro	Lime 0 NPK 0 Micro	Lime NPK 0 Micro	Lime 0 NPK Micro
Rep 1	Lime NPK Micro	0 Lime NPK Micro	Lime 0 NPK Micro	0Lime 0 NPK Micro	Lime NPK 0 Micro	0 Lime NPK 0 Micro	0 Lime 0 NPK 0 Micro	Lime 0 NPK 0 Micro

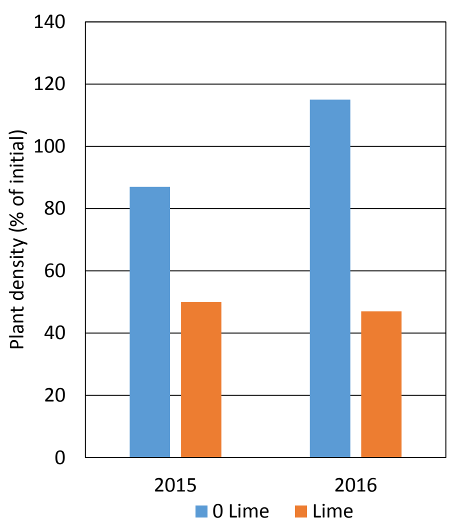
- Ona = Lime (2012); Aracadia = S; St. Cloud = None

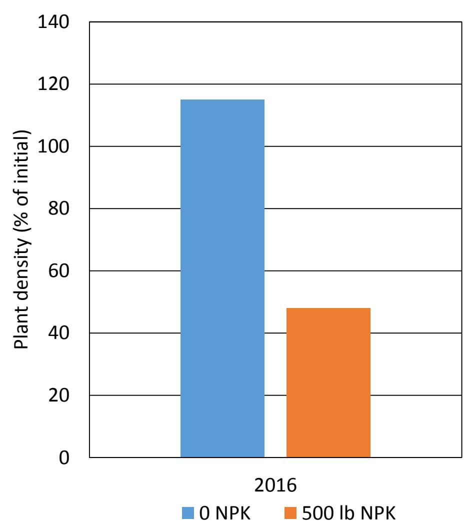
Results - Arcadia

- NPK response
- No response:
  - S
  - Micros



Results - Ona





Soil pH

- Arcadia: No change
- Ona: 4.3 to 4.9 (limed plots)
- St. Cloud: 5.5 to 5.0 (averaged across all plots)

Soil Macronutrients

- No major changes in P concentrations (4 to 6”)
  - 48 lb/A in Arcadia (all years)
  - 38 lb/A (2012) to 17 lb/A (2015) in Ona
  - 40 lb/A (2012) to 23 lb/A (2015) in St. Cloud
- Differences in K only in Arcadia
  - 117 lb/A (2012) to 47 lb/A (2015) in Ona
  - 39 lb/A (2012) to 53 lb/A (2015) in St. Cloud

NPK	2013	2014	2015
lb/acre	————lb/acre————		
0	31 b[1]	22 b	19 b
500	48 a	39 a	24 a

Tissue P Concentrations

	Arcadia		Ona		St. Cloud	
Year	0 NPK	NPK	0 NPK	NPK	0 NPK	NPK
	%					
2012	0.07	0.13	0.15	0.17	0.09	0.12
2013	0.10	0.15	0.26	0.30	0.15	0.18
2014	0.07	0.12	0.13	0.15	NS (0.15)	
2015	0.09	0.14	0.15	0.17	0.09	0.13

Using a Wiper

- Usually a 10% v/v solution (glyphosate)
- Wipe in two directions
- Practice makes perfect
  - Use of foam marker solution?

Wiping Broomsedge

Wiping Broomsedge – 2 years

Summary

- Where soil pH is off, broomsedge beginning to respond
- This approach will take years
- Wiping is an alternative
- More research
  - Which macronutrient is doing the work?
  - What is the optimal glyphosate concentration for wiping?
  - Roller chopping followed by fertilization?

Questions

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SS-AGR-08

Weed Management in Pastures and Rangeland—2016[1]

B. A. Sellers and J. A. Ferrell[2]

Weeds in pastures and rangeland cost ranchers in excess of $180 million annually in Florida by reducing forage yield, lowering forage quality, and causing animal injury through toxicity or specialized plant organs (thorns and spines). Effective weed management begins with a healthy pasture. Weeds are seldom a serious problem in a well-managed, vigorously growing pasture. Good pasture management involves the proper choice of the forage species and variety, an adequate fertility program, controlled grazing management, and pest management (weeds, insects, and diseases).

If pasture health declines, weeds will exploit the situation and become established. Bare ground is the perfect environment for establishment of weeds. Once established, weeds must be controlled with mechanical or chemical methods. However, unless the pasture-management problem that caused forage decline is corrected, the grass will not re-establish and weeds will re-infest the area.

Integrated weed management is both an economically and environmentally sound approach to weed management. An integrated approach involves scouting, prevention, and control (biological, cultural, mechanical, and chemical) in a coordinated plan.

Scouting

Scouting pastures is the foundation of a sound weed management program, but is often overlooked. Scouting involves routinely walking or driving through pastures and identifying weeds. This defines the scope of the problem and allows the best management practices to be implemented in a timely fashion. The number of weeds, the species present, and their locations are important. Note the dominant species as well as uncommon or perennial weeds. The management strategies adopted should focus on controlling the dominant species, while preventing the spread of less common species. If not managed proactively, the less common weeds in a pasture may become future dominant weed problems.

Proper identification of weeds is the first step toward weed control. A good example is knowing the difference between tropical soda apple (TSA) and red soda apple (cockroach berry). Of the two, only TSA is a troublesome invasive weed that must be controlled. However, some have occasionally confused the two species and allowed TSA to go uncontrolled. Unfortunately, this costly mistake results in TSA spreading throughout the ranch and potentially onto neighboring ranches. If there are questions concerning

1. This document is SS-AGR-08, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date January 2000. Revised February 2009, February 2010, March 2011, January 2012, January 2013, January 2014, February 2015 and December 2015. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. B. A. Sellers, associate professor, Agronomy Department, UF/IFAS Range Cattle Research and Education Center; and J. A. Ferrell, associate professor, Agronomy Department; UF/IFAS Extension, Gainesville, FL 32611.

weed identification, contact your local county Extension office for assistance.

Some weeds grow best in wet sites (maidencane ponds, depressional areas, ditches, etc.), while others can be found on dry sites (ditch banks, upland areas, and fence rows). Scout pastures for weeds in conjunction with other activities, such as checking calves, working cattle, and feeding. When a weed is first discovered, remove it or spot treat with an appropriate herbicide. Do not allow that one plant to produce seed and give rise to hundreds of new plants. It is less expensive (in terms of both time and money) to control one plant than to wait and have to control hundreds of plants.

Poisonous plants (e.g., *Crotalaria*, black nightshade, spiny pigweed, lantana, etc.) are commonly found throughout Florida. Animals do not usually choose to graze most poisonous plants when forage is abundant; however, when quality forage is limited because of poor growing conditions or overstocking, they may graze these plants.

Prevention

Prevention is any activity that keeps weeds from infesting a pasture. Most weeds spread by seed. Thus, preventing the movement of weed seeds onto the ranch reduces potential weed pressure. Weed seeds can be transported in hay, harvested grass seed, sod, cattle, mowing equipment, or dispersed by wind, water, and wildlife. Producers should avoid buying hay or grass seed that is contaminated with weed seeds. Refuse to purchase hay from someone who cannot provide a weed-free product. Using certified forage seed reduces weed seed contamination and is highly recommended.

Also, consider TSA. Cattle have been shown to excrete TSA seeds for at least 7 days after consumption. If cattle are grazing in a TSA-infested pasture, it is recommended that the cattle are held in a clean area for 10 days before moving them to a new pasture. This will reduce the likelihood of transporting TSA seeds. Remember, an ounce of prevention is worth a pound of cure.

Control

Cultural Control

Cultural practices improve weed control by increasing the competitiveness of the forage. This involves optimizing forage production through monitoring soil pH, fertility, and, potentially, water management. Generally speaking, a thick sward will prevent weed emergence, will outcompete emerged weeds, and will capture the majority of environmental resources (light, water, nutrients) necessary for growth. The aim of cultural practices is to modify your management program so that the sward is as competitive as possible.

Soil pH is an important factor for forage growth as well as weed establishment. Forage agronomists and soil scientists at the University of Florida have determined the optimum soil pH for most forages grown in Florida. Acidic soils limit plant growth and can result in aluminum and manganese toxicity, and magnesium, calcium, phosphorous, molybdenum, and potassium deficiency. Soil acidity may also result in poor root growth, which can reduce water and nutrient uptake. Weeds that grow under such conditions can be indicators of low soil pH. For example, crowfoot grass germination is optimum at soil pH levels between 4 and 5, which is too low for optimum forage growth. Thus, the presence of crowfoot grass in your pasture may warrant a soil test and corrective action.

Mechanical Control

Mowing is one of the most often used weed control methods in pastures. Mowing improves the appearance of a pasture, temporarily increases forage production, and, if properly timed, prevents weeds from producing seed. Mowing is generally more effective on broadleaf weeds than grass weeds and is more effective on annual weeds than perennial weeds. Carefully consider the cost of mowing and the anticipated effectiveness. As fuel prices increase, it may be more cost-effective to avoid mowing and use other forms of weed control since other weed control methods may be more effective on a given species.

Mechanical weed control does have drawbacks. Large weeds with extensive root systems will not be controlled through mowing alone. Additionally, mowing misses prostrate-growing weeds like crabgrass, spurges, and matchweed. Mowing can also spread vegetative plant stems, allowing the plant (e.g., prickly pear) to root elsewhere. If mowing is performed after seed set, seeds can accumulate on the mowing equipment and worsen the weed problem by spreading seed to other pastures.

Biological Control

Biological control involves the use of biotic agents (e.g., plants, herbivores, insects, nematodes, and phytopathogens) to suppress weeds. Overall, biological control is still in its infancy, but great strides are being made, especially against invasive plants. Two good examples are the tobacco mild green mosaic tobamovirus (TMGMV), and the newly released insect, *Gratiana boliviana*, both used for TSA control. The virus, TMGMV, can be sprayed to control existing TSA plants, while the beetle is used primarily for suppression.

Most biological control agents rarely provide complete weed control, but they usually suppress the weed population to a manageable level. Additionally, biological control agents are rarely fast-acting, so time is needed for the agent to suppress a given weed population. For example, the effect of *Gratiana boliviana* is not often seen until the year following the release of the beetle.

Chemical Control

Chemical weed control includes the use of herbicides. Herbicides kill weeds by inhibiting plant processes that are necessary for growth. Herbicides should be selected based on forage species being grown, weed species present, cost, and ease of application. Application method and environmental impact should also be considered.

Proper herbicide choice and application rate are extremely important. Lower-than-recommended application rates will not provide consistent weed control, while excessive application rates may cause injury to the forage or result in only killing the above-ground portion of perennial weeds. Also, herbicides must be applied at the correct time to be cost-effective.

Preemergence applications are made before weeds germinate and emerge. Understanding the life cycle of the weed is important when using a preemergence herbicide. Some weed seeds germinate in the summer, while others germinate in the winter months. Always refer to the herbicide label for additional information about controlling specific weeds.

Postemergence applications are made after the weeds emerge. The most effective and cost-efficient applications are made when the weeds have recently emerged and are small. For perennial weeds (regrowing from root storage organs), it is advisable to allow them to bloom before spraying, which allows sufficient leaf surface for coverage and ensures that the perennial is transporting photosynthates back to the roots.

Postemergence herbicides may be broadcast over the entire pasture or may be applied as a spot treatment to sparse weed patches. Spot treatment is less costly compared to broadcast spraying. Other application methods include wipers and mowers that dispense herbicide while mowing the weed. In all cases, it is extremely important to carefully read the herbicide label before purchase to determine if that herbicide controls the weeds in your situation.

PRECAUTIONS WHEN USING PHENOXY OR BENZOIC ACID HERBICIDES

1. For information about growth-regulating herbicides not covered below, see IFAS Publication SS-AGR-12, *Florida's Organo-Auxin Herbicide Rule 2015* (http://edis.ifas.ufl.edu/wg051).

2. Application of other pesticides from sprayers previously used for 2,4-D, dicamba, or other phenoxy or benzoic acid herbicides to susceptible crops, may result in injury.

3. Legumes in pastures or rangelands will be injured or killed by these herbicides.

4. Avoid drift to susceptible crops by applying at low pressures and when wind speeds are low and blowing away from susceptible crops. The use of a drift-control additive is advisable.

5. Clean sprayer thoroughly with household ammonia as follows:

   a. Flush system with water. Drain.

   b. Flush the system with ammonia (1 qt ammonia per 25 gallons water); let it circulate for at least 15 minutes, then flush the system again. Drain again.

   c. Remove screens, strainers, and tips, and then clean in fresh water.

   d. Repeat step 5b.

   e. Thoroughly rinse the tank, hoses, booms, and nozzles.

   f. Be sure to clean all other associated application equipment.

Forage Tolerance

Not all cultivars of a particular forage species respond similarly to a given herbicide (Table 5). 'Argentine' bahiagrass tolerates most pasture herbicides except Roundup, while 'Pensacola' may be severely injured by metsulfuron-containing products such as Cimarron and others. All herbicides may be used on stargrass and bermudagrass, with some level of injury from Velpar. *Hemarthria*, also known as limpograss, is the most sensitive to herbicide applications of all forage grasses grown in Florida.

It is important to realize that the response observed from an herbicide application can vary. For example, the chance for forage injury can increase or decrease as the rate of herbicide applied either increases or decreases. Additionally, environmental conditions such as high temperature and high relative humidity may increase the potential for herbicide injury. For example, we have observed little or no injury to limpograss from 8 pt./acre 2,4-D amine when applied under cooler conditions, while 4 pt./acre in warmer weather caused moderate to severe injury.

The response of forages in Table 5 is for established forage cultivars. However, 2,4-D + dicamba (2 pt./acre) can be applied to sprigged forage cultivars, except for limpograss, seven days after planting/sprigging. A forage can be considered established when at least three tillers are present on bahiagrass or at least 6 in. of new stolon growth is present on sprigged forages.

Summary

Maintaining healthy, productive pastures will minimize the risk associated with weedy plants. Good pasture management practices such as adequate fertilization, insect control, and controlled grazing will result in healthy pastures. Unfortunately, weeds are present in pastures and the associated loss in forage production can have serious economic implications. An integrated weed management strategy involving prevention, detection, and control is the most economical and environmentally friendly approach to pasture weed management.

Table 1. Weed control in pastures and rangeland.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
DURING ESTABLISHMENT		
Preemergence to Weeds		
2,4-D Several Brands[1] 1.0–2.0 qt. of 4 lb./gal. formulation	2,4-D amine or LV ester 1.0–2.0 lb.	**Bermudagrass and stargrass only.** Apply after sprigging and before emergence of sprigged bermudagrass. Will not give complete weed control; however, short residual control of seedling broadleaves, sedges, and certain grasses may be noted for 2–3 weeks, if proper environmental conditions exist.
Diuron 4L 1.5–4.5 pt./ac. or Diuron 80 1–3 lb./ac.	Diuron 0.8–2.4 lb.	**Bermudagrass only**. Will provide fair to good control of crabgrass, crowfootgrass, and goosegrass. Plant sprigs 2 inches deep. If sprigs have emerged at time of application, bermudagrass injury will occur. Do not graze or cut hay within 70 days. Before application, ensure that your product has proper labeling, since not all Diuron products are labeled for use in pastures.
2,4-D + dicamba[1] (Weedmaster, others) 2 pt.	dicamba + 2,4-D	**Bermudagrass and stargrass only.** Similar to 2,4-D, but often provides greater weed control. Short residual control of seedling broadleaves, sedges, and certain grasses may be noted for 2–3 weeks if proper environmental conditions exist. **Do not apply to limpograss (*Hemarthria*).**
Postemergence to Weeds		
2,4-D Several Brands[1] (0.5–1.0 qt. of 4 lb./gal. formulation)	2,4-D amine	**Do not apply to bahiagrass until plants are 5”–6” tall. Do not apply to limpograss (*Hemarthria* sp.).** Bermudagrass can tolerate 2,4-D at any growth stage. Controls most seedling broadleaf weeds. Repeat application may be needed.
2,4-D + dicamba[1] (Weedmaster, others) 2 pt./ac.	dicamba + 2,4-D	Can be used during establishment of hybrid bermudagrass, stargrass, and pangolagrass. Annual sedges and some grasses will be suppressed if less than one inch at time of application. Best results are seen if applications are made 7–10 days after planting. **Do not apply to limpograss (*Hemarthria*).**
Banvel, Clarity, Vanquish 1.5–2 pt./ac.	dicamba	Primarily used for establishment of Floralta limpograss (*Hemarthria*). Annual sedges and some grasses will be suppressed if less than one inch at time of application. Best results are seen if applications are made 7–10 days after planting.
Outrider 1.0–1.33 oz./ac.	sulfosulfuron	Use for perennial and annual sedge control 30 days after planting of bermudagrass, stargrass, and limpograss. Mix with 2,4-D or 2,4-D + dicamba when broadleaf pressure is also high. Do not apply to bahiagrass or Mulato (*Brachiaria* species) during establishment.
ESTABLISHED STANDS		
Dormant Pastures		
Gramoxone SL 1-2 pt.	paraquat	For **dormant** bermudagrass or bahiagrass. Apply in 20–30 gallons of water in late winter or early spring (probably in January or February) before grass begins spring green-up. Add one pt. surfactant (non-ionic) per 100 gal. spray mix. Do not mow for hay until 40 days after treatment. Can be mixed with 2,4-D or other herbicides for more broad-spectrum control.
Prowl H_2O 2-4 qt./ac.	pendimethalin	Dormant grass only. Applications of 3 qt/ac. have provided satisfactory weed control, but late-season escapes should be expected. Provides preemergence control of crabgrass, goosegrass, Texas panicum, sandbur, and other summer annual grasses. A 60-day hay restriction and a 45-day grazing restriction must be observed. Must have activating rainfall or irrigation within two weeks or control will be minimal at best.
Roundup Weathermax 11 oz.	glyphosate	Apply in mid- to late-winter months to bermudagrass or bahiagrass pastures and hayfields for the control of weedy grasses. Apply before new growth appears in the spring. Bermudagrass that is not dormant at the time of application may show a 2–4 week delay in green-up. No restrictions exist between application and grazing or haying.
Non-Dormant Pastures		
2,4-D Several Brands [1] 2.0-4.0 pt. of 4 lb./gal. formulation	2,4-D amine **or** LV ester 1.0-2.0 lb.	**Broadleaf weeds.** Annual weeds should be treated soon after emergence for best control with lower rates. Perennial weeds should be allowed to obtain a leaf surface large enough to allow sufficient spray coverage (about 12”–18” tall). Use amine formulations during warm weather and LV esters during cool weather. Avoid drift. Applications of 2,4-D to limpograss (*Hemarthria* sp.) will cause significant injury during periods of high temperatures and humidity; much less injury has been observed during cool and dry conditions.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
Banvel[1], Clarity, Vanquish 0.5 - 2.0 qt	dicamba	**Broadleaf weeds.** Rate depends on weed species and size. Refer to the label for grazing restrictions. Avoid drift. *Hemarthria* sp. has generally exhibited more tolerance to dicamba than 2,4-D.
Chaparral 2.0–3.3 oz./ac.	metsulfuron + aminopyralid	Use on bermudagrass, pangolagrass, stargrass, and limpograss. Do not use on bahiagrass. Controls tropical soda apple, pigweed, blackberry, and many other problematic weed species. Will not control dogfennel. Add a non-ionic surfactant at 1–2 pt./100 gal. of solution. Avoid applications during spring green-up.
Cimarron Plus 0.125–1.25 oz./ac. or Cimarron Xtra 0.5–2.0 oz./ac.	metsulfuron + chlorsulfuron	Use on bermudagrass, pangolagrass, and stargrass. Controls several cool-season broadleaf weeds, pigweeds, and Pensacola bahiagrass. Bermudagrass should be established no less than 60 days prior to application. Add a non-ionic surfactant at 1–2 pts./100 gal. of solution. Avoid application during spring green-up.
Cimarron Max Part A (0.25–1.0 oz.) Part B (1.0–4.0 pt.)	Part A—metsulfuron Part B—2,4-D + dicamba	Cimarron Max is a two-part product that should be mixed at a ratio of 5 oz. *Part A* to 2.5 gallons *Part B*. Depending on the weeds present and the rate range that is selected, this mix will treat between 5 to 20 acres. For specific information on rate selection, consult the product label.
GrazonNext HL[1] 1.6–2.1 pt.	aminopyralid + 2,4-D	Excellent control of TSA, horsenettle, and other members of the nightshade family. Also controls pigweeds and other broadleaf weeds including less than 20" dogfennel. Do not apply more than 2.1 pt./ac./yr. Do not apply to desirable forage legumes or severe injury and stand loss will occur. Do not apply to limpograss. GrazonNext will pass through animals and remain in the waste. Do not mulch sensitive crops with manure if animals have been grazing on GrazonNext-treated pastures. Avoid applications of this product to limpograss pastures during hot and humid conditions.
MSM 60, others 0.3–1.0 oz./ac.	metsulfuron	Use on bermudagrass, pangolagrass, and stargrass. Controls several cool-season broadleaf weeds, pigweeds, and Pensacola bahiagrass. Bermudagrass should be established no less than 60 days prior to application. Add a non-ionic surfactant at 1–2 pt./100 gal. of solution. Avoid application during spring green-up.
Impose or Panoramic 4–12 fl. oz./az.	imazapic	DO NOT apply to bahiagrass. DO NOT apply during spring transition or severe bermudagrass or stargrass injury will occur. In summer months, expect 3–4 weeks of bermudagrass stunting after application, followed by quick recovery and rapid growth. This will reduce harvest yields of that cutting by 30%–50%. If this yield reduction is not acceptable, do not use these herbicides. Yield reductions of subsequent cuttings have not been observed. For control of crabgrass, sandspur, nutsedges, and vaseygrass, use 4 oz./ac. For suppression of bahiagrass, use 12 oz./ac.
Milestone 3–7 oz.	aminopyralid	Excellent control of tropical soda apple, horsenettle, and other members of the nightshade family. Controls pigweeds and other broadleaf weeds, but does not control blackberry or dogfennel. Can be safely applied under trees. Do not apply more than 7 oz./ac./yr. Do not apply to desirable forage legumes or loss of stand will occur. The use of a non-ionic surfactant is recommended. Milestone will pass through animals and remain in the waste. Do not mulch sensitive crops with manure if animals have been feeding on Milestone-treated pastures. Safe on limpograss.
Outrider 1.0–1.33 oz.	sulfosulfuron	Safe to apply to established bermudagrass, bahiagrass, stargrass, and limpograss. Provides excellent control of annual and perennial sedges.
Pastora 1–1.5 oz.	metsulfuron + nicosulfuron	**Established Bermudagrass Only**. Can be used to effectively control seedling crabgrass, sandbur, vaseygrass and established johnsongrass. Established vaseygrass will require retreatment for long-term control. If sandbur or crabgrass is greater than 4" tall, only seedhead suppression should be expected. Do not apply more than 2.5 oz/ac./yr. Do not apply to limpograss or bahiagrass due to high injury potential.
PastureGard HL[1] 1–2 pt.	triclopyr + fluroxypyr	Provides excellent control of dogfennel, blackberry, teaweed, and other broadleaf weeds. Less effective on tropical soda apple than triclopyr-ester (Remedy Ultra, others) alone. Forage legumes will be severely injured or lost if present at time of application. Applications of 2 pt/A may result in less than desirable weed control. Do not apply more than 8 pts/A per season. Surfactant should be added to spray mixture at 0.25% v/v.
Remedy Ultra, others 2 pt.	triclopyr ester	Provides excellent control of herbaceous and certain woody plants in pasture and rangeland. For best results, apply in 30 or 40 gallons of water per acre. The addition of a non-ionic surfactant at 0.25% v/v will increase control. Applications at air temperatures >85F° may cause moderate to severe bermudagrass injury for 2–3 weeks.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
Roundup Weathermax 8–11 fl. oz./ac.	glyphosate	For control of annual grasses in bermudagrass and stargrass. Apply immediately after hay removal, but prior to regrowth. Applications made after regrowth has occurred will cause stunting. Application rates as low as 6 oz./ac. are often effective for crabgrass and other small annual grass weeds. Do not apply more than 2 qt/.ac./year. If Roundup Weathermax is applied to a dormant pasture, it cannot be sprayed again that season.
Telar 0.1–1.0 oz.	chlorsulfuron	For use on established warm-season forage grass species. Telar will control blackberry, pigweeds, wild radish, and selected winter weeds. Not effective on ragweed, tropical soda apple, and other common weeds. Ryegrasses will be severely injured or killed by Telar. Do not apply more than 1.3 oz./ac./yr. There are no grazing restrictions for any animals.
Sandea 0.67 – 1.33 oz	halosulfuron	Safe to apply to bahiagrass, bermudagrass, and stargrass for annual and perennial sedge control. Does not control Surinam sedge. Do not apply more than 1.33 oz per acre in a 12 month period.
2,4-D + dicamba[1] (Weedmaster, others) 0.5–4.0 pt.	dicamba + 2,4-D amine	See remarks for 2,4-D and dicamba above. This mixture is usually more effective than either herbicide used alone.
		Hard-To-Kill Perennial Grasses
glyphosate 1–4. oz per gal	glyphosate 1%–3% solution for hand sprayer	**Spot treatment.** Apply when perennial weeds are actively growing. Surrounding forage will be killed if sprayed.
glyphosate 4–8 qt. to 2 gal. water	glyphosate 33%–50% solution	**Wiper application.** Apply at speeds up to 5 mph. Two passes in opposite directions. No more than 10% of any acre should be treated at one time.
		Smutgrass
Velpar L 2.75–4.5 pt., Velossa 2.29–3.75 pt. or Velpar DF 0.9–1.5 lb.	hexazinone	Apply Velpar to established stands of bermudagrass or bahiagrass when soil conditions are warm and moist and weeds are actively growing. Best control of smutgrass is usually achieved in late spring to early summer when regular rainfall occurs. Some temporary yellowing of the bermuda or bahiagrass will be noted, but plants will soon outgrow this effect. Apply Velpar by ground equipment only, and only **one** application is allowed per year. **KEEP SPRAYS WELL AWAY (AT LEAST 100 ft.) FROM THE BASE OF DESIRABLE TREES, ESPECIALLY OAKS.** Check label instructions for further precautions and safe use suggestions.
		Pensacola Bahiagrass
MSM 60, others 0.3 oz./ac.	metsulfuron	Apply to bermudagrass hay fields early in the season, after bahiagrass green-up but prior to seedhead formation. Early applications are often most effective; fall applications rarely control bahiagrass. Do not apply with liquid fertilizer solutions, as poor control may occur. Prolonged periods of dry weather prior to application will greatly decrease herbicide effectiveness. Always include a non-ionic surfactant at a rate of 0.25% v/v. Common or 'Argentine' bahiagrass will not be effectively controlled. Pasture legumes will be severely injured or killed.
Cimarron Plus 0.5 oz./ac. or Cimarron Xtra 1.0 oz./ac.	metsulfuron + chlorsulfuron	Same as metsulfuron.
		Tropical Soda Apple
Chaparral 2–3 oz.	metsulfuron + aminopyralid	Excellent control of TSA plants. Provides preemergence control of TSA seedlings for approximately six months after application. There are no grazing or haying restrictions; however, delaying cutting for 14 days will enhance weed control. Not for use on 'Pensacola' bahiagrass.
GrazonNext HL[1] 1.6–2.1 pt.	aminopyralid + 2,4-D	Excellent control of tropical soda apple. Provides preemergence control of TSA seedlings for approximately six months after application. The 1.6 pt./ac. rate is highly effective on emerged TSA plants, but the 2.1 pt./ac. rate will provide the greatest length of residual control. Do not apply more than 2.1 pt./ac./yr. Will severely injure desirable forage legumes. Do not apply to limpograss. There are no grazing restrictions, but do not harvest for silage or hay for seven days.
Milestone 5–7 oz.	aminopyralid	Excellent control of tropical soda apple. Provides preemergence control of TSA seedlings for approximately six months after application. The 5 oz rate is highly effective on emerged plants, but the 7 oz. rate will provide the greatest length of residual control. Do not apply more than 7 oz./ac./yr. Do not apply to desirable forage legumes or loss of stand will occur. Volatility is low. The use of a non-ionic surfactant at 0.25% v./v. is recommended.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
Remedy Ultra, others [1] 1.0 qt.	triclopyr ester	Apply in late spring through summer as a broadcast spray for control of this species. Best results will occur when plants are adequately covered with spray solutions. Application of 30–40 gal./ac. of herbicide solution will be more effective than 20 or lower. The addition of a non-ionic surfactant at 0.25% v./v. will increase control. Retreatment will be required as new seedlings emerge. Spot spray rate is 0.5%–1.0% v./v.
	Prickly Pear Cactus	
Remedy Ultra, others [1] 20% + basal oil 80%	triclopyr ester 20% diesel fuel or basal oil 80% (Spot treatment)	Apply as a spot treatment directly to prickly pear pads during spring and summer. Grass will be burned in treated spots but will recover. The addition of diesel fuel drastically enhances herbicide uptake, which will lead to prickly pear control. Prickly pear will die slowly over a period of 6–8 months with a few plants requiring retreatment.
Trump Card 3 pt./ac.	fluroxypyr + 2,4-D	Apply Trump Card as a broadcast treatment in water. The use of a surfactant is required. A maximum of 3 pt./acre per growing season is allowed, but 6 pt./ac. is required for effective control. Two applications of 3 pt./ac. over two growing seasons, has been shown to be effective.
Vista XRT 22 oz./ac.	fluroxypyr	Apply Vista XRT at 22 oz./ac. as a broadcast treatment in water. The use of a surfactant is required. For spot treatment, use 0.5 fl. oz. (15 ml) per gallon of water. Control is very slow, and it often takes more than one year to see satisfactory results.
	Blackberry	
Chaparral 2 oz./ac.	metsulfuron + aminopyralid	Chaparral will provide good-to-excellent control of blackberry. For best results, apply when moisture conditions are sufficient and blackberry plants are not under drought stress. Late bloom and fall applications of Chaparral are the most effective. DO NOT apply in bahiagrass pastures. Do not mow within one year prior to application or control will be greatly reduced.
Cimarron Plus 0.75 oz./ac. or Cimarron Xtra 2.0 oz./ac.	metsulfuron + chlorsulfuron	Cimarron will provide good to excellent control of blackberry. Results are best when applied at blooming or late in the fall. Do not mow within one year prior to application or control will be reduced. **DO NOT** apply to bahiagrass pastures.
MSM 60, others 0.3–0.5 oz	metsulfuron	Metsulfuron will provide good to excellent control of blackberry. Results are best when applied at blooming or late in the fall. Apply to bahiagrass pastures only as a last resort and expect 6–8 weeks of reduced growth and some stand thinning. Mixing with 1 pt./ac. 2,4-D amine will help reduce bahiagrass injury when applying in bahiagrass.
PastureGard HL[1] 2 pt.	triclopyr + fluroxypyr	Control similar to Remedy.
Remedy Ultra, others [1] 2 pt.	triclopyr	For best control of blackberry, apply 2 pt. when blooming, and do not mow within one year prior to application. Remedy does not control dewberry. Applications made during prolonged periods of dry weather can greatly decrease control. Fall applications often provide more consistent blackberry control.
Telar 0.75 oz.	chlorsulfuron	Similar to control with Cimarron. Telar can safely be applied to bahiagrass or bermudagrass.
	Dogfennel	
2,4-D + dicamba[1] (Weedmaster, others) 2–3 pt.	dicamba + 2,4-D	Apply when plants reach a height of 12″–18″. Weedmaster is most effective approximately one month after dogfennel transition from winter dormancy. Refer to previous comments for dicamba and 2,4-D above.
GrazonNext HL[1] 24 oz.	aminopyralid + 2,4-D	Apply when plants are less than 30″ tall. If plants are larger than 30″, tank-mix GrazonNext with 3 pt./ac. 2,4-D, or 8 oz/A PastureGard HL.
PastureGard HL[1] 24 oz.	triclopyr + fluroxypyr	For control of larger dogfennel that has reached 40 inches or more in height.
Trump Card 3 pt.	fluroxypyr + 2,4-D	For control of dogfennel that are 18″–36″.
	Mixed Stands: Grass - Clover/Lespedeza Pastures	
2,4-D amine[1] 0.5–1.0 pt.	2,4-D (0.25 + 0.5 lb)	Apply only one treatment per year to established perennial clover. Slight to moderate injury may occur. See label for specific use information.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
Thistles		
2,4-D 2 qt.	2,4-D	Highly effective if applied to thistles in the rosette stage. 2,4-D is not effective on thistles that have bolted or flowered. During cool temperatures, the ester formulation of 2,4-D will be most effective.
GrazonNext HL[1] 1.6–2.1 pt.	aminopyralid + 2,4-D	Excellent control of thistles at any stage of growth.
2,4-D + dicamba[1] (Weedmaster, others) 1.0–2.0 qt	dicamba + 2,4-D	Apply late fall to early spring when daytime temperatures are > 50ºF. Applications are most effective if applied before flower stalks elongate. The addition of crop oil will increase herbicidal activity. Refer to previous comments for dicamba and 2,4-D above. For small rosettes, 1 qt./ac. rate is sufficient. For larger rosettes, 1.5–2 qt./ac. will be required.
[1] For state rules pertaining to application of organo-auxin herbicides in Florida, see EDIS Publication SS-AGR-12, *Florida Organo-Auxin Herbicide Rule 2015* (http://edis.ifas.ufl.edu/wg051). Herbicide recommendations in this report are contingent upon their registration by the U.S. Environmental Protection Agency. If an herbicide's EPA registration is canceled, the herbicide is no longer recommended.		

Table 2. Estimated effectiveness of herbicides on common broadleaf weeds in pastures and hayfields (2,4-D through Impose/ Panoramic).[1]

Weed Name	2,4-D	Chaparral	Cimarron Plus or Xtra	Banvel or others	Vista XRT	Diuron	GrazonNext HL	Metsulfuron	Impose/ Panoramic
bagpod	F-G	E	E	G	-	-	E	E	-
bitter sneezeweed	E	E	E	E	-	G	E	E	-
blackberry	P	G–E	G–E	F–G	F	P	P–F	G–E	P
bracken fern	P	E	E	P–F	P	P	P	E	-
Brazilian pepper-tree	P	P	P	P	P	-	P	P	P
bullrush	G	-	-	G	P	P	P	-	-
bushmint	P	-	-	F	F-G	-	F	-	-
butterweed	F-G	E	E	F-G	-	-	E	E	-
buttonbush	P	-	-	-	-	-	-	-	-
Caesarweed	G-E	G	G	-	G-E	-	G-E	G	-
camphor weed	F-G	-	-	F-G	-	-	G	-	-
Carolina geranium	P-F	G	G	F-G	G	-	F-G	G	-
castor bean	F-G	-	-	-	-	-	F-G	-	-
chickweed	F	E	E	E	-	P	F	E	-
coffee weed	G	E	E	E	G	-	E	E	-
coral ardisia	P	P	P	P	P	-	P	P	G
creeping indigo	G	E	E	G	-	-	E	E	-
crotalaria, showy	G	G	-	G	G	-	G	-	-
cudweed	F	G	G	E	-	-	E	G	-
curly dock	F	E	E	E	-	P	E	E	-
dayflower	G	F	F	F	-	-	F-G	F	-
dewberry	P	F-G	F-G	P	-	-	P	F-G	-
dodder	P	-	-	P	-	P	-	-	-
dogfennel	F–G	P	F	F–G	G	P	F–G	F	-
dollarweed	G	G	G	E	F	-	G	G	-
elderberry	F-G	-	-	F-G	-	-	F-G	-	-
evening primrose	E	G	G	E	-	G	E	G	-
Florida pusley	P	-	-	P–F	P	E	G–E	-	-
flat-top goldenrod	G	P	P	F-G	P	-	G	P	-
gallberry	G	-	-	E	-	P	-	-	-
goatweed	G	G	G	F–G	P–F	-	-	G	P
goldenrod	F	P	P	G	-	P	G	P	-
greenbrier	P	F	F	P	F-G	-	P	F	-
groundcherry	F-G	-	-	F-G	-	-	E	-	-
hairy indigo	F-G	E	E	F-G	F-G	-	E	E	-
hempvine	F-G	E	-	F-G	E	-	E	-	-
honeysuckle	-	-	-	E	-	P	-	-	-
horsenettle	P	E	P–F	G	F	P	E	P–F	-
horseweed	F	G	F	E	-	P	E	F	-
kudzu	P–F	G	P–F	G	P	P	G	P–F	P
lantana	P	P	P	P	F-G	-	P	P	-
matchweed	G	-	-	G	F-G	-	G-E	-	-

Weed Name	2,4-D	Chaparral	Cimarron Plus or Xtra	Banvel or others	Vista XRT	Diuron	GrazonNext HL	Metsulfuron	Impose/ Panoramic
maypop	P	P	P	P	-	-	-	P	-
Mexican tea	G	E	E	G-E	-	-	E	E	-
milkweed	F-G	-	-	G	-	-	F-G	-	-
morningglory	G-E	E	G-E	E	E	-	E	G-E	-
stinging nettle/ fireweed	P	E	-	-	G–E	-	E	-	P
palmetto	P	P	P	F	G	P	P	P	P
pawpaw	P	P	F	P	F-G	-	P	F	-
persimmon	P	-	-	F–G	-	P	P	-	P
pigweed	F	E	E	E	P	F	E	E	G
plantains	E	E	E	E	-	-	-	E	-
pokeberry	G	-	-	E	P	P	P	-	-
prickly pear	P	P	P	F	G	P	P	P	P
prickly poppy	G	E	G	G-E	G	-	E	G	-
ragweed	E	E	G	E	G	G	E	G	F
red sorrel	P	E	E	E	-	F	-	E	-
redroot, Carolina	-	P-F	P-F	-	P-F	-	-	P-F	F-G
rosary pea	F	E	G	G	F-G	-	E	G	-
sand vetch	F	E	G	G	G	-	E	G	-
saltbush	P	P	P	P	F	-	P	P	-
shepherd spurse	E	-	-	E	-	G	-	-	-
sicklepod	G	G	G	E	G	F	G	G	F–G
smartweed	G	E	G	G	-	-	E	G	-
softrush	G	P	P	F-G	P	-	F-G	P	-
Spanish needles	G-E	E	G	E	-	-	E	G	-
tall elephant's foot	F	-	-	F-G	-	-	F-G	-	-
teaweed	P	G	G	G	-	-	G	G	-
thistles	E	E	F	G	G	F	E	F	-
toadflax, oldfield	F-G	G-E	G-E	G	-	-	G-E	G-E	-
tropical soda apple	P	E	P	F–G	F	P	E	P	P
Virginia pepperweed	G	-	-	E	G	G	-	-	-
wax myrtle	P	P	-	P–F	-	P	P	-	-
whitehead broom	P	P-F	P-F	P	P	-	P	P-F	-
winged sumac	F-G	-	-	-	F-G	-	F-G	-	-
wild garlic	G–E	G	G	E	-	P	-	G	-
wild radish	G	G–E	G–E	E	-	P	G	G–E	-
yellow jessamine	-	G	G	-	-	-	-	G	-
yellow woodsorrell	P	F-G	F-G	G	F	-	F-G	F-G	-
Weed control symbols: E = 90%–100% control; G = 80%–90% control; F = 60%–80% control; P < 60% control.									

Table 3. Estimated effectiveness of herbicides on common broadleaf weeds in pastures and hayfields (Milestone through WeedMaster or others).[1]

Weed Name	Milestone	Outrider	PastureGard HL	Remedy	Velpar	WeedMaster, others
bagpod	E	-	G	F-G	-	F-G
bitter sneezeweed	E	-	E	E	-	E
blackberry	P	P	G–E	G–E	F	P–F
bracken fern	P	-	P–F	P–F	F	P
Brazilian pepper-tree	P	P	P-F	G-E	G-E	P
bullrush	P	-	P	G	-	-
bushmint	P	-	G	G	-	P
butterweed	G-E	-	G-E	-	-	F-G
buttonbush	-	-	F-G	G	-	-
Caesarweed	G-E	-	E	E	-	G-E
camphor weed	-	-	G	F-G	-	G
Carolina geranium	G-E	-	-	-	-	G
castor bean	-	-	G	G	-	F-G
chickweed	-	-	F	E	E	E
coffee weed	E	-	E	E	-	G
coral ardisia	P	-	F-G	G	-	P
creeping indigo	E	-	G	G	-	G
crotalaria, showy	-	-	E	E	-	G
cudweed	E	-	G	E	-	G
curly dock	E	-	F	E	P	E
dayflowers	-	-	G	G	-	G
dewberry	-	-	F-G	F-G	-	P
dodder	-	-	P	P	-	P–F
dogfennel	P–F	P	E	G–E	G	G
evening primrose	E	-	G	E	E	E
Florida pusley	-	-	G	-	-	F
flat-top goldenrod	P	-	P	P	-	G
gallberry	-	-	E	E	P	G
goatweed	-	-	F	F	-	G
goldenrod	G	-	G	G	-	G–E
hairy indigo	E	-	G-E	G	-	G
hempvine	E	-	E	E	-	F-G
honeysuckle	-	-	P	P	-	E
horsenettle	E	-	F	F–G	-	F
horseweed	E	-	G	G	-	E
kudzu	G	P	F	F	-	F
lantana	P	-	P-F	P-F	-	P
matchweed	G	-	G	G	-	G
maypop	-	P	G	F	-	P–F
Mexican tea	E	-	E	E	-	E
milkweed	F-G	-	F-G	F-G	-	F-G
morningglory	E	-	E	E	-	E
stinging nettle/fireweed	E	P	E	E	-	F

Weed Name	Milestone	Outrider	PastureGard HL	Remedy	Velpar	WeedMaster, others
palmetto	P	P	G	F	P	P–F
pawpaw	P	-	F-G	G	-	P
persimmon	P	P	F–G	F–G	F	P–F
pigweed	E	-	F	E	G	E
plantains	P	-	-	-	-	E
pokeberry	F	-	P	P	-	E
prickly poppy	E	-	E	E	-	G-E
prickly pear	P	P	F	G[2]	P	P–F
ragweed	E	-	E	E	F	E
red sorrel	-	-	F	E	-	G
redroot, Carolina	-	-	F-G	G	-	G
rosary pea	E	-	G-E	G-E	-	F-G
sand vetch	E	-	E	E	-	E
saltbush	P	-	G-E	E	-	F
shepherd spurse	-	-	G	E	E	E
sicklepod	-	-	G–E	E	-	E
smartweed	E	-	G	G	-	G-E
softrush	P	-	F	P-F	-	F-G
Spanish needles	E	-	E	E	-	E
tall elephant's foot	F	-	F-G	F-G	-	F
teaweed	-	-	G	G	-	F-G
thistles	E	-	G–E	E	E	E
tropical soda apple	E	P	G	G–E	F–G	F–G
Virginia pepperweed	-	-	G	P	E	E
wax myrtle	P	-	F–G	G	P	P–F
whitehead broom	P	-	P	P	F-G	P
winged sumac	-	-	G	G	-	F-G
wild garlic	P	-	P	-	-	E
wild radish	P	-	G–E	E	E	E
yellow jessamine	-	-	G	G	-	-
yellow woodsorrell	-	-	F	F	-	F

[1] Estimated effectiveness based on rates recommended in this report. Effectiveness may vary depending on factors such as herbicide rate, size of weeds, time of application, soil type, and weather conditions.
[2] When applied as spot-treatment in basal oil.
Weed control symbols: E = 90%–100% control; G = 80%–90% control; F = 60%–80% control; P < 60% control.

Table 4. Estimated effectiveness of herbicides on common grass and sedges in pastures and hayfields.

Herbicide	bahia-grass	bermuda-grass	broom-sedge	crab-grass	dallis-grass	guinea-grass	johnson-grass	rye-grass	sandbur	smut-grass	vasey-grass	nutsedge
2,4-D	P	P	P	P	P	P	P	P	P	P	P	P
Banvel or others	P	P	P	P	P	P	P	P	P	P	P	P
Chaparral	G	P	P	P	P	P	-	P	P	P	P	P
Cimarron Plus or Xtra	G	P	P	P	P	P	-	P	P	P	P	P
Diuron	P	P	P	F–G	P	P	P	P	G	P	P	P
GrazonNext HL	P	P	P	P	P	P	P	P	P	P	P	P
Metsulfuron	G	P	P	P	P	P	-	P	P	P	P	P
Impose/ Panoramic	P–F	P	P	E	F	-	G	F	G–F	P	P–G	G–E
Milestone	P	P	P	P	P	P	P	P	P	P	P	P
Outrider	P	P	P	P	P	P	E	-	-	P	F–G	E
Pastora	F–G	P	P	F–G	F–G	F–G	G	G	G	P	F–G	P
PastureGard HL	P	P	P	P	P	P	P	P	P	P	P	P
Remedy	P	P	P	P	P	P	P	P	P	P	P	P
Velpar	P	P	P	P	-	-	-	G	-	E	-	P
Vista XRT	P	P	P	P	P	P	P	P	P	P	P	P
Weedmaster or others	P	P	P	P	P	P	P	P	P	P	P	P

[1] Estimated effectiveness based on rates recommended in this report. Effectiveness may vary depending on factors such as herbicide rate, size of weeds, time of application, soil type, and weather conditions.
Weed control symbols: E = 90%–100% control; G = 80%–90% control; F = 60%–80% control; P < 60% control.

Table 5. Tolerance of ***established*** (for at least 6 months) forage cultivars to commonly used herbicides.

Forage Species	Cultivar	2,4-D	Aim	Banvel	Chaparral	Cimmarron Plus	Cimmarron X-tra	Vista XRT	Grazon-Next HL	Impose/ Panoramic	Metsulfuron (MSM 60, others)	Milestone	Outrider	Pastora	Pasturegard HL	Remedy Ultra, others	Roundup/ others	Telar	Vista	Banvel + 2,4-D (WeedMaster, etc.)	Velpar
Bahiagrass																					
	Argentine	T	T	T	I	I	I	T	T	S	I	T	T	NL	T	T	S	T	T	T	T
	Pensacola	T	T	T	S	S	S	T	T	S	S	T	T	NL	T	T	S	T	T	T	T
Bermudagrass																					
	Coastal	T	T	T	T	T	T	T	T	I	T	T	T	T	T	T	I–S	T	T	T	T-I
	Florakirk	T	T	T	T	T	T	T	T	I	T	T	T	T	T	T	I–S	T	T	T	T-I
	Jiggs	T	T	T	T	T	T	T	T	I–S	T	T	T	T	T	T	I–S	T	T	T	T-I
	Tifton-85	T	T	T	T	T	T	T	T	I	T	T	T	T	T	T	I–S	T	T	T	T-I
Brachiaria																					
	Mulato	T	I	T	N	N	N	T	T	N	N	T	T	NL	T	T	S	N	T	T	N
Stargrass																					
	Florico	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I–S	T	T	T	NL
	Florona	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I–S	T	T	T	NL
	Okeechobee	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I–S	T	T	T	NL
	Ona	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I–S	T	T	T	NL
Hemarthria																					
	Floralta	I–S	T	T	T	T	T	T–I	I–S	T–I	T	I	T	NL	I	I	S	T	I	I-S	NL

T = tolerant; very little injury if any
I = Intermediate; slight injury, will regrow in approximately one month
S = Severe injury; more than two months to recover or complete death
N = No current information available
NL = Not labeled

Table 6. Days between herbicide application to forage or pasture and feeding, grazing, or animal slaughter.

Herbicide	Non-lactating Cattle			Lactating Dairy Cattle		Horses
	Grazing	Hay Cutting	Slaughter	Grazing	Hay Cutting	
Banvel						
Up to 1 pt.	0	0	30	7	37	0
Up to 1 qt.	0	0	30	21	51	0
Up to 2 qt.	0	0	30	40	70	0
Chaparral	0	0	0	0	0	0
Cimarron Plus and Cimarron Xtra	0	0	0	0	0	0
Vista XRT	0	7	0	0	7	0
2,4-D	0	30	3	7	30	0
GrazonNext HL	0	7	0	0	7	0
Metsulfuron	0	0	0	0	0	0
Impose or Panoramic	0	7	0	0	7	0
Milestone	0	0	0	0	0	0
Outrider	0	14	0	0	14	0
Pastora	0	0	0	0	0	0
PastureGard HL	0	14	3	1 season	1 season	0
Prowl H_2O	45	60	0	45	60	45
Remedy Ultra, others	0	14	3	1 season	14	0
Roundup WeatherMax						
Dormant application	0	0	0	0	0	0
Between cuttings	0	0	0	0	0	0
Pasture renovation	56	56	56	56	56	56
Sandea	0	37	0	0	37	0
Telar	0	0	0	0	0	0
Trump Card	7	14	2	7	14	7
Velpar	0	38	0	0	38	0
2,4-D + dicamba (Weedmaster, others)	0	37	30	7	37	0

The Working Ranch and Wildlife

Raoul Boughton, Assistant Professor
Rangeland Ecosystems and Wildlife

Through ranch development and management the cattle industry has modified and manipulated natural landscapes to improve production of beef. Upon first thought this might be detrimental to wildlife, and for some species that is definitely true, but for others the story is not so simple, and in certain cases the ranch environment is actually preferred. This is particular important for wildlife species that are Threatened, Endangered or have been on the decline that use ranch modified habitats. Examples on Florida ranches include Crested Caracara, Wood Storks, and Burrowing Owls to name a few. One major role of the Rangeland Wildlife and Ecosystem program is to work with ranchers on ranches to identify how important ranch habitats are. You may ask "Why is it so important to know? ".

I have two answers for you. The first is these large connected ranch environments provide the core habitat for many species and as ranch habitats are slowly developed, the last bastion for some species will be lost. The second is that ranches have conservation value and understanding how ranch habitats are important to a species will increase that value. In turn a thorough understanding should provide the populace and agencies information that will argue for increased dollar incentives to be provided to ranchers to be both beef producers and best practice wildlife managers. From a ranching perspective this can be thought of as diversifying your business.

A number of incentive and cost share programs already exist, at federal and state levels. Two excellent examples are the USDA NRCS Working Lands for Wildlife program that restores habitat critical to 7 species of wildlife on working lands, and the USDA NRCS Agricultural Conservation Easement Program that will pay up to 50-75% of the land value to conserve current practices that support both agriculture and conservation goals. The more data provided to show the importance of private ranch lands to wildlife the more potential there will be for expanding and extending funding programs.

We have just embarked on a project to understand the importance of ranchlands to the Florida Burrowing Owl or Ground Owls as a true cracker would call them. If you don't know, the species has been declining in many places especially along both the east and west coast where development has removed habitat and owls can no longer survive. These little owls are grassland specialists and you can see them hovering across pasture to forage. They excavate 6-10ft burrows in higher drier ground in which they lay eggs, raise their young, and can be found close to during the breeding season.   Interestingly, these little owls use pasture as habitat, and what we believe is that short cropped (grazed) pasture is preferred and that ranching is providing habitat to support populations of this species of special concern. Functionally the species is coexisting with cattle on ranches and cattle may improve their habitat through maintaining low vegetation and providing manure nutrients that attracts invertebrate food sources.

During this project we will be documenting breeding success, population stability, and site fidelity of rural Burrowing Owls, and comparing them to urban populations. Elizabeth White a doctoral graduate student is leading the project and has just started the process of marking all the birds with bands (see photo) so we can track them over time. Some of the questions being asked include: How much space does each breeding pair need in rural and urban habitats? What is the population structure of owls across Florida? Is it one big population where juveniles disperse widely, or are populations isolated? We will answer that question using DNA and genetic analyses to see how alike or different populations are.

This little owl is an iconic species of grasslands in Florida and in this project we will document how important ranch habitats are to supporting populations of Florida Burrowing owls. The work on Burrowing owls is one example where the Rangeland Wildlife and Ecosystems Program can help collect data to support species continued existence. As well as, provide information to the public and agencies to help raise awareness and funds to support best management conservation practices that ranchers can then provide on their ranches. One day like Gopher Tortoises ranchers may be able to provide habitat to receive urban Burrowing Owls that would have been destroyed by development if not translocated.

Grasslands: The Importance of Mosaics for Wildlife

Raoul Boughton, Assistant Professor
Rangeland Ecosystems and Wildlife


Crested Caracara, Photo credit Tom Grey

Natural grasslands in the US have been disappearing as land uses and management of our landscapes alter. Urban sprawl and agricultural intensification have reduced many grasslands; changes in fire and flooding regimes and loss of grazing by large herbivores has allowed establishment of woody shrubs and a shift to more wooded and forested habitats. These woody habitats were always part of the mosaic, often found in gullies, in fire shadows, and areas that just didn't carry fire, but the woods in many places did not dominate the landscape. Nor were vegetation communities fixed, they were melded by disturbance, and disturbances were not always the same. Fire is a disturbance, and grasslands one year after fire are quite different to grasslands five years after fire, in both species diversity and structure. For a diverse community it is important to have a mosaic of times since fire, short and long, as different species have adapted to different fire disturbances to survive.


Burrowing Owl, Photo credit Tom Grey

In Florida grasslands and flatwoods fires probably cycled every two to five years, with some refugia that rarely burnt. The suppression of fires and lack of knowledge of fire effect on habitats early in the century has left a legacy of overgrown and under burnt habitats. Fire suppression eventually leads to greater fuel accumulation and increased intensity of fire, and in the 1920s Florida's big fires received national attention and were a major reason for the creation of the Florida Division of Forestry. In 1935 the Big Scrub Fire in the Ocala National Forest was the fastest spreading fire in the history of the U.S., covering 35,000 acres in 4 hours, and in 1956 in a single day the Buckhead Fire burnt 100,000 acres of the Osceola National Forest. During droughts wildfire increases and between 1969 and 1976 some fires in the Everglades were up to 50,000 acres in size. Fires in Florida naturally occur with an annual lightning strike rate of

~100 strikes per mile[2], and wildfires were very common until European settlement and suppression. It is also thought some fires were purposefully lit by native Indians.

Eastern Meadowlark, Photo credit Tom Grey

Fire was not the only regular environmental disturbance in Florida. The summer wet season created a hydroperiod where a rise in the water table produced extended summer flooding in many areas of the peninsular. This hyrdoperiod of flooded plains maintained both wetlands and wet prairie grasslands, inhibiting the ability of woody shrub and tree establishment, as did fire. Through engineered drainage we have modified the hydroperiod to be shorter creating less flooding, but in doing so have likely reduced and changed native grassland habitats. Coupled with less frequent burning the disturbances once common in maintaining grasslands have been considerably altered.

Bachmans Sparrow, Photo credit Tom Grey

As land was parceled, broken up, sold, and managed in smaller and smaller areas, wide ranging fires were diminished and many grasslands were set on a different trajectory, and with those changes many species of wildlife were also impacted. In addition grassland habitats have been further modified to “improved” states for grazing, using drainage, fertilization, pH adjustments and planting of higher quality non-native forage grasses, such as Bahaia grass, Pangola grass and Limpograss. These high productivity improved grasslands are more homogenous than the natural systems, but still provide habitat for many grassland species of wildlife. In some cases they are even preferred. For example, species such as Eastern Meadowlarks, Burrowing Owl and Crested Caracara use improved pastures and possible increase reproductive success in improved pasture. It has been shown that Crested Caracara have smaller territories on improved pastures, Burrowing Owls often select grazed improved pasture for burrow locations, and Eastern Meadowlarks nest in these improved systems.

To have a diversity of wildlife it is important to maintain a mosaic or patchwork of habitats and a sea of homogenous grass is not optimal. Using birds again as an example, you will find different species that need native grasslands. Bachman's Sparrow is a species found in grassy open flatwoods and occurs more frequently if areas are maintained by burning and is not found in improved pasture. Similarly, the Endangered Florida Grasshopper Sparrow, a now almost extinct species of native grasslands also prefers to use areas burnt one to two years previously. A favorite game species of the south, the Bob White Quail require diverse grassland and shrubs, as they are attracted to newly burnt areas to feed on seeding forbs but also require denser grasses and shrubs for nesting and escape from predators.

Florida Grasshopper Sparrow, Photo credit Christina Evans

The take home message for improved wildlife diversity is creating a mosaic of different vegetation communities. Improved pasture can be one tile of the mosaic, but for diversity native grasslands are also important. One important tool we can use is fire and an appropriate burn program is essential to ensure a diversity of length of time since last burn. Protecting remaining native grasslands from conversion to improved pasture is important for the conservation of certain species. Coupled with appropriate burn programs native grasslands can be managed well for both wildlife and grazing. Assistance programs are available through USDA NRCS Agricultural Conservation Easement Program and to learn more I would encourage you to visit your local NRCS agent, read about the programs on http://www.nrcs.usda.gov, or just give me a call at the Range Cattle Research and Education Center: 863-735-1314 ext. 216.

Bobwhite Quail Photo credit: Braford Research Center

Using the Ecosystem Services Approach to Advance Conservation Efforts on Private Lands [1]

Melissa M. Kreye, Elizabeth Pienaar, Raoul K. Boughton, and Lindsey Wiggins[2]

Introduction

Decision-makers in Florida have shown increased interest in using the Ecosystem Services (ES) approach to incentivize or reward ecosystem conservation efforts on private lands (FPRIT 2014). For example, payments for ecosystem services (PES) strategies have been effective in providing landowners with the motivation needed to participate in conservation behaviors (Ferraro and Kiss 2002). Some landowners may find a better understanding of the ES approach to be useful when deciding to participate in a PES program. To support these efforts this document will provide landowners, Extension agents, government and agency leaders, and other stakeholders with a better understanding of the following:

1. how ES are classified,
2. the different ways ES can be valued,
3. how quantifying ES values can help support conservation efforts on private lands in Florida, and,
4. challenges to using the ES approach.

Benefits of the Ecosystem Services Approach

The ES approach is primarily an assessment of how humans benefit from the natural functions of ecosystems (Alcamo and Bennett 2003; Costanza et al. 1998). Understanding how these benefits are valued by humans can allow decision-makers to:

- better assess the impact of different ecosystem management options on human well-being.
- determine the most efficient strategy for achieving a policy goal, such as paying landowners to conserve or provide wildlife habitat.

There are two key reasons why private lands are at a high risk of change in ES benefits: (1) landowners receive little or no external reward for securing certain ecosystem services (e.g., wildlife habitat) through good land stewardship practices; and (2) there is increased pressure on landowners to engage in land uses that are financially profitable, which often leads to changes in environmental quality (Meyer and Turner 1992). The ES approach can help address this problem by associating different types of land uses with the ES benefits generated for humans. *This information can improve the efficiency of conservation policies and programs that seek to protect important ecological services on private lands.*

1. This document is WEC369, one of a series of the Department of Wildlife Ecology and Conservation, UF/IFAS Extension. Original publication date April 2016. Visit the EDIS website at http://edis.ifas.ufl.edu.

2. Melissa M. Kreye, postdoctoral associate; Elizabeth Pienaar, assistant professor; Raoul K. Boughton, assistant professor; Department of Wildlife Ecology and Conservation; and Lindsey Wiggins, UF/IFAS Extension agent, Hendry County.

Putting the Concept to Use

The ES decision-making approach can best be described in a series of steps (Figure 1):

1. The structure of an ecosystem (e.g., size, diversity, and distribution of plant and animal species) provides a platform on which ecosystem processes occur (e.g., physical, chemical, biological, hydrological), which in turn influences how an ecosystem functions (Fisher et al. 2009). In other words, land management actions that alter the age of plants and types of plant species growing on the landscape influence how organisms interact with each other and with the physical environment.

2. These interactions determine the type, quality, and quantity of ecosystem services produced.

3. Ecosystem services are beneficial to humans in ways that are valuable or important to humans. For example, water-regulating functions of forests help to maintain clean water, which gives rise to a variety of health and recreational benefits for humans.

4. Decision-makers can identify important tradeoffs associated with a range of different land uses by examining which ES benefits are provided by each of the land uses. For example, converting a rangeland to row crop production produces food but may result in reduced soil and water quality and the loss of habitat for native species. Benefits can be discussed in a qualitative sense or quantified in monetary terms to be used in a cost-benefit analysis (Pienaar 2013).

5. The outcomes of these analyses can help inform policies that impact future land use decisions, which in turn impact ecosystem structures and processes. Further explanation regarding these steps is provided in the following sections.

Ecosystem Functions and Structure

Ecosystems around the world have been classified into several main biomes including marine and coastal systems, wetlands, lakes and rivers, forests, woodlands and shrub lands, grass and rangelands, desert, tundra, cultivated areas, and urban areas (de Groot 2010). Ecosystem functions that occur within these biomes include regulation functions, habitat functions, production functions, and cultural functions (United Nations Millennium Ecosystem Assessment 2005). Land management activities modify ecosystem

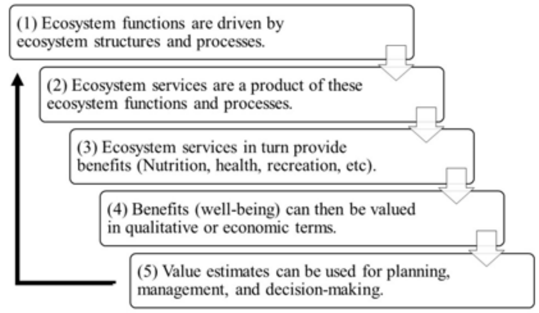

Figure 1. Putting the Ecosystem Services concept to use.

structures so that they function better in providing one type of service over another (Table 1).

For example, natural areas are managed for regulation and habitat functions, which help maintain biological and genetic diversity services. Comparatively, agricultural lands are managed to better function in the provision of raw organic materials.

Ecosystem Service Benefits

Ecosystem functions give rise to intermediate and final services which benefit humans in many ways. The direct benefits for humans include material inputs for production (e.g., timber), life support (e.g., clean water and water), and amenity values (e.g., recreation) (Champ et al. 2003). Figure 2 illustrates how direct benefits can rise from the intermediate and final services associated with a forest ecosystem.

Ecosystems can also benefit humans even when humans are not using a particular service. These benefits are known as "nonuse values." For example, "existence value" is the satisfaction that a person derives from knowing that something (e.g. a rare species) exists, even though that person might never see that species. "Option value" is the benefit people derive from simply knowing they have the option to use ecosystem services in the future.

It is also important to recognize that ecosystems can also provide disservices that are not beneficial to humans. For example, bees provide pollination services that allow plants to fruit and be eaten by humans, but bee stings can also seriously harm some humans by causing an extreme allergic reaction (i.e., anaphylactic shock).

Valuing Ecosystem Services

Humans value ecosystems based on the benefits they derive from ecosystems (e.g. clean air, clean water, recreational opportunities, food, timber, and species conservation). Social-cultural values related to diversity and identity,

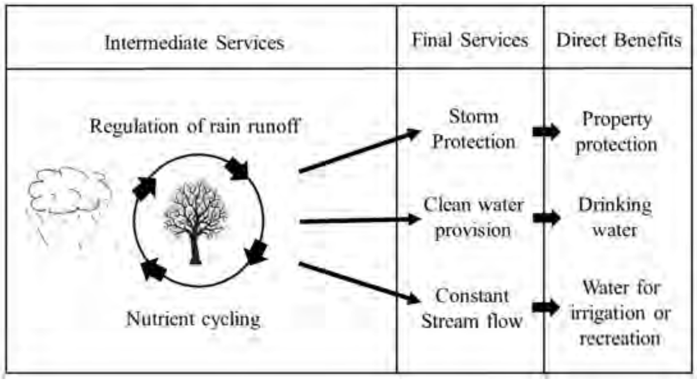

Figure 2. Conceptual relationship between final and intermediate services and direct benefits for humans of a forest ecosystem (based on Fisher et al. 2009)

human health, education, freedom, and spirituality influence these values because they inform individuals about which end-states or qualities they want in an ecosystem (Farber et al. 2002). In other words, the personal and cultural values of individuals influence their decisions about how ecosystems should be conserved or managed.

Loss of forest land and environmental pollution has long been recognized as an issue of societal importance. To address public concerns, US government agencies frequently use economic analyses (e.g., cost-benefit analysis) to understand how environmental policies impact human well-being. When generating estimates of economic value, it is assumed that the values held by the public are reflected in the economic choices people make, or their willingness to pay for a good or service (i.e., assessed monetary value) (Just et al. 2004). Value is easily measured in existing markets where the purchasing behaviors of buyers informs sellers and producers how much of the good or service should be produced to meet demand and how much money people are willing to pay for goods and services. Unfortunately, demand for ecosystem conservation is not well understood because many of the benefits associated with conservation (e.g., clean water and air) are not traded in an existing market.

To help inform policy decisions, economists use several different types of valuation methods to estimate the value of ES (King and Mazzotta 2000). Surveys are used to assess people's willingness to pay (WTP) for ES, which are not traded in the market. The survey method is particularly useful for assessing the value of the existence of species (Champ et al. 2003). Other methods examine the prices paid for goods that are related to ES in order to approximate the value of the ES that support these goods. For example, a person's willingness to pay more for a house next to a state park can reflect the value the person places on certain environmental amenities (e.g., nature, observation of wildlife, open space) generated by the park. Monetary value can also be described using costs-avoided approaches, where the quantification of costs avoided is used to determine the cost-effectiveness of natural ecosystems over man-made technologies. For example, a 10% increase in forest land in a groundwater recharge area has been found to reduce the chemical and treatment costs of drinking water facilities by up to 20% (Ernst et al. 2004).

Incorporating Services and Values into Decision-Making

Understanding the value associated with different ES can allow decision-makers to make better-informed decisions about different land use options. In many cases, a mix of biophysical and economic measures is used to express changes in benefits and services. For example, the value of a forest wetland ecosystem can be expressed using the value of fish harvested ($), the spatial concentration of recreation boaters (m^2) and concentration (g/m^3) of fecal coliform bacteria in the water (Guerry et al. 2012). Deciding which measure is used to express changes in human well-being depends on the context in which the decision is made and stakeholder needs.

Sometimes when human well-being has already been significantly impacted, decision-makers will intervene using laws and regulations. The Clean Water Act is a good example. This Act seeks to control pollution in navigable waterways. Practitioners who use the ES approach can use predictive modeling tools to quantify how changes in ecosystem structure (e.g., different types of forest management) may result in changes in water quality (e.g., lbs. of sediment). Simple spatially explicit modeling tools are already available to help planners identify scenarios where conservation actions will be most effective. For example, the InVEST program by the Natural Capital Project is a suite of free, open-source software models that can be used to map and value the goods and services from nature. This information can help decision-makers and stakeholders work together to develop policies or programs to help meet landowner needs and societal objectives.

One policy strategy is to use financial incentives to encourage changes in landowner behaviors and ecosystem service outcomes. The payment for ecosystem services (PES) strategy pays private landowners to provide public benefits through ecosystem management. A PES program does this by facilitating negotiations between ecosystem service providers (i.e., landowners) and buyers (e.g., a government agency representing public demand) (Ferraro and Kiss

2002). In some cases, economic valuation methods can help decision-makers design more efficient incentive programs because landowner payments can be directly linked to quantified estimates of public demand for ES.

Challenges to Using the Ecosystem Services Approach

While there is great potential for using the ecosystem services approach in a variety of decision contexts, there are a number of challenges (Ruckelshaus et al. 2013). The primary challenge is a poor understanding of how changes in ecosystem structure impact the production of key services and benefits. Spatial models often require certain kinds of data that may not always be available to practitioners. Simple spatial models are also limited in predictive power, especially at smaller spatial scales. Adding to this are science gaps in understanding how changes in ES impact broader measures of human well-being such as livelihoods and community health. Another challenge is engaging leaders and stakeholders. An interactive and iterative approach to decision-making is often time consuming but necessary for building trust and ensuring success in subsequent negotiations and agreements about proposed policy actions.

Suggested Websites and Readings

Integrating Ecosystem Services Into Federal Resource Management https://nespguidebook.com/introduction/integrating-ecosystem-services-into-federal-resource-management-a-guidebook/

InVEST by the Natural Capital Project http://www.naturalcapitalproject.org/invest/

Ecosystem Valuation http://www.ecosystemvaluation.org/

References

Alcamo, J., and E. M. Bennett, Eds. 2003. *Ecosystems and human well-being: a framework for assessment*. Island Press. New York, NY.

Costanza, R., R. d'Arge, R. D. Groot, S. Farber, M. Grasso, B. Hannon, et al. 1997. "The value of the world's ecosystem services and natural capital." *Nature* 387 253–260.

Champ, P.A., K. J. Boyle, T. C. Brown, Eds. 2003. *A Primer on Nonmarket Valuation*, Volume 3. Springer: New York, NY, USA.

De Groot, R. S., R. Alkemade, L. Braat, L. Hein, and L. Willemen. 2010. "Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making." *Ecological Complexity* 7(3), 260–272.

Ernst, C., R. Gullick, and K. Nixon. 2004. "Conserving Forests to Protect Water." *American Water Works Association* 30(5), 1–7.

Farber, S. C., R. Costanza, and M. A. Wilson. 2002. "Economic and ecological concepts for valuing ecosystem services." *Ecological Economics* 41(3), 375–392.

Ferraro, P. J., and A. Kiss. 2002. "Direct payments to conserve biodiversity." *Science* 298(5599), 1718–1719.

Fisher, B., R. K. Turner, and P. Morling. 2009. "Defining and classifying ecosystem services for decision making." *Ecological Economics* 68.3: 643–653.

Florida Panther Recovery and Implementation Team (FPRIT). 2014. *Partners for fish and wildlife program proposal for managing native landscapes on private lands in the Florida Panther Focus Area*. Vero Beach, Florida. Downloaded on January 1, 2015 from https://www.fws.gov/verobeach/FloridaPantherRIT/20140324_PESConceptPaperDRAFT.pdf

Guerry, A. D., M. H. Ruckelshaus, K. K. Arkema, J. R. Bernhardt, G. Guannel, C. K. Kim, and S. A. Wood. 2012. "Modeling benefits from nature: using ecosystem services to inform coastal and marine spatial planning." *International Journal of Biodiversity Science, Ecosystem Services & Management* 8(1–2), 107–121.

Just, R. E., D. L. Hueth, and S. Andrew. 2004. *The Welfare Economics of Public Policy: A Practical Approach to Project and Policy Evaluation*. Edward Elgar Publishing: North-Hampton, England, UK.

King, D. M. and M. J. Mazzotta. 2000. *Ecosystem Valuation*. US Department of Agriculture Natural Resources Conservation Service and National Oceanographic and Atmospheric Administration.

Meyer, W. B., and B. L. Turner. 1992. "Human population growth and global land-use/cover change." *Annual Review of Ecology and Systematics* 39–61.

Millennium Ecosystem Assessment 2005. *Ecosystems and human well-being: Synthesis*. Washington (DC): Island Press.

Pienaar, E. 2013. *The Use of Cost-Benefit Analysis in Environmental Policy*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. Retrieved April 14, 2015 from http://edis.ifas.ufl.edu/UW383.

Ruckelshaus, M. E., McKenzie, H. Tallis, A. Guerry, G. Daily, P. Kareiva, S. Polasky, et al. 2013. "Notes from the Field: Lessons Learned from Using Ecosystem Services to Inform Real-World Decisions." *Ecological Economics*. doi: 10.1016/j.ecolecon.2013.07.009.

Table 1. Examples of ecosystem functions and services.

Function	Intermediate Services	Final Goods and Services
Regulation	Land cover features that regulate rain runoff.	Water provision in local watersheds and aquifers.
	Breakdown of nutrients and compounds (by plants and biota).	Nutrient control, waste treatment, and pollution control.
Habitat	Wild plants and animals.	Maintenance of biological and genetic diversity.
	Nurseries that support reproduction.	Maintenance of commercially harvested species.
Production	Raw organic materials (e.g., vegetables/meat, lumber, litter).	Physical health and vitality, building and manufacturing, fuel and energy, fodder and fertilizer.
Cultural	Varied landscapes.	Aesthetic, artistic, educational, and spiritual services.

Landowner Cost-Share Incentives and Payments for Ecosystem Services: A Comparison of Key Program Features [1]

Melissa M. Kreye, Elizabeth Pienaar, and Raoul K. Boughton[2]

Introduction

There are several ways that landowners can receive financial assistance from the government when conducting land management activities that protect environmental benefits, but not all incentive strategies are necessarily the same. This paper will compare traditional cost-share programs offered to landowners through federal agencies (e.g., USDA NRCS), and payments for ecosystem services (PES) programs, a new type of market-based incentive program. This information can help private landowners understand the advantages and limitations of both approaches and guide decision-makers in designing future conservation incentive programs.

Environmental Quality

The term "environmental quality" is used to generally describe the condition of the environment, or ecosystem, relative to humans' needs. Different types of land uses can result in changes in environmental quality and associated benefits depending on how intensively the land is managed (Pannell 2008) (Figure 1). For example, the conversion of a more natural ecosystem to row crop agriculture has been linked with changes in water quality as well as increases in the provision of food and fiber resources (Ritter and Shirmohammadi 2010). The purpose of both cost-share and PES programs is to help protect environmental quality while also increasing the provision of select environmental benefits on private lands managed for different uses.

Less intensive land uses ☐------------------------------------☐ More management intensive
More environmental benefits ☐---------------------------------☐ Fewer environmental benefits

Figure 1. Examples of different land uses based on how intensively the lands are managed.
Credits: From left to right: AVTG; fotokostic; mtreasure; AlbertPego. Getty Images/iStockphoto.com

Cost-Share Incentives

Traditionally, the cost-share, or matching payments, approach focuses on encouraging landowners to engage in good stewardship practices so as to prevent loss of environmental benefits. More specifically, these programs offer landowners partial compensation to offset the costs of implementing best management practices (BMPs) recommended for their land use. Many landowners are already familiar with the Environmental Quality Incentives Program (EQIP) offered by the Natural Resources Conservation Service (NRCS) and have worked with NRCS

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to develop a conservation activity plan (CAP) (NRCS 2015). Compensation levels are usually a set dollar value per acre and come in the form of a direct annual payment. In addition to EQIP, there are a number of other federal- and state-sponsored assistance programs that provide technical and financial assistance to landowners in the state of Florida (USDA 2009). These include programs such as the Conservation Reserve Program and the Florida Forest Stewardship Program.

Payments for Ecosystem Services

The term "ecosystem services" describes an ecosystem management approach that is focused on linking ecosystem structure and function with the production of specific services and benefits (de Groot et al. 2010). Payments for ecosystem services (PES) is a strategy that pays landowners for the services and benefits produced by ecosystems on their land (Ferraro and Kiss 2002). The approach is "market-based" when trade negotiations about service provision are made between ecosystem service provider(s) and buyer(s) (Ferraro 2008). In the United States, the ecosystem service provider is typically a landowner, with enforceable private property rights, who can control how the land is used and thereby ensure that certain ecosystem services are provided. The buyer is typically a government agency representing public demand for ecosystem service benefits. The negotiations between the provider and the buyer center on the conditions set out in the conservation contract. Conditions typically pertain to payment levels, how payments are linked with quantified levels of ecosystem services, and monitoring/enforcement procedures that guarantee delivery of service.

A good example of a market-based PES program in Florida is the Northern Everglades – Payment for Environmental Services Program offered by the South Florida Water Management District (SFWMD). To help restore the hydro-period, or timing of flows, in the Florida Everglades, this program establishes contracts with landowners to store excess water collected during the wet season on private rangelands around Lake Okeechobee. The negotiated payment levels described in the contract are based on acre-feet of water retained over a specified time period. The quantity of water retained is measured at the weir using approved methods as the water is released into existing canals for transport. So far the program has provided approximately 6,700 acre-feet of water retention services and, since the SFWMD board approval for six new projects, the program is expected to provide an additional 95,812 acre-feet of retained water in 2016 (SFWMD 2014).

Many of the PES strategies in the United States are watershed protection programs where payment levels are linked with pounds of nutrients retained by ecosystems that have been managed for less intensive land uses (Breetz et al. 2004). Outside the United States, other types of PES strategies have been used to increase the provision of a range of ecosystem service benefits. For example, several PES programs in Queensland, Australia, provide annual payments to landowners for maintaining wildlife habitat for imperiled species (Moon et al. 2012). PES programs have been found to be effective in helping government agencies meet conservation goals while providing landowners with additional sources of income (Ferraro and Kiss 2002). However, the PES strategy does not offer a cure-all solution to the problems associated with ecosystem conservation, but is one among a diverse set of potential policy solutions (Muradian et al. 2013).

Comparing the Programs

Cost-share and PES programs are similar in several ways. The goal of both approaches is to ensure the protection of environmental quality or the provision of environmental benefits for the public. Both programs recognize private landowners as providers of environmental benefits, and both programs use voluntary incentives to encourage changes in the landowner's behavior (Table 1). There are several differences among key program features which has implications for how these programs can be used to help meet conservation goals.

The foremost way these programs differ relates to the conditions of the conservation contract and associated payment levels. Cost-share contracts require the landowner to conduct specific land management activities in order to receive financial compensation or assistance.

In a cost-share contract, the level of compensation is typically based on the landowner's expected per-acre costs, is set by the agency, and is not negotiable. The subsequent changes in environmental benefits are not quantified and do not have any bearing on whether or not the landowner receives compensation, as long as the management activity is undertaken according to the contract. In contrast, under a market-based PES program, payment levels are directly linked with the production of quantified levels of a defined ecosystem service(s), and providers (e.g., landowners) offer competitive bids for level of service provided. To ensure service provision, the landowner may need to conduct certain land management activities and monitoring activities; however, payment levels are linked to the ecosystem services provided and ***not*** to pre-defined specific land management activities (such as weed removal).

Under certain conditions, market-based PES programs can be an improvement over cost-share programs. Namely, a market-based PES approach can help prevent land-use conversion to more intensive uses (e.g. urban development or row crops) by offsetting all land stewardship costs and even allowing landowners to potentially profit from being an ecosystem service provider (as opposed to the landowner profiting from other types of land uses like development). However, the potential for landowners to profit is dependent on the level of public demand for the ecosystem service and the number of available service providers (i.e., landowners whose lands can provide the ecosystem service) to help meet that demand (Ferraro 2008). In other words, this approach can only provide additional conservation if the ecosystems on the lands targeted by the program are at a high risk of being converted and the landowners are not willing to engage in programs that provide more permanent conservation outcomes (e.g., conservation easement). In some cases, the personal motivations of landowners may coincide with the conservation efforts of sponsoring agencies, and the landowner may only need assistance with covering certain land stewardship costs (e.g., BMPs).

References

Breetz, H. L., K. Fisher-Vanden, L. Garzon, H. Jacobs, K. Kroetz, and R. Terry. 2004. *Water quality trading and offset initiatives in the US: A comprehensive survey.* Dartmouth College and the Rockefeller Center for the US Environmental Protection Agency.

De Groot, R. S., R. Alkemade, L. Braat, L. Hein, and L. Willemen. 2010. "Challenges in integrating the concept of ecosystem services and values in landscape planning, management and decision making." *Ecological Complexity* 7 (3), 260–272.

Ferraro, P. J. 2008. "Asymmetric information and contract design for payments for environmental services." *Ecological Economics* 65 (4), 810–821.

Ferraro, P. J., and A. Kiss. 2002. "Direct payments to conserve biodiversity." *Science* 298 (5599), 1718–1719.

Meyer, W. B., and B. L. Turner. 1992. "Human population growth and global land-use/cover change." *Annual Review of Ecology and Systematics* 39–61.

Moon, K., N. Marshall, and C. Cocklin. 2012. "Personal circumstances and social characteristics as determinants of landholder participation in biodiversity conservation programs." *Journal of Environmental Management* 113, 292–300.

Muradian, R., M. Arsel, L. Pellegrini, F. Adaman, B. Aguilar, B. Agarwal, E. Corbera et al. 2013. "Payments for ecosystem services and the fatal attraction of win-win solutions." *Conservation letters* 6 (4) 274–279.

NRCS. 2015. *NRCS Environmental Quality Incentives Program*. Accessed July 7, 2015 at http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Osborne, L. L., and D. A. Kovacic. 1993. "Riparian vegetated buffer strips in water-quality restoration and stream management." *Freshwater Biology* 29 (2), 243–258.

Pannell, D. J. 2008. "Public benefits, private benefits, and policy mechanism choice for land-use change for environmental benefits." *Land Economics* 84 (2), 225–240.

Ritter, W. F., and A. Shirmohammadi, Eds. 2010. *Agricultural nonpoint source pollution: watershed management and hydrology*. CRC Press.

USDA. 2009. *Forest Incentive Programs Available from Federal Sources*. Accessed on May 28, 2015 at http://www.srs.fs.usda.gov/econ/data/forestincentives/federal.htm

Zabel, A., and S. Engel. 2010. "Performance payments: A new strategy to conserve large carnivores in the tropics?" *Ecological Economics* 70:2, 405–412.

Table 1. Similarities and differences in key program features between Payments for Ecosystem Services (PES) and a typical cost-share program.

Key Program Features	PES	Cost-Share
Prevents loss of environmental benefits associated with certain land uses.	X	X
Payments are set and directly linked with land stewardship/best management practices.	-	X
Providers are compensated for part of the management costs.	-	X
Promotes production of certain ecosystem services and benefits.	X	-
Payments are directly and dynamically linked with provision of environmental benefits.	X	-
Payment levels are negotiated between providers and buyers.	X	-

Beef Cattle Nutrition Research Program at RCREC

Philipe Moriel, Assistant Professor
Beef Cattle Nutrition and Management

Beef Cattle Nutrition Team

Philipe Moriel, Assistant Professor: I am originally from São Paulo city, Brazil. In 2008, I received my bachelor degree in Animal Science from Sao Paulo State University (Botucatu city, Brazil). I moved to the U.S. in 2009 to study at the University of Wyoming where I received my master degree in Animal and Veterinary Sciences in 2010. Then, I moved to Florida and completed my doctorate degree at the University of Florida - Range Cattle REC in 2013. From October 2013 to June 2016, I worked as an Assistant Professor and Livestock Specialist at North Carolina State University. My office was located at the Mountain Research Station in Waynesville, NC and my appointment included 75% extension and 25% research on beef cattle nutrition and management. On June 1st 2016, I joined the faculty at Range Cattle REC with a 60% research and 40% extension appointment, and I am looking forward to work with all of you. Contact: pmoriel@ufl.edu

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Research Focus

The beef cattle nutrition program will focus on 4 major areas that address multiple research priorities established by the FL Cattlemen's Association:

(1) Nutritional management of cows and heifers during gestation (Fetal-programming) and pre-weaning calf nutrition (Metabolic Imprinting) which are areas that might permanently modify the offspring metabolism and cause long-term consequences to their health, growth, and reproductive performance.

(2) Evaluate the impact of heat stress during gestation, and identify nutritional and management approaches to overcome these negative effects.

(3) Strategic supplementation of protein and energy during pre- and post-breeding periods to optimize pregnancy rates and calving distribution of beef females.

(4) Identify cost-effective, pre- and post-weaning nutrition and management strategies to:

(a) Develop replacement beef heifers;

(b) Alleviate stress, increase immunity, response to vaccination and value of calves.

Upcoming Event

You are invited to join us by webinar on **November 28**, at noon. We will present a summary of the most recent research conducted at Ona on nutritional management of beef heifers. This summary will also be published at the November issue of The Florida Cattlemen and Livestock Journal. We will be available for questions on that day. To participate, you simply need to register online here: https://attendee.gotowebinar.com/register/7496424475530968324, or you can also visit our website for the registration link: http://rcrec-ona.ifas.ufl.edu. If you are nearby our Center, you are also welcome to attend the presentation in person by joining us in the Grazinglands Education Building.

Ona Report Webinar (Nov. 28th, 2016): Recent nutritional strategies to enhance reproductive performance of heifers – A summary of Range Cattle REC studies

Replacement heifers are an important part of the cow-calf operation and represent genetic improvement of the cow herd. Heifers should calve by 24 months of age to achieve maximum lifetime productivity, and heifers that lose a pregnancy or conceive late in the breeding season are likely to not have enough time to rebreed during a defined breeding season. In addition, *bos taurus* heifers that calved during the first 21 days of calving season remained in those calving groups longer and weaned heavier calves in the subsequent 6 parturitions. In fact, early-calving heifers had an increase in weaning weight that amounted to the production of an extra calf during their lifetime compared to late-calving heifers. This represents a substantial financial benefit for cow-calf producers and reinforces the importance of having replacement heifers conceive as early as possible. Providing the correct nutrition that will allow the heifer to achieve these goals is crucial, and this topic has been the focus of multiple research studies at the RCREC. In this report, you will be provided with a summary of the most recent experiments evaluating growth and reproductive performance of beef heifers.

Frequency of energy supplementation. *J. Anim. Sci. 90(2012):2371-2380.*

Forage is the main component of cattle diets, but it is usually energy deficient. Consequently, energy supplementation is often required for growing animals. However, the expenses associated with energy supplementation can significantly increase production costs and become unattractive to cow-calf producers. A typical approach to decrease these expenses is to reduce the frequency of supplementation, such as 3 times weekly (Monday, Wednesday, and Friday) instead of daily to minimize costs associated with labor, fuel, and equipment.

Starting 60 days before breeding season, we compared the growth and reproductive performance of Brangus heifers that were supplemented with concentrate either daily or 3 times weekly. Supplements consisted of soybean hulls and wheat middlings, and were offered at weekly rates of 35 lb/heifer for 120 days. During the study, heifers receiving daily supplementation had similar average daily gain compared with heifers supplemented 3 times weekly (0.59 vs. 0.55 lb/day, respectively). However, the percentage of heifers reaching puberty at the start of breeding season (33 vs. 21%) and final pregnancy rate (21 vs. 12%) was greater for heifers supplemented daily compared to heifers supplemented 3 times weekly. Therefore, replacement beef heifers receiving diets based on low-quality forages should receive energy supplements daily to enhance their reproductive development.

Calf management systems for early-weaned heifers. *J. Anim. Sci. 92(2014):3096-3107.*

Calves from first-calf cows are early-weaned at 70 days of age at the Range Cattle REC. This practice improves the reproductive performance of first-calf beef cows. However, many beef producers are unwilling to adopt this management practice due to a lack of information on the nutritional management of early-weaned calves. Therefore, we evaluated different management systems for early-weaned beef calves and their long-term consequences on calf performance.

In January, heifers were assigned to be normally weaned at 8 to 9 months of age in July, or early weaned in January and: (1) limit fed a high-concentrate diet in drylot for 180 days; or (2) limit fed a high-concentrate diet in drylot for 90 days, then grazed on bahiagrass pastures until day 180. Then, heifers were managed similarly from July to end of the breeding season in early February. Early-weaned heifers limit-fed a high-concentrate diet for 90 days in drylot had similar growth performance than normally-weaned heifers. Interestingly, 80% of heifers that were limit-fed a high-concentrate diet in drylot for 90 days achieved puberty at the start of the breeding season, but only 40% of normally-weaned heifers achieved puberty at the start of the breeding season. This response indicates that early puberty attainment may be achieved if heifers are exposed to high-concentrate diets at young ages (approximately 70 days of age).

Should I mix cottonseed meal with Sugarcane molasses in a slurry form, or offer them separately to beef heifers? *Prof. Anim. Sci. 32(2016):302–308*

Sugarcane molasses is a by-product of the sugarcane industry typically used as an energy source for grazing beef cattle in Florida. Commercially available molasses-based liquid supplements usually rely on urea to increase protein concentrations. However, adding cottonseed meal to a sugarcane molasses–urea mixture has been shown to improve growth performance of younger cows compared to those supplemented with molasses–urea supplement. Currently, the mixing of dry feeds with molasses in a beef cattle operation is performed manually or through relatively expensive equipment that is not widely available. Providing sugarcane molasses and natural protein feed sources separately could further decrease labor and feed costs. Recently, beef heifers were fed cottonseed meal manually mixed with sugarcane molasses in a slurry form (**SLU**) or fed cottonseed meal and molasses in separate bunks (**SEP**); 70 lb of sugarcane molasses and 14 lb of cottonseed meal were delivered twice weekly (Tuesdays and Fridays) for 70 days.

Average daily gain of heifers did not differ between feeding treatments (0.37 vs. 0.35 lb/day for SLU and SEP heifers respectively). However, 19% of heifers supplemented with molasses and cottonseed meal in a slurry form achieved puberty at the start of breeding season compared to only 8% of heifers fed molasses and cottonseed meal separately. This negative impact on puberty can likely be attributed to a faster consumption of cottonseed meal by heifers when fed cottonseed meal and molasses separately leading to different and more variable energy metabolism and impairing puberty achievement. However, overall pregnancy rates and calving distribution did not differ between treatments. This demonstrates that cottonseed meal and molasses could be offered separately rather than in a slurry form without affecting growth and reproductive performance of grazing replacement beef heifers. By providing cottonseed meal and molasses separately, cow-calf operations should be able to reduce labor and further lower feed costs, leading to greater profitability compared with providing cottonseed meal and molasses in a slurry form.

Highlighted Research

NUTRITIONAL AND MANAGEMENT STRATEGIES FOR STRESSED CALVES

Project description and relevance: Bovine respiratory disease is the leading cause of morbidity and mortality, resulting in significant economic losses to the beef cattle industry. Therefore, nutritional strategies to enhance the immunity efficiency of calves might enable greater growth performance and protection against respiratory diseases. Our laboratory focuses on increasing nutrient density and frequency of supplementation to enhance growth and vaccine response of growing, recently weaned calves. Decreasing the frequency of supplementation may reduce the costs associated with feeding (labor, fuel and equipment). However, our previous study (Artioli et al., 2015; funded by NC Cattlemen's Association) demonstrated that decreasing the frequency of energy supplementation from daily to 3 times weekly increased the stress response, and decreased growth performance, percentage of beef calves responding to vaccination and antibody production against bovine viral diarrhea virus type 1-b (one of the major pathogens causing bovine respiratory disease; **Table 1**). These responses were associated with fluctuations on the release of hormones and metabolites associated with energy metabolism. Taken together, our previous results would suggest that decreasing the frequency of energy supplementation during stress is not recommended. However, additional management practices need to be identified to overcome the observed negative effects of supplementation frequency on growth and immunity of calves, in order to facilitate the implementation of preconditioning programs and decrease feeding cost and labor of cow calf producers. Therefore, we are investigating if a gradual reduction on frequency of energy supplementation (STUDY 1) and different timing of vaccination (STUDY 2) could be used as alternative methods to overcome the negative effects previously observed for calves supplemented less frequently.

Table 1. Growth performance, percentage of calves responding to vaccination and serum antibody titers against bovine viral diarrhea viral type 1b of steers provided daily free-choice access to ground tall fescue hay and similar weekly concentrate amount offered daily or 3 times weekly during a 42-d preconditioning period. Project funded by NC Cattlemen's Association #1107 2014-1885.

	Supplementation frequency			
Item	**Daily**	**3 times weekly**	**SEM**	***P*-value**
Average daily gain (day 0 to 42), lb/day	2.86	2.27	0.088	0.02
Calves responding to vaccination, %	100	79	8.8	0.06
Serum antibody titers, log base 2	2.51	1.46	0.306	0.03

STUDY 1 - Effects of gradual reduction on frequency of energy supplementation on growth and immunity of stressed calves. G. M. Silva, P. Moriel, N. Henson, J. Ranches, G. S. Santos, and M. H. Poore.

This study evaluated the effects of gradual reduction on frequency of energy supplementation following vaccination on growth and measurements of immunity of beef steers. Briefly, beef calves were offered free choice access to ground hay for 42 days. Treatments consisted of similar weekly concentrate amount (1% of body weight times 7 days) that was divided and offered daily from day 0 to 42 (**7X**), 3 times weekly from day 0 to 42 (**3X**; Monday, Wednesday, and Friday), or daily from day 0 to 14 and then 3 times weekly from day 15 to 42 (**7-3X**). Growth performance over the 42-day period was similar among treatments ($P \geq 0.26$). However, steers supplemented 3 times weekly had greater plasma concentrations of haptoglobin and cortisol (indicators of inflammatory response and stress) compared to 7-3X and 7X steers (Table 2). Also, steers supplemented 3 times weekly produced less antibody titers against infectious bovine rhinotracheitis virus, and had a lower percentage of calves responding to vaccination against parainfluenza-3 virus, which are viruses that can cause bovine respiratory disease. In summary, a gradual reduction on frequency of energy supplementation during a 42-day preconditioning period did not impact growth, but alleviated inflammation and prevented detrimental effects on vaccine response against infectious bovine rhinotracheitis virus and parainfluenza-3 virus compared to steers fed 3 times weekly during the entire study.

Table 2. Stress indicators and vaccine response of steers provided similar weekly concentrate amount that was divided and offered daily from day 0 to 42 (7X), 3 times weekly from day 0 to 42 (3X), or daily from day 0 to 14 and then 3 times weekly from day 15 to 42 (7-3X).[1]

	Treatment				*P*-value		
Item	**3X**	**7-3X**	**7X**	**SEM**	**Frequency**	**Day**	**Freq. × day**
Plasma haptoglobin, mg/dL	0.44[a]	0.37[b]	0.37[b]	0.026	0.04	<0.0001	0.94
Plasma cortisol, ng/mL	20.6[a]	19.2[ab]	15.7[b]	1.68	0.10	0.040	0.57
Infectious bovine rhinotracheitis virus							
Antibody titers, $\log_2$	0.29[a]	0.88[b]	0.79[b]	0.179	0.05	<0.0001	0.24
Vaccine response, %	22.2	33.1	30.6	8.51	0.60	<0.0001	0.76
Parainfluenza-3 virus							
Antibody titers, $\log_2$	3.54	4.46	3.66	0.606	0.52	<0.0001	0.81
Vaccine response, %							
day 15	36.0[a]	76.6[b]	57.0[b]	8.24	0.09	<0.0001	0.04
day 42	100.0[a]	98.0[a]	98.9[a]				

[a-b] Within a row, means without a common superscript differ ($P \leq 0.05$).

DOES YEAR-ROUND SUPPLEMENTATION OF COWS PAY OFF?

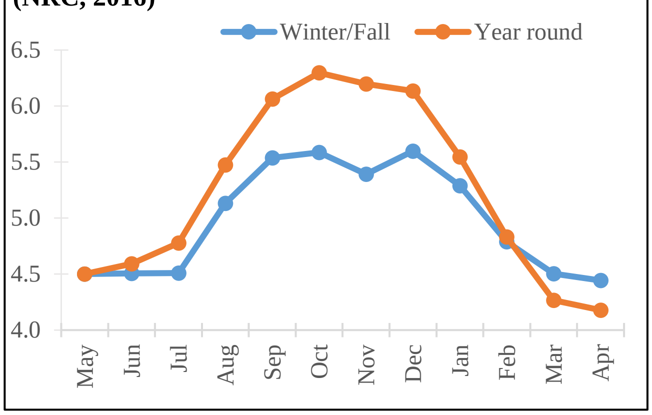
In 2017, we will begin one long-term study to address 3 research priorities of the Florida Cattlemen's Association (Calf loss, Mineral and winter supplementation, and Animal health). We will evaluate if year-round supplementation can improve performance of cows and calves compared to the traditional Fall/Winter supplementation program. More specifically, we will use year-round supplementation of energy, protein and minerals to:

1. Better manage the body condition score of cows and increase their pregnancy rates;
2. Improve calf development during gestation and impact their subsequent health, growth, and consequently, cowherd profitability;
3. Improve our understanding of the differences on the metabolism of mature cows (and their calves) under different supplementation strategies, which will assist on designing future studies and harvest greater performance levels;
4. Generate novel information for local educational programs to further assist producers and county agents on cowherd supplementation strategies.

Project description and relevance: Fall/Winter seasons in Florida correspond with critical events that determine the economic success of a cow-calf operation, and those are the late gestation, breeding season, and first trimester of the subsequent gestation of beef females. These events occur during periods of low forage quality and availability, but highest nutrient demand for the growing fetus and cow milk production. Unfortunately, reproduction has the lowest nutrient priority, and consequently, it is often impaired by the mismatch between nutrient demand and availability. Increased reproductive success can be achieved by increasing body condition score at calving (5 or 6, according to a 1 to 9 scale) and trace mineral status of mineral-deficient beef cows. In fact, body condition score at calving is the most important factor that influences the interval from parturition to first ovulation, overall pregnancy rate, and calving distribution of beef cows. Most of FL cow-calf operations provide year-round supplementation of trace minerals, but provide protein and energy supplementation to alleviate cow weight loss only during early-lactation. However, inadequate dietary energy/protein during late pregnancy lowers reproduction even if the amount of energy and protein consumed during early-lactation are sufficient.

Until recently, the decisions about cow-herd supplementation considered only the cost of supplements and its impact on pregnancy rates. However, recent studies have shown that nutritional insults during gestation can also modify placental development, fetal organ formation, and offspring growth and health (a process called ***fetal-programming***). For instance, calves born to cows that experienced energy deficiency during the last 40 days of gestation (which often occurs in cows grazing warm-season grasses) experienced poor vaccine response and antibody production, which might compromise calf health and increase calf loss. Additional studies also indicated that providing beef cows sufficient nutrition during late-gestation can compensate for many of the negative consequences of nutrient restriction that occur in early- to mid-gestation, and improve calf survivability, weaning performance, and economic returns. Thus, the decisions about cowherd supplementation should also include the impact on future offspring performance. Identifying nutritional strategies that can improve reproductive performance of cows, decrease calf loss, and optimize future calf growth and health is crucial and the primary goal of this proposal.

Figure 1. Body condition score simulation (NRC, 2016)



One strategy that can improve cow reproductive success and offspring performance following birth is the use of year-round supplementation. Figure 1 simulates a scenario of body condition score change of two Brangus cows calving in November. Both cows received **similar total annual amount of sugarcane molasses** (600 lb of dry matter/cow) that was provided during the Fall/Winter season only or distributed throughout the entire year (see Table 3 also). Cows supplemented year-round might achieve a greater body condition score at calving without increasing the annual supplement amount. Another advantage is that the trace mineral salt can be mixed into the supplement, reducing annual fluctuations in voluntary intake and wastage of free choice trace mineral formulations, which will improve cow trace mineral status. Our hypothesis is that year-round supplementation of molasses- or range cubes will increase body condition score at calving and trace mineral status of cows throughout the year, which will enable cows to experience greater body condition loss during early-lactation without reducing their reproductive performance compared to cows supplemented with molasses during Winter/Fall season only. In addition, year-round supplementation of molasses and range cubes will improve calf development during pregnancy, and then, improve calf health, survivability, and growth following birth.

Approach

Starting in May, pregnant Brangus cows will be allocated into bahiagrass pastures. Treatments will consist of cows supplemented with molasses-urea mix from calving until the end of breeding season (November to April; **CON**), or cows receiving year-round supplementation of molasses-based (**YMOL**) or range cubes-based (**YRAN**) formulations. Total annual amount of supplement will be similar among all treatments (approximately 600 lb of supplement dry matter/cow annually; Table 3). Supplements will be offered on Mondays and Thursdays.

Offspring evaluation: Calf growth performance will be evaluated every 60 days from birth to weaning. After weaning, steers will be assigned to a 45-day post-weaning evaluation of growth performance and immunity, whereas heifers will be developed from July to November and assigned to a 60-day breeding season from December to February. Blood samples of steers will be collected to assess multiple indicators of innate immunity, antibody production and vaccine response. Blood samples of heifers will be collected periodically to determine their puberty achievement during the study.

Table 3. Supplement dry matter intake (lb/cow daily) of cows offered molasses-based supplementation during Fall/Winter (Control) or year-round supplementation of molasses- or range cubes-based mixtures.

Treatments [a]	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Year-round Molasses	*lb of dry matter/cow daily*											
96% Molasses + 4% Urea							2.5	2.5	2.5	2.5	2.5	1.5
Molasses only	0.5	0.5	0.5	1.5	1.5	1.5						
Year-round Range cubes												
Range cubes 1							2.5	2.5	2.5	2.5	2.5	1.5
Range cubes 2	0.5	0.5	0.5	1.5	1.5	1.5						
Fall/Winter supp. (Control)												
96% Molasses + 4% Urea							3.3	3.3	3.3	3.3	3.3	3.3

[a] Total annual supplement dry matter offered will be approximately 594 lb/cow.

Anticipated outcomes and timeline for the project: We estimated one positive scenario for using year-round supplementation in FL based on a previous research, and also the necessary increment on annual calf production to breakeven compared to winter supplementation.

Positive scenario: A previous study (Chapman et al., 1965; Florida Agr. Exp. Sta. Bull. 701) reported that year-round supplementation of molasses (2.3 kg of molasses/cow for 365 days) increased annual calf production by 40 lb/cow compared to winter supplementation of molasses (2.3 kg of molasses/cow for 130 days). Assuming that FL has about 1 million cows and that approximately 30% of producers would adopt the year-round supplementation strategy, the potential impact of this research could achieve 12 million pounds of additional calf production per year.

Breakeven: We estimated the extra pounds of weaned calves needed for a herd of 100 cows supplemented year-round to breakeven compared to a herd provided only Fall/Winter supplementation. The total amount of supplement will be the same among all treatments. Hence, the only difference among treatments is the additional hours of labor needed to provide molasses or range cubes compared to feeding trace mineral salt twice weekly during Spring and Summer. We expect that 2 hours of additional labor will be needed for every feeding event to provide molasses or range cubes compared to feeding loose mineral supplements (2 hours ×

$12.05/hour cost with minimum wage and fuel ÷ 100 cows = $0.241/cow/feeding event). Thus, the extra labor cost for cows supplemented year-round will be $12.53/cow annually (26 weeks of Summer and Spring × 2 feeding events/week × $0.241/cow/feeding event). Therefore, a herd of 100 cows will require 1090 lb of additional pounds of weaned calves to cover the extra labor costs of year-round supplementation ($12.53/cow ÷ $1.15/lb of weaned calves × 100 cows). In other words, pregnancy rate needs to be increased by 2.5 percentage units (assuming an 80% calving rate) or calf loss needs to be decreased by 2 percentage units to cover the additional labor costs.

This research project will be an outstanding opportunity to collaborate with livestock agents and educate several producers using hands-on, on-farm educational programs in multiple counties of FL. It is expected that a minimum of 150 producers will be outreached by these educational programs (25 producers per event × 3 events per year × 2 years). In addition, some of those educational programs will be recorded and available online for those not able to attend. Producer attendance and knowledge increase will be determined before and after each educational program using evaluation questionnaires. In addition, data collected during the study will be summarized and shared with producers via educational programs and popular press, as well as, submitted for peer reviewed publication at the Journal of Animal Science.

Cow reproductive performance data will be available in May 2018 (year 1) and 2019 (year 2). Steer performance data will be available by July 2018 (year 1) and 2019 (year 2), whereas heifer reproductive performance data will be available by March 2019 (year 1) and 2020 (year 2).

For further information about fetal-programming effects on beef cattle, please see the article **“Fetal Programming: Cow Nutrition and its Effects on Calf Performance”** that follows.

Fetal Programming: Cow Nutrition and its Effects on Calf Performance

Animal Science Facts

Introduction

"Cow nutrition impacts pregnancy rates and subsequent calf performance."

The North Carolina beef cattle industry relies primarily on the use of high-forage diets to develop replacement heifers, maintain the cow herd, and sustain stocker operations. However, forage quantity and quality changes with season and environmental conditions. Depending on the physiological state and animal category, forage-based diets may not always meet 100% of the nutritional requirements, resulting in body weight loss or reduced performance if supplemental nutrients are not provided (Funston et al., 2012). Animals experience nutrient restriction more often than realized because of overgrazing situations and a lack of forage frequently observed throughout the state.

There are two typical priorities related to feeding beef cows: (1) provide the cheapest diet possible to reduce annual feeding costs, and (2) provide enough nutrients to prevent reproductive failure. It is well known that poor cow nutrition can decrease reproductive performance. If cows' nutrient requirements are not met before calving, they will start mobilizing nutrients from their own reserves to survive and to maintain fetal calf growth. Consequently, it is likely that these cows will calve at a low body condition score (BCS). The BCS system is an indicator of the percentage of body fat during cows' production cycles, and it is a crucial determinant of their reproductive performance and productivity. Cows will not conceive at an acceptable rate (generally >85%) without adequate body fat reserves (BCS = 5; 1 to 9 scale).

A low BCS at the time of calving (less than 5) extends the *anestrous period*, which is the period when the cow is recovering from calving and is not cycling. An extended anestrous period decreases the percentage of cows that are cycling and able to breed at the start of the breeding season, leading to lower pregnancy rates as shown in Figure 1. As BCS at calving decreases, pregnancy rates also decrease (Figure 1). In addition, pregnancy will probably occur at the end of the breeding season, delaying the subsequent calving and leaving less time to recover before the next breeding season.

Recently, a lot of researchers have demonstrated that cow nutrition can impact more than just pregnancy rates. In this publication, we will summarize some of the recent data showing the effects of poor cow nutrition on calf growth and performance.

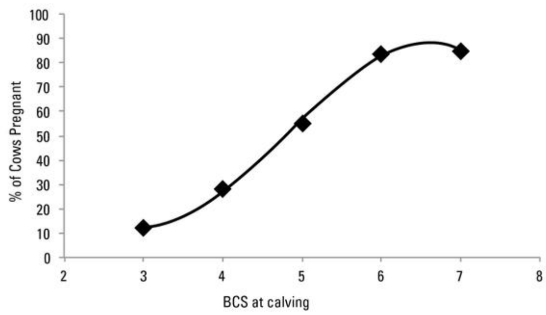


Figure 1. Pregnancy rates of cows calving at different body condition scores (BCS; Selk et al., 1988; n = 300 multiparous cows).

Fetal Programming

Fetal programming is the concept that a maternal stimulus or insult at a critical period in fetal development has long-term effects on the offspring (Funston et al., 2010). Approximately 75% of calf fetus growth occurs during the last two months of gestation (Robinson et al., 1977). Calf nutrient requirements are therefore relatively low during the first two trimesters of gestation. For that reason, many people believed that cow nutrition could only affect calf growth during the last trimester of gestation. Recent data demonstrate that this is not the case.

Maximal placental growth, differentiation, and vascularization occur during the early phase of fetal development. The placenta is the major regulator of calf fetal growth, and it appears that maternal nutrition may affect the development and function of the placenta (Funston et al., 2010). In addition, the majority of calf organs form simultaneously with placental development during early gestation. For instance, heartbeat is apparent as early as 21 days of pregnancy, whereas pancreas, liver, adrenals, lungs, thyroid, spleen, brain, thymus, and kidneys start to develop at 25 days of pregnancy (Hubbert et al., 1972). Each organ and tissue has its own “window” of formation. For example, organs such as kidneys and pancreas occur during early gestation, whereas muscle and adipose tissue formation occurs primarily during mid to late gestation (Du et al., 2010). Thus, nutrient restriction during gestation might impact placental formation and calf organ development. Also, depending on when the nutrient restriction happens during gestation, the outcome of this insult might have different consequences to calf performance. We will report how cow nutrient restriction during early, mid, and late gestation might differently affect the subsequent calf performance.

Consequences of Nutrient Restriction

Early Gestation (0 to 3 months of gestation)

Cows must conceive within 80 days postpartum if a yearly calving interval is desired. Cows' milk production and nutrient requirements peak at 60 days postpartum; however, intake lags behind. This results in negative energy balance during early to mid lactation (NRC, 1996), especially if cows are managed to calf during the dry or winter seasons when poor forage quality and loss forage mass is available. Thus, nutrition inadequacy often occurs in beef cattle production systems (Caton and Hess, 2010).

Unfortunately, a limited amount of published results exists regarding the effects of cow nutrient restriction during early gestation on beef calf performance. A University of Wyoming study attempted to evaluate the growth performance and organ development of calves born to cows experiencing nutrient restriction during (Long et al., 2010). In that study, cows were separated into two groups that were fed at 55 or 100% of their nutrient requirements for the first 83 days of gestation. Following 83 days, both groups were provided 100% of their nutrient requirements until calving. Understandably, cows provided 55% of their nutrient requirements lost 137 lb of body weight, whereas cows fed 100% of their nutrient requirements gained 95 lb of body weight during the first 83 days of gestation. No differences were observed on calf birth weight, weaning weights, and average daily gain from birth to weaning or during the feedlot finishing phase (Table 1). However, lung and trachea weights of steers born to heifers provided 55% of their nutrient requirements were significantly less ($P < 0.05$) than steers born to heifers fed 100% of their nutrient requirements (Figure 2). Although growth performance was not affected, it would be misleading to interpret these results as if nutrient restriction during early gestation does not impact calf performance. In a commercial feedlot, calves are constantly exposed to several pathogens and commingled with calves of unknown health background. It is therefore possible that smaller lungs could be detrimental to calf performance if those calves experience bovine respiratory disease after entering a commercial feedlot. However, additional studies are needed to confirm this hypothesis.

Table 1. Growth performance of male offspring born to first-calf heifers fed 55 or 100% of their nutrient requirements during the first 83 days of gestation (Long et al., 2010).

	Steers born to heifers fed:		SEM	*P*-value
	55% of requirements	100% of requirements		
Body weight, lb				
Birth	69	71	2.8	0.31
Weaning	491	480	26.4	0.32
Average daily gain, lb/day				
Birth to weaning	1.8	1.9	0.08	0.14
During finishing	4.9	4.6	0.28	0.40

Mid Gestation (3 to 6 months of gestation)

Production-oriented tissues, such as muscle, appear to be responsive to fetal programming effects in utero (Caton and Hess, 2010). Muscle formation is divided into two waves of muscle fiber synthesis. The first wave begins at mid gestation, whereas the second wave occurs from six to nine months of gestation (Du et al., 2010). Thus, nutrient restriction during mid gestation is expected to decrease muscle fiber formation, leading to lower birth and weaning weights.

At the University of Wyoming, researchers evaluated the growth performance of steers born to cows grazed on low-quality, native pastures (6% crude protein) or high-quality, fertilized and irrigated pastures (11% crude protein) for 60 days from 120 to 150 days through 180 to 210 days of gestation (Underwood et al., 2010). In that study, researchers reported that body weight at weaning and carcass weights were reduced for male offspring born to cows grazed on native pastures compared to male offspring born to cows grazed on improved pastures during mid gestation (Table 2). In addition, the Warner-Bratzler shear force, which is an indicator of meat tenderness, was less for *Longissimus* muscle samples of male offspring born to cows grazed on improved pastures (31 vs. 37 N; $P = 0.004$). In other words, cows that grazed on improved pastures during mid gestation produced calves that were heavier at weaning and harvesting, and that had greater meat tenderness at slaughter.

Nutrient restriction during mid gestation also may have consequences on organ development. Angus × Gelbvieh cows were randomly allotted into groups and fed at 70 or 100% of their nutrient requirements from day 45 to 185 of gestation. They were then commingled and fed at 100% of their nutrient requirements from day 185 of gestation until calving (Long et al., 2012). Although body weight at birth and at weaning did not differ ($P \geq 0.19$) between treatments, heifers born to cows fed at 70% of their nutrient requirements had smaller ovaries and luteal tissue (Figure 3). Luteal tissue is crucial for progesterone synthesis and pregnancy maintenance. Therefore, smaller ovary and luteal tissue could affect cows' reproductive performance during their first breeding season. Additional studies are required in this area to confirm these results and evaluate long-term effects of nutrient restriction during mid gestation on subsequent reproductive performance of the heifer progeny.

Table 2. Growth performance of male offspring born to cows grazed on native (6% crude protein) or improved pastures (11% crude protein) for 60 days during mid gestation (Underwood et al., 2010).

	Grazing management during mid gestation		SEM	*P*-value
	Native pastures	Improved pastures		
Birth, lb	85	81	4.4	0.46
At weaning, lb	533	564	8.1	0.02
At slaughter, lb	1145	1198	17.0	0.04
Hot carcass weight, lb	726	767	10.6	0.04

Late Gestation (6 to 9 months of gestation)

Late gestation is probably the most important gestation period in terms of potential impact on production-oriented tissues such as muscle and adipose tissue. As mentioned before, major portions of beef cattle muscle and adipose tissue form during late gestation (Du et al., 2010). Muscle fiber number is set at birth, meaning that after the calf is born, there is no net increase in the number of existing muscle fibers. Thus, if nutrient restriction during late gestation reduces muscle fiber number (Zhu et al., 2004), calf growth performance following birth might be compromised. In addition, maternal nutrient restriction may also compromise adipocyte populations (cells responsible for accumulating fatty acids and generating intramuscular fat, for example), resulting in carcasses with lower quality and marbling scores.

In a series of studies from University of Nebraska (Stalker et al., 2006, 2007; Larson et al., 2009), researchers evaluated the effects of providing protein supplementation during late gestation on subsequent offspring performance (Table 3). Cows were sorted into groups that received or did not receive 1 lb/day of a protein supplement (42% crude protein) during late gestation. All studies reported that male offspring born to cows that received the protein supplement were heavier than male offspring born to non-supplemented cows. In addition, two of those three studies (Stalker et al., 2007; Larson et al., 2009) reported heavier carcasses for males born to cows that were supplemented with protein, whereas one study (Larson et al., 2009) reported greater percentages of carcasses grading Choice and greater marbling scores for steers derived from cows that were supplemented with protein during late gestation.

Table 3. Growth performance and carcass quality of male offspring born to cows that received (Supp.) or did not receive (No Supp.) protein supplementation (1 lb daily of a 42% crude protein supplement) during late gestation (*P < 0.05).

Item	Stalker et al. (2007)		Stalker et al. (2006)		Larson et al. (2009)	
	No Supp.	Supp.	No Supp.	Supp.	No Supp.	Supp.
Weaning weight, lb	441*	463*	465*	480*	518*	531*
Carcass weight, lb	764*	804*	800	813	802*	819*
Choice, %	-	-	85	96	71*	86*
Marbling	449	461	467	479	444*	493*

Similar studies from University of Nebraska also evaluated the effects of supplementing beef cows with 1 lb/day of a protein supplement during late gestation (Table 4). In those studies, weaning weights (Martin et al., 2007) and weights adjusted for 205 days of age (Funston et al., 2010) were greater for heifers born to cows that received protein supplementation during late gestation. In addition, heifers born to cows that were supplemented achieved puberty at younger ages (Funston et al., 2010) and had greater pregnancy rates (Martin et al., 2007) than heifers born to cows that did not receive protein supplementation (Table 4).

Table 4. Growth and reproductive performance of heifers born to cows that received (Supp.) or did not receive (No Supp.) protein supplementation (1 lb daily of a 42% crude protein supplement) during late gestation (*P < 0.05).

Item	Martin et al. (2007)		Funston et al. (2010)	
	No Supp.	Supp.	No Supp.	Supp.
Weaning weight, lb	456	467	496*	511*
Adj. 205-day weight	480*	498*	469	478
Age at puberty, days	334	339	366*	352*
Pregnancy rate, %	80*	93*	80	90

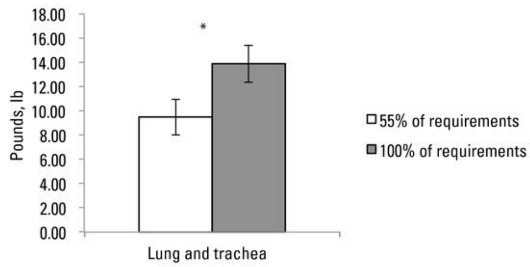


*Figure 2. Lung plus trachea weights of steers born to first-calf heifers provided 55 or 100% of their nutrient requirements during the first 83 days of gestation (n = 10 steers per treatment; *P < 0.05).*

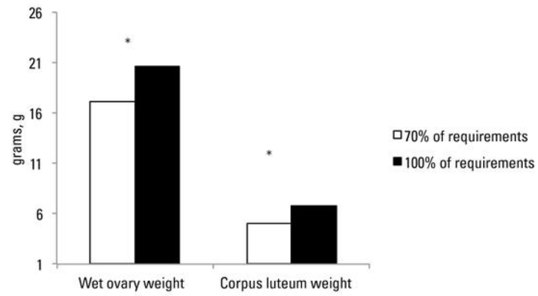


*Figure 3. Wet ovary and luteal tissue weights of heifers born to cows provided 70 or 100% of their nutrient requirements from 45 to 185 days of gestation (Long et al., 2012; n = 4 heifers per treatment; 13 months of age; *P < 0.05).*

Final Comments

Nutrient deficiency often occurs in animals provided forage-based diets due to seasonal variation in forage quality and quantity, and as a result of mismanagement leading to overgrazed pastures. This nutrient deficiency has been shown to impact the reproductive performance of cows, the subsequent growth and reproductive performance of calves, and meat quality. Hence, closer attention and proper nutrition of the herd need to be enforced in order to avoid or alleviate the negative impacts of nutrient restriction during gestation on cow and calf performance. Furthermore, this publication focused solely on the effects of gestational nutrient restriction. It is important to realize that excessive nutrient consumption (energy, protein, minerals, vitamins, and fatty acids), diet composition (starch concentration), energy and protein sources, and stress also have potential for programming calf development in utero. In conclusion, cow-calf nutrition termed "fetal programming" has large implications for the beef industry and merits producer attention and further research attention in the future.

References

Caton, J. S., and B. W. Hess. 2010. Maternal Plane of Nutrition: Impacts on Fetal Outcomes and Postnatal Offspring Responses. In *Proc. Graz. Lives. Nut. Conf.*, 104-119. Casper, WY.

Du, M., J. Tong, J. Zhao, K. R. Underwood, M. Zhu, S. P. Ford and P. W. Nathanielsz. 2010. Fetal Programming of Skeletal Muscle Development in Ruminant Animals. *J. Anim. Sci.* 88:E51-E60.

Funston, R. N., D. M. Larson, and K. A. Vonnahme. 2010. Effects of Maternal Nutrition on Conceptus Growth and Offspring Performance: Implication for Beef Cattle Production. *J. Anim. Sci*. 88:E205-E215.

Funston, R. N., A. F. Summers, and A. J. Roberts. 2012. Implications of Nutritional Management for Beef Cow-Calf Systems. *J. Anim. Sci*. 90:2301-2307.

Larson, D. M., J. L. Martin, D. C. Adams, and R. N. Funston. 2009. Winter Grazing System and Supplementation during late Gestation Influence Performance of Beef Cows and Steer Progeny. *J. Anim. Sci*. 87:1147–1155.

Long, N. M., M. J. Prado-Cooper, C. R. Krehbiel, U. DeSilva, and R. P. Wettemann. 2010. Effects of Nutrient Restriction of Bovine Dams during Early Gestation on Postnatal Growth, Carcass and Organ Compositions, and Gene Expression in Adipose Tissue and Muscle. *J. Anim. Sci*. 88:3251–3261.

Long, N. M., C. B. Tousley, K. R. Underwood, S. I. Paisley, W. J. Means, B. W. Hess, M. Du and S. P. Ford. 2012. Effects of Early- to Mid-Gestational Undernutrition with or without Protein Supplementation on Offspring Growth, Carcass Characteristics, and Adipocyte Size in Beef Cattle. *J. Anim. Sci*. 90:197-206.

Martin, J. L., K. A. Vonnahme, D. C. Adams, G. P. Lardy, and R. N. Funston. 2007. Effects of Dam Nutrition on Growth and Reproductive Performance of Heifer Calves. *J. Anim. Sci*. 85:841–847.

NRC. 1996. Nutrient Requirements of Beef Cattle. 7th rev. ed. Washington, DC: Natl. Acad. Press.

Hubbert, W. T., O. H. V. Stalheim, and G. D. Booth. 1972. Changes in Organ Weights and Fluid Volumes during Growth of the Bovine Fetus. *Growth* 36:217-233.

Robinson, J. J., I. McDonald, C. Fraser, and I. McHattie. 1977. Studies on Reproduction in Prolific Ewes. I. Growth of the Products of Conception. *J. Agric. Camb*. 88:539-552.

Selk, G. E., R. P. Wettemann, K. S. Lusby, J. W. Oltjen, S. L. Mobley, R. J. Rasby and J. C. Garmendia. 1988. Relationships among Weight Change, Body Condition and Reproductive Performance of Range Beef Cows. *J. Anim. Sci*. 66:3153-3159.

Stalker, L. A., D. C. Adams, T. J. Klopfenstein, D. M. Feuz, and R. N. Funston. 2006. Effects of Pre- and Postpartum Nutrition on Reproduction in Spring Calving Cows and Calf Feedlot Performance. *J. Anim. Sci*. 84:2582–2589.

Stalker, L. A., L. A. Ciminski, D. C. Adams, T. J. Klopfenstein, and R. T. Clark. 2007. Effects of Weaning Date and Prepartum Protein Supplementation on Cow Performance and Calf Growth. *Rangeland Ecol. Manage*. 60:578–587.

Underwood, K. R., J. F. Tong, P. L. Price, A. J. Roberts, E. E. Grings, B. W. Hess, W. J. Means, and M. Du. 2010. Nutrition during Mid to Late Gestation affects Growth, Adipose Tissue Deposition, and Tenderness in Cross-bred Beef Steers. *Meat Sci*. 86:588–593.

Zhu, M. J., S. P. Ford, P. W. Nathanielsz, and M. Du. 2004. Effect of Maternal Nutrient Restriction in Sheep on the Development of Fetal Skeletal Muscle. *Biol. Reprod*. 71:1968–1973.

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2017 Beef Cattle Market Outlook

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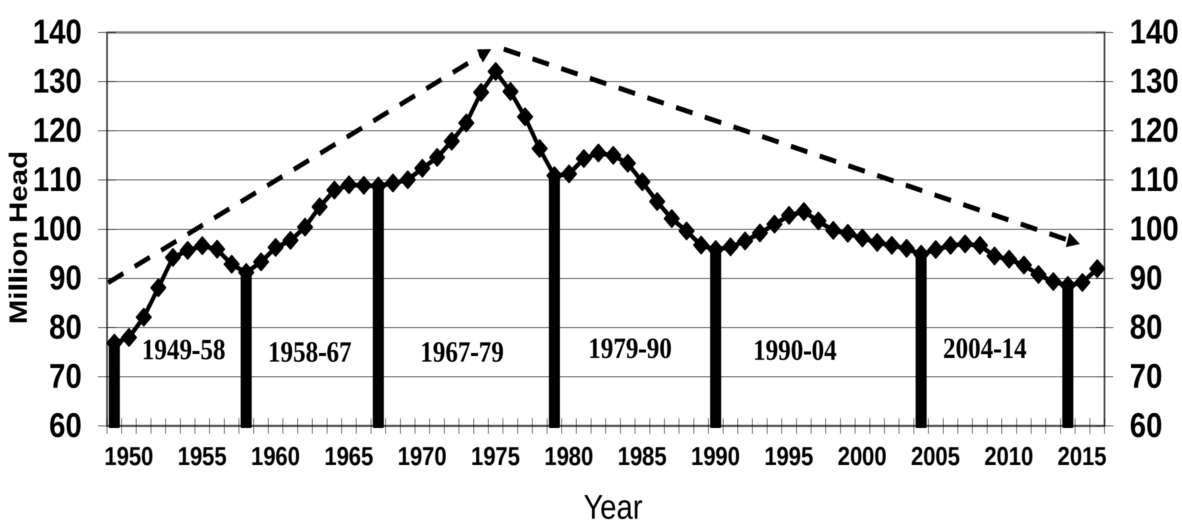
Livestock and Forage Economics

The U.S. beef cattle industry has historically been a large contributor to U.S. cash receipts of agricultural commodities. During 2015, the U.S. beef cattle industry accounted for approximately $79 billion (21 percent) of the $377 billion of total U.S. cash receipts of agricultural commodities (Economic Research Service, USDA). Supporting this large dollar contribution of the U.S. beef cattle industry to the U.S. agricultural economy is a beef industry that is widely dispersed throughout 50 states and composed of numerous specialized production enterprises (seed-stock, extensive and intensive cow-calf, stocker, backgrounder, and feedlot enterprises). These enterprises expand and decrease over time as a result of an infinite number of variables that affect the levels of cattle inventory numbers and pounds of beef production.

The U.S. cattle inventory numbers have shown significant increases and decreases over the last six decades. Figure 1 describes the expansion and contraction of the U.S. cattle inventory between 1949 and 2016. Two distinct observations are notable in Figure 1 regarding cattle and calves inventory.

Figure 1. U.S. Cattle and Calves Inventory, January 1, 1949-2016



First, there was an increasing trend between 1949 and 1975 followed by a decreasing trend between 1975 and 2016 in U.S. cattle and calves inventory (denoted by the dashed lines with arrows). Between 1949 and 1975 U.S. cattle and calves increased from 77 to 132 million head, an increase of 55 million head or 77 percent. Then inventories declined between 1975 and 2016 from 132 to 92 million head, a decrease of 40 million head or -30 percent. The decline in U.S. cattle and calves inventory since 1975 has been caused by higher levels of efficiency in all sectors of the U.S. beef industry (more pounds of beef per brood cow), larger levels of competing meats, and a wider array of other goods and services demanded by U.S. consumers. This chart documents in the most recent cattle cycles (1990-04 and 2004-14) that the increases and decreases of cattle inventory numbers have been more moderate compared with historic cattle cycles which suggests that we may see only modest declines in cattle inventory numbers during the current cattle cycle. Arguably, U.S. policy and regulatory decisions, consumer beef demand, weather, and competition for land, labor, capital, and management, will influence the future size of the U.S. cattle industry.

Secondly, the mound shapes between the vertical bars in Figure 1 are cattle cycles. A cattle cycle is measured as the period of time from the lowest cattle and calves inventory to the next lowest level of inventory over time. Many cattle producers describe the cattle cycle as being from trough to trough. Since 1949 cattle cycles have ranged between 10 and 15 years in length. During the cattle cycles between 1949 and 1979 cattle and calves inventory increased by 18 to 23 million head during each cycle followed by a smaller decline in inventory numbers. Since 1979 the cattle and calves inventory increased by only 2 to 8 million head during each cycle followed by much larger declines of -8 to -20 million head. As should be expected, higher market prices (profits) lead to increases in cattle and calves inventory and lower market prices (losses from oversupply) lead to decreases in cattle and calves inventory. The current 2016 cattle and calves inventory level is similar to those of the mid-1950s.

2016 Cattle and Beef Supply Situation

U.S. cattle inventory numbers are currently surveyed once per year by the USDA as of January 1 of each year. U.S. cattle producers told the USDA their January 1st, 2016 cattle inventory numbers and this information was reported in the publication entitled “Cattle.” The total cattle and calves inventory estimate was 92 million head. Figure 2 details the 2016 inventory levels for specific categories of cattle.

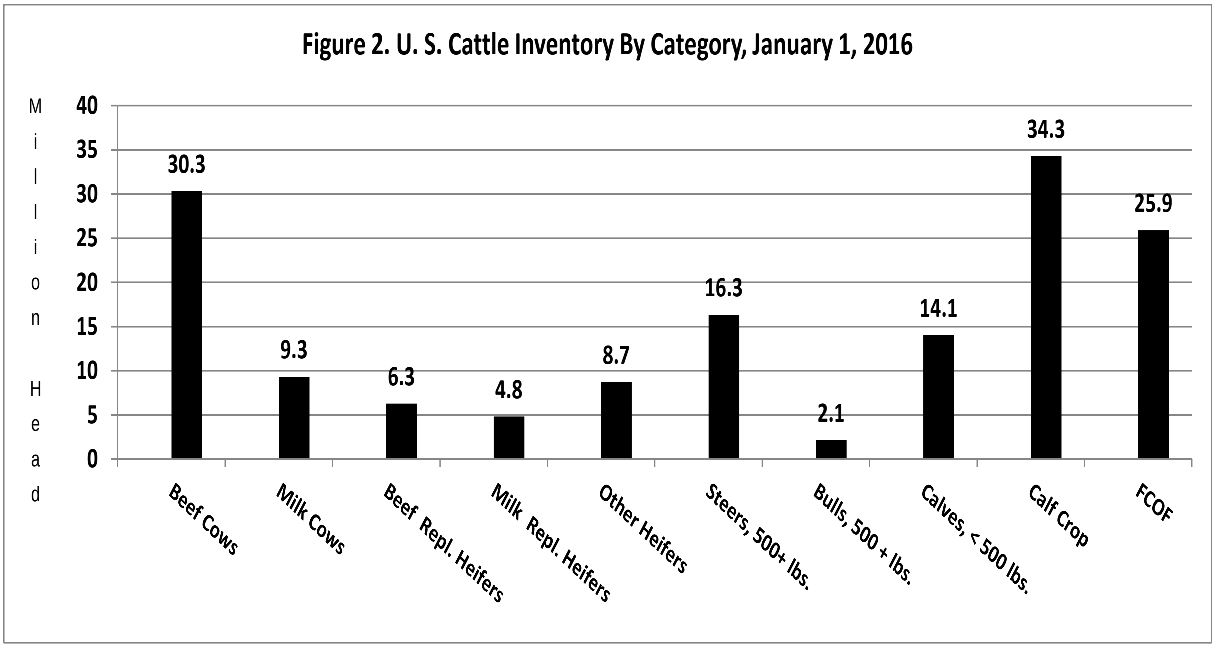
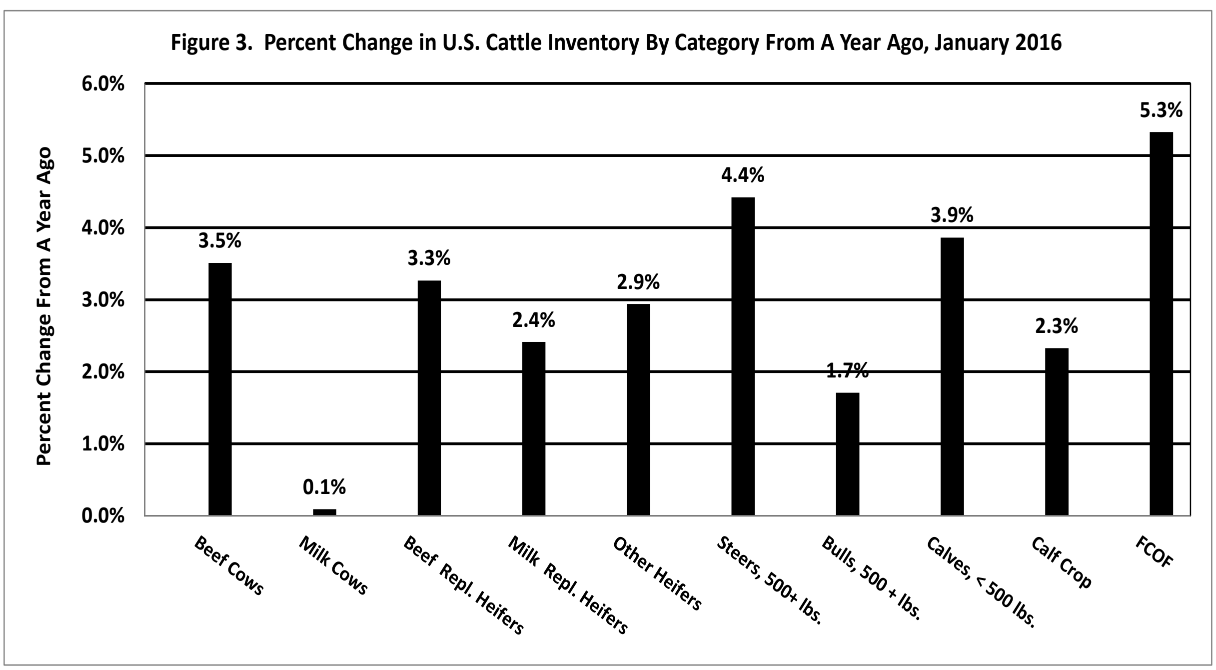


Figure 3 reports the percent change in the U.S. Cattle Inventory by category from a year ago (January 1, 2015 vs January 1, 2016). Increases were realized in all categories of the U.S. cattle inventories. Higher than average cattle prices, improved grazing conditions, lower production costs (feed, fertilizer, fuel, etc.), and profits are cited as the major factors supporting the increases in all categories of the U.S. cattle inventory.



The January 1, 2016 USDA survey reported that cattle producers had about 1.04 million head (2.7 percent) more cows that had calved than a year ago. Beef cows that had calved were 30.3 million head, up 1.03 million head (3.5 percent) from a year ago. Dairy cows that had calved increased about 8,000 head from a year ago to 9.32 million head (0.1 percent). Beef cow replacements increased about 199,000 head from a year ago to 6.3 million head (3.3 percent). Dairy cow replacements at 4.8 million head were up 114,000 head (2.4 percent) from a year ago. In summation, an increase in total cows (1.04 million head of beef and dairy cows) and total replacements (313,000 head of beef and dairy replacements) between January 1st, 2015 and January 1st, 2016 documents that robust herd expansion is underway in the U.S. cattle industry.

Additionally shown in Figure 3 were increases in inventory estimates compared with one year ago for other heifers (2.9%), steers, 500+ pounds (4.4%), bulls, 500+ pounds (1.7%), calves less than 500 pounds (3.9%). These increases provide support for a larger estimate of the inventory of cattle and calves when the January 1, 2017 Cattle Report is released.

A larger inventory of cattle and calves and larger calf crop during 2016 is expected to result in higher levels of beef production during 2017. USDA projects U.S. beef production during 2016 to be about 24.9 billion pounds which would be up 5.3 percent from the 2015 estimate of 23.7 billion pounds. This level of beef production will be influenced by any adjustments in average carcass weights and the level of feeder and live cattle imports (from Canada and Mexico). Due to significantly cheaper feedstuffs, slaughter weights should be heavier during 2016 and 2017.

Expected Outlook

- 2016 U.S. beef production is expected to increase to a total of 24.9 billion pounds, up about 1.2 billion pounds (5.3 percent) from 2015. The 2017 U.S. beef production is expected to increase to a total of 25.8 billion pounds, up about 0.9 billion pounds (3.4 percent) from 2016.

- 2016 U.S. beef exports are expected to increase to 2.5 billion pounds, up 0.2 billion pounds (8.6 percent) from 2015. 2017 U.S. beef exports are expected to increase to 2.6 billion pounds, up 0.1 billion pounds (4.9 percent) from 2016 due to improving trade agreements, lower beef prices, and world population growth. As should be expected with approximately 10 percent of U.S. beef currently being exported, any increase or decrease in the levels of U.S. exports of beef and/or competing meats (pork and poultry) will have a significant impact on U.S. domestic beef prices.

- 2016 U.S. beef imports are expected to decrease to 3.0 billion pounds, down 0.4 billion pounds (-12.3 percent) from 2015. 2017 U.S. beef imports are expected to decrease to 2.6 billion pounds, down about 0.4 billion pounds (-12.0 percent) from 2016 due to larger domestic beef production and other domestic competing meats.

- 2016 net beef supply (domestic beef production plus beef imports minus beef exports) is expected to increase to 25.4 billion pounds, up 0.6 billion pounds (2.6 percent) from last year. The 2016 increase is the result of an increase in domestic beef production (1.2 billion pounds or 5.3 percent), a decrease in beef imports (-0.4 billion pounds or -12.3

percent), and an increase in beef exports (0.2 billion pounds or 8.6 percent). Beef and veal imports are expected to be about 3.0 billion pounds during 2016, while exports are expected to be about 2.5 billion pounds. The resulting beef trade deficit (exports minus imports) of about -0.5 billion pounds is expected to be realized during 2016.

- 2017 net beef supply is expected to increase to a total of 25.8 billion pounds, up 0.4 billion pounds (1.5 percent) from 2016. The increase in 2017 is the result of an increase in domestic production (0.9 billion pounds or 3.4 percent), a decrease in beef imports (-0.4 billion pounds or -12.0 percent), and an increase in beef exports (0.1 billion pounds or 4.9 percent). Beef and veal imports are expected to be about 2.6 billion pounds, while exports are also expected to be similar at about 2.6 billion pounds during 2016. The resulting 2016 beef trade surplus/deficit (exports minus imports) is expected to be about even.

- 2016 competing U.S. meat production (pork and poultry) is expected to show a modest increase compared to a year ago. Pork production during 2016 is expected to show an increase of 0.4 billion pounds (1.6 percent) and broiler production is expected to increase by about 0.9 billion pounds (2.1 percent). Pork and broiler production are expected to total 24.9 and 40.9 billion pounds during 2016, respectively.

- 2017 competing U.S. meat production (pork and poultry) is also projected to increase compared with 2016. 2017 pork production is expected to increase 0.6 billion pounds (2.5 percent) and broiler production is expected to increase by about 1.1 billion pounds (2.7 percent). Pork and broiler production are expected to total 25.5 and 42.0 billion pounds, respectively.

Competing Meats

All three major meats, beef, broilers, and pork, are expected to increase during 2016 and 2017. During 2016 the three major meats are expected to increase to 90.7 billion pounds (up 2.5 billion pounds or 2.8 percent from 2015). Likewise, 2017 U.S. meat production of beef, broilers, and pork is expected to increase to 93.3 billion pounds (up 2.6 billion pounds or 2.8 percent). Figure 4 shows the U.S. beef, broiler, and pork production levels for 2013-2017. 2016 and 2017 are projected estimates by USDA as of 9/16/16. Notice the upward trends for each commodity.

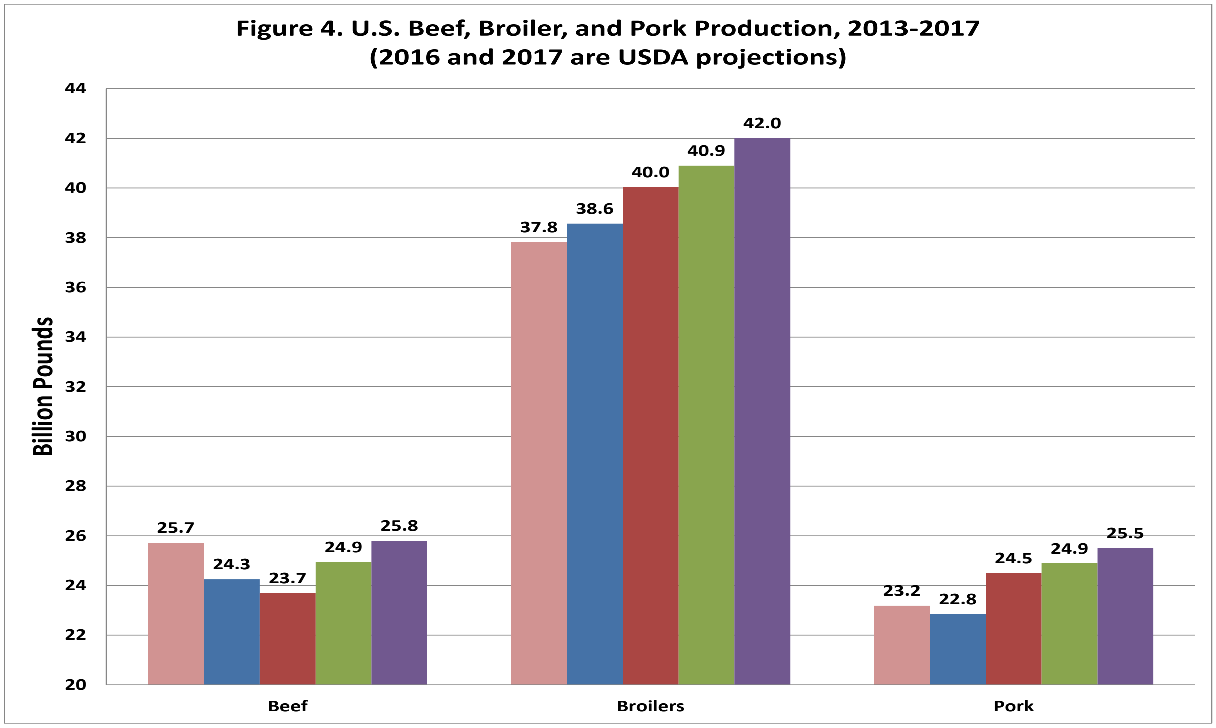
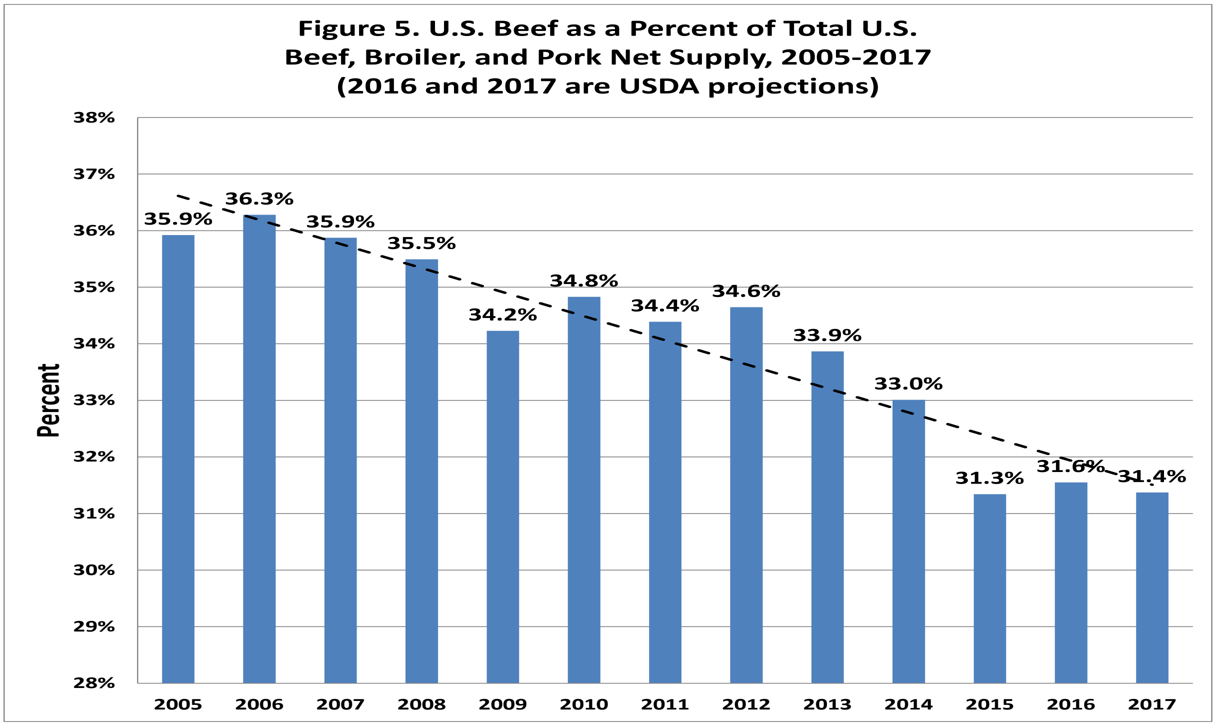


Figure 5 describes U.S. beef as a percent of total U.S. beef, broiler, and pork net supply between 2005 and 2017. U.S. beef as a percent of total U.S. beef, broiler, and pork net supply has ranged between 31.3 and 36.3 percent during the 13 years evaluated. The trend line shows that U.S. beef as a percent of U.S. beef, broiler, and pork net supply is decreasing over time. In order to reverse this trend a combination of actions will be necessary such as increased cattle and forage performance, lower production costs, favorable weather for forage production, improved consumer beef demand, and reasonable profits are needed to encourage future increased beef production.



Any changes in these production, import, and/or export levels of beef, pork, and broilers could have a significant effect on U.S. beef prices. Additionally, any increases or decreases in production input prices will likely alter these 2017 production projections. A watchful eye on the production and export levels of competing meats and input prices will help identify potential changes in beef production and prices.

Feed and Forage Conditions

The 2016 growing season of the major corn and soybean growing regions started with a normal planting schedule, but with more acres planted. Above average weather and growing conditions have caused yield levels to return to or exceed trend levels in most major grain growing areas (Crop Production, 09/12/16).

The 2016 corn production is forecast to be the highest level of production on record for the United States at 15.1 billion bushels. The area harvested for grain is forecast at 86.6 million acres, 7 percent above last year. The 2016 soybean production is forecast to be 4.2 billion bushels. The area for harvest in the United States is forecast at a record 83.0 million acres, up 1 percent from 2015.

Additionally, harvest weather is currently adequate in most areas for a timely harvest. If these production levels are realized, corn production will be about 1.66 billion bushels larger than a year ago (11 percent) and soybean production will be about 0.29 billion bushels larger than a year ago (7 percent).

2016 corn and soybean futures prices have decreased corresponding to the forecasted larger crops that were projected this season. Since the beginning of their respective futures contracts, the December 2016 corn futures prices ranged from a high of about $4.49 per bushel on 06/17/2016 to a low of $3.14 per bushel on 08/31/2016, while November 2016 soybeans ranged from a high of $11.86 per bushel on 06/13/2016 to a low of $8.59 per bushel on 11/10/2015. December 2016 corn is currently trading at $3.39 per bushel (CME Group, 10/07/16), while November 2016 soybeans is at $9.56 per bushel. The current futures prices represent a decrease in futures prices for corn and soybeans of about -25 percent and -19 percent from the highs during 2016, respectively. Corn and soybean prices are expected to move slightly lower as the 2016 harvest season continues. Therefore, livestock producers with storage facilities should take advantage of these lower prices and buy their feedstuffs during the 2016 crop harvest. If these lower grain prices continue, many sectors of animal agriculture will continue to see expansion.

Another factor that affects feed prices, feeder calf prices, and feeder cattle prices is the level of export demand for corn and soybeans. Any major changes in world grain supplies and/or export demand for these commodities could significantly move cattle market prices. Economic growth in several Asian countries has begun to slow down which may affect export grain demand. Additionally, the strength of the U.S. dollar is certain to influence the world grain export demand (a strong U.S. dollar negatively impacts U.S. grain export demand and vice-versa).

Total 2016 U.S. hay production is expected to be larger than a year ago. USDA's September Crop Production Report (9/12/16) estimated total hay production at about 140 million tons. That is up about 6.1 million tons (4.5 percent) from last year. Average yield is expected to increase marginally and acreage harvested is expected to increase slightly for hay production. Average yield is expected to increase from 2.47 to 2.50 tons per acre (1.2 percent). Harvested acreage is estimated to be up 0.68 million acres (3.1 percent) from 2015.

Pasture and range conditions have been better over many of the cow-calf states this year. The pasture and range conditions as of September 27, 2015 rated as poor or very poor was 18 percent of the total U.S. acreage compared to 22 percent last year (Crop Progress, 10/03/16). The current U.S. pasture and range conditions rated as good to excellent was 50 percent of the total U.S. acreage compared to 44 percent this time last year. These improved pasture and forage conditions coupled with increased hay supplies should continue to encourage some herd expansion even with moderately cattle prices being realized during 2016.

Beef Demand and Trade

U.S. beef demand has enjoyed moderate growth during the last several years despite a slow U.S. economic recovery. 2017 domestic beef demand is expected to be tested as significant increases in beef and competing meats are realized and consumers are expected to experience rising interest rates and prices for most goods and services. If consumer disposable income does not rise proportionally, shopping habits and choices will shift forcing consumers to substitute and/or reduce the bundle of goods and services they have consumed in the past.

Per capita consumption of beef is expected to increase during 2016. Domestic disappearance is expected to result in beef per capita consumption of 55.2 pounds per person in 2016. The combination of higher domestic beef production, a decrease in imports, and slightly higher exports are expected to show an increase in domestic net beef supply in 2016 (0.6 billion pounds or 2.5 percent) compared with a year ago. USDA has estimated per capita beef consumption for 2017 to be 55.6 pounds per person.

The 2015 average retail beef price was $6.29 per pound. Monthly average retail beef prices during the first eight months of 2016 averaged 28 cents per pound lower than a year ago ($6.07 vs. $6.35). The 2016 average retail beef price is expected to be about 3-4 percent lower than 2015. Average retail beef prices during 2017 are also expected to show a decrease of 3-4 percent due to expanding beef and competing meat supplies.

Additionally, it is very important that the U.S. beef industry continues to sustain and/or grow beef export markets. The U.S. currently exports about 10 percent of domestic beef production each year. The beef export market commonly adds between 12-18 percent of the value of a steer marketed (based on sales of beef, offal, and hides, etc.). For example, during August 2016 the added export value of beef slaughter contributed $257 per head to the value of each slaughter beef. Furthermore, the growth in beef export markets will also help to moderate the price impacts should any weaknesses occur in U.S. broiler and pork exports.

2017 Beef Price Outlook

The 2017 cattle market will likely experience lower average cattle prices compared with 2016 due to increased net beef supply, increases in domestic competing meat production, and weaknesses in the U.S. economy. The decrease in cattle market prices should be moderate and not as precipitous as the decreases experienced during 2016 and the second half of 2015. Volatile price movements in either direction are possible with abrupt changes in levels of meat production, beef demand, trade issues, and other economic variables.

The 2015-2017 U.S. net beef supply estimates are shown in Table 1. U.S. net beef supply is domestic beef production plus beef imports minus beef exports. The net beef supply is the amount of beef that is consumed in U.S. markets. The 2016 U.S. net beef supply is expected to show an increase of about 0.6 billion pounds (25.437B - 24.804B = 0.633B, 2.55 percent) compared with 2015. The 2017 U.S. net beef supply is expected to show an increase of 0.4 billion pounds (25.820B - 24.437B = 0.383B, 1.55 percent) compared with 2016.

Table 1. U.S. Net Beef Supply (Billion Pounds), 2015-2017.[1]

Item	2015	2016	2017
	(Billion Pounds)		
U.S. Domestic Beef Production	23.698	24.942	25.800
U.S. Beef & Veal Imports	3.371	2.955	2.600
U.S. Beef & Veal Exports	2.265	2.460	2.580
U.S. Net Beef Supply	24.804	25.437	25.820

[1]USDA data estimates reported as of September 16, 2016. Columns may not sum exactly due to rounding.

Minor changes in future U.S. beef import and/or export levels (due to beef demand, food safety, exchange rates, politics, regulations, etc.) can significantly change the U.S. net beef supply and consequently domestic beef prices. Additionally, the strength of the U.S. dollar will have a major influence on the levels of U.S. beef exports and imports. If the U.S. dollar trades stronger against currencies of our trading partners, expect less U.S. beef exports to these countries and more lean U.S. beef imports.

Total 2016 U.S. net supply of beef, broilers, and pork is expected to increase about 1.5 billion pounds (1.9 percent) compared with 2015. Likewise the 2017 U.S. net supply of beef, broilers, and pork is expected to increase about 1.7 billion pounds (2.1 percent) compared with 2016. Individually, 2016 U.S. net broiler supply is expected to increase 0.6 billion pounds (1.8 percent) and net pork supplies are expected to increase 0.2 billion pounds (1.1 percent), while U.S. net beef supply is expected to increase 0.6 billion pounds (2.6 percent). The increased supplies of beef and competing meats will likely limit beef prices during 2016.

Supplies of beef, broilers, and pork are expected to respond quickly to changes in demand. Any significant changes in domestic demand and/or foreign demand of these three competing meats could cause major movements in beef prices. Each industry is very capable of significantly altering production levels and is subject to wide changes in export and import levels.

Given the above projections regarding the 2017 U.S. net beef supply, beef cattle price projections were estimated for 2017. Beef cattle negotiated price projections were estimated by quarter for choice slaughter steers (basis USDA 5-area slaughter cattle), feeder steers, 750# (basis Florida), feeder steer calves, 550# (basis Florida), and breaking utility cows (basis Florida), as shown in Table 2. These auction market prices represent the range over which the particular class of cattle would average for the indicated quarter. For example, Choice slaughter steers during the first quarter of 2017 are expected to average between $99 and $109 per hundredweight. The highest average prices are expected during the first quarter for choice slaughter steers, the second and third quarters for 750# feeder steers, the second quarter for 550# feeder calves, and the second quarter for breaking utility cows of 2017.

Table 2. Estimated average cattle market prices by quarter, 5-area fed slaughter and Florida, 2017[1].

Item	2017 1st Qtr.	2017 2nd Otr.	2017 3rd Otr.	2017 4th Qtr.	2017 Avg.
Choice slaughter steers, 5-area, $/cwt.	$99-$109	$98-$108	$94-$104	$95-$105	$97-$107
Feeder steers, 750#, Florida, $/cwt.	$99-$109	$101-$111	$101-$117	$97-$107	$100-$110
Fdr. steer calves, 550#, Florida, $/cwt.	$107-$117	$113-$123	$106-$123	$101-$118	$107-$117
Breaking utility cows, Florida, $/cwt.	$46-$56	$50-$60	$45-$55	$40-$50	$45-$55

[1]The authors reserve the right to update these price projections as more economic information enters the marketplace.

For 2017, choice slaughter steers (basis USDA 5-area slaughter cattle) are forecast to post an annual average price between $97 and $107 per hundredweight. Florida feeder steers (750#) are expected to report an annual average price between $100 and $110 per hundredweight, Florida feeder steer calves (550#) between $107 and $117 per hundredweight, and Florida breaking utility cows between $45 and $55 per hundredweight. Breeding heifer, cow, and bull prices are expected to show decreases as the demand for herd replacements becomes weaker.

Factors to watch in 2017 that impact U.S. cattle markets include the growth of the U.S. economy, levels of unemployment, consumer confidence, domestic and international beef demand, input prices, exchange rates, interest rates, energy prices, levels of competing meats, adverse weather events, and outliers (food safety, war, terrorists incidents, etc.). Any significant movement of one or some combination of these factors is believed to have an overwhelming effect on U.S. business and consumer spending and cattle prices. As should be expected, the 2017 cattle market has the potential for some large price swings. Abrupt changes in the levels of the factors mentioned above could add much volatility to 2017 cattle market prices. Cattle producers will need to search for ways to lower their unit cost of production (what it costs to produce a pound of beef) and ways to enhance market prices in order to achieve higher levels of profitability during 2017.

Agronomic and Environmental Impacts of Land Application of Biosolids to Bahiagrass Pastures in Florida

Dr. Maria Silveira, Associate Professor
Soil and Water Sciences

Land application of biosolids is an environmentally sound management practice for disposal and recycling of wastewater residuals. Biosolids contain essential nutrients and organic matter that can improve soil fertility conditions and crop production. Perennial pastures are good candidates for receiving biosolids as a nutrient source because of their relatively high nutrient requirements relative to most agronomic crops. Although most biosolids applied to pastures convey significant agronomic benefits, concerns over accumulation of nutrients in soils and subsequent impacts on water quality limit land application of biosolids in Florida. Pastures represent the major cropping system where biosolids are recycled in Florida, yet limited information is available to document and support agronomically and environmentally-sound biosolids recycling programs in forage systems. Most studies of the implications of land application of biosolids were conducted under greenhouse and laboratory conditions, and extrapolation to field conditions is problematic. Although these previous research efforts were instrumental in developing guidelines for safe land application of biosolids in many areas of Florida and nationally, the results obtained from these studies are not universally applicable. Large-scale field trials are essential to accurately assess the risks and benefits of land application of biosolids to pastures in Florida. In addition, the ability of biosolids to restore and protect soil quality needs further attention. Information is needed to establish soil fertility programs that promote ecosystem services such as soil organic matter accumulation and carbon sequestration while reducing farmer's dependence on commercial fertilizers. Pastures in Florida are typically low-input systems and have been historically under fertilized and often overgrazed. Biosolids can be valuable resources to improve the sustainability of degraded pastures and to restore ecosystem functions.

To address **FCA Research Priorities # 9 (Land Application of Biosolids on Pastures) and # and # 1 "Fertilization (Alternative Fertilizer Sources)**, a field trial was established in 2015 at the UF/IFAS Range Cattle REC to evaluate the agronomic benefits of biosolids application on bahiagrass (*Paspalum notatum* Flugge) pastures. During the first year of this project, significant resources and efforts were committed to two main priorities: 1. documenting soil, forage, water, and gas emissions baseline data, and 2. instrumenting the experimental area. The results from this study are expected to generate important science-based information suitable for demonstrating and promoting the agronomic and environmental benefits of land application of biosolids to pastures in Florida. However, several biotic and abiotic factors (e.g., rainfall, temperature, and timing of fertilizer application) can affect bahiagrass responses to biosolids application. Thus, multi-year research is necessary to confirm and validate the data. Pastures represent the major cropping system for biosolids recycling in FL, but multi-year **field** data to support the sustainability and safety of the practice are scarce. Most previous studies were conducted in greenhouses or laboratories. The agronomic and environmental impacts must be demonstrated in the field to credibly promote environmentally-sound biosolids land applications in livestock production systems.

Appendix 1 - Photos

Experimental Area

Drain gauge lysimeter

Initial soil core sampling

<table>
<tr><td></td><td></td></tr>
<tr><td>Lysimeter instalation</td><td>Water sampling</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Land application of biosolids and biochar to the experimental area</td></tr>
</table>

Identification of Superior Limpograss Cultivars Under Low-Input Systems

Joe Vendramini, Associate Professor
Forage Management

Fertilization is one of the most costly inputs in cow-calf production systems in Florida. However, fertilization is essential to enhance production, nutritive value and persistence of warm-season forages. Over the last 10 years, the expressive increase in fertilizer cost has led producers to decrease fertilizer utilization in grazing systems, and consequently decrease productivity of beef cattle production systems. Therefore, there is a need to refine fertilization recommendations in order to develop a more efficient forage production system for beef cattle producers in Florida.

Limpograss (*Hemarthria altissima*) is the second most used forage species for beef cattle production in south Florida. Limpograss can withstand short periods of seasonal flooding and grows best in areas of heavier soil which retain moisture. Limpograss produces very little seed and is established through vegetative propagation. It has superior winter yield compared to other warm season perennial grasses. In south Florida, limpograss can be expected to produce as much as 30 to 40% of its annual growth during the winter months, offsetting the cost of winter feeding.

Due to the high importance of limpograss to beef cattle producers in Florida, the UF/IFAS developed two new cultivars, Gibtuck and Kenhy, which were the first limpograss hybrids (Floralta x Bigalta) ever released in the world. Gibtuck and Kenhy were released in 2014 and there has been a rapid increase in acreage of these new cultivars in south and central Florida. Gibtuck and Kenhy were clearly the best performers among 56 hybrids tested in the last 5 years; however, cultivar “1” also showed some promising attributes and further research may be necessary to identify the merit of this cultivar to be released as a commercial cultivar in Florida.

Despite 5 years of research showing that the new cultivars had greater forage production, nutritive value, and persistence than Floralta, there is no information regarding specific fertilization requirement of the new cultivars and whether there is any difference in fertilization use efficiency among the new cultivars and Floralta.

Preliminary results show that there was a significant ($P < 0.05$) effect of cultivar, regrowth interval, and fertilization level on herbage accumulation of limpograss (Table 1). Gibtuck had the greatest herbage accumulation, followed by Kenhy and Floralta. Entry 1 had the least herbage accumulation among the cultivars. Plots harvested at 12 week interval had greater herbage accumulation than 6 weeks (Table 2) and plots receiving greater fertilization levels had greater herbage accumulation (Table 3).

There was no difference in crude protein (CP) concentration among cultivars; however, Gibtuck, Kenhy, and Entry 1 had greater TDN than Floralta. Forage harvested at 6 weeks had greater CP and TDN than 12 weeks and greater fertilization levels resulted in greater CP and TND at 6 weeks; however, there was no effect of fertilization level on nutritive value when the forage was harvested at 12 weeks (Table 4).

The DNA was extracted and a primer from rice (*Oryza sativa*) was used to estimate the Rubsico gene (*rbcs*) expression. Our hypothesis is that gene expression of key genes related to growth and fertilizer use efficiency is affected by cultivar and management practices, such as fertilization and defoliation. There are no specific limpograss primer available and we tried to test primers from comparable crops. There was no difference in the expression of the *rbcs* pre- or post-treatment (12 weeks harvest); however, this initial analyzes provided evidence and preliminary knowledge to advance the original hypothesis. The next step will be to try a maize primer (*Zea mays*) and try to estimate the expression of Dof 1 and glutamine synthetase (GS), which are genes associated with N use efficiency in corn.

It is expected that this trial will be conducted for 2 additional years to collect representative information on nutrient extraction and persistence of limpograss under different harvest frequencies and fertilization levels. In addition, the extended time will be necessary to define if cultivar 1 would be more persistent under frequent defoliation and would have merit for release. The advance in the identification of genes related to nitrogen use efficiency in limpograss may provide important information to identify and select forages that will be adapted to extensive low-input grazing systems.

Table 1. Herbage accumulation of Gibtuck, Kenhy, Entry 1, and Floralta limpograss in Ona FL.

Limpograss Cultivar				
Gibtuck	Kenhy	Entry 1	Floralta	SE
------Herbage accumulation (lb DM/acre)-----				
5400a*	3800b	4300b	3200c	300
-----Crude Protein (%)-----				
8.7a	9.3a	7.9a	7.4a	0.7
-----TDN (%)-----				
55a	57a	55a	51b	1.0

*Means followed by the same letter within rows are not different (*P* > 0.05)

Table 2. Regrowth interval effects on herbage accumulation of limpograss cultivars in Ona and Gainesville, FL

Regrowth interval		
6 weeks	12 weeks	SE
---Herbage accumulation (lb DM/acre)---		
4000b*	4700a	200

*Means followed by the same letter within rows are not different (*P* > 0.05)

Table 3. Fertilization levels effects on herbage accumulation of limpograss cultivars in Ona and Gainesville, FL

Fertilization level		
80-20-80	40-10-40	SE
---Herbage accumulation (lb DM/acre)---		
5000a*	3800b	300

*Means followed by the same letter within rows are not different (*P* > 0.05)

Table 4. Regrowth interval x fertilization levels effects on CP and TDN of different cultivars of limpograss in Ona, FL.

	Fertilization levels		
	80-20-80	40-10-40	SE
Ona	-----CP (%)-----		
6 weeks	10.7a*	7.5b	0.5
12 weeks	6.5a	5.9a	0.5
	-----TDN (%)-----		
6 weeks	57a	53b	1.0
12 weeks	50a	49b	1.0

*Means followed by the same letter within rows are not different (*P* > 0.05)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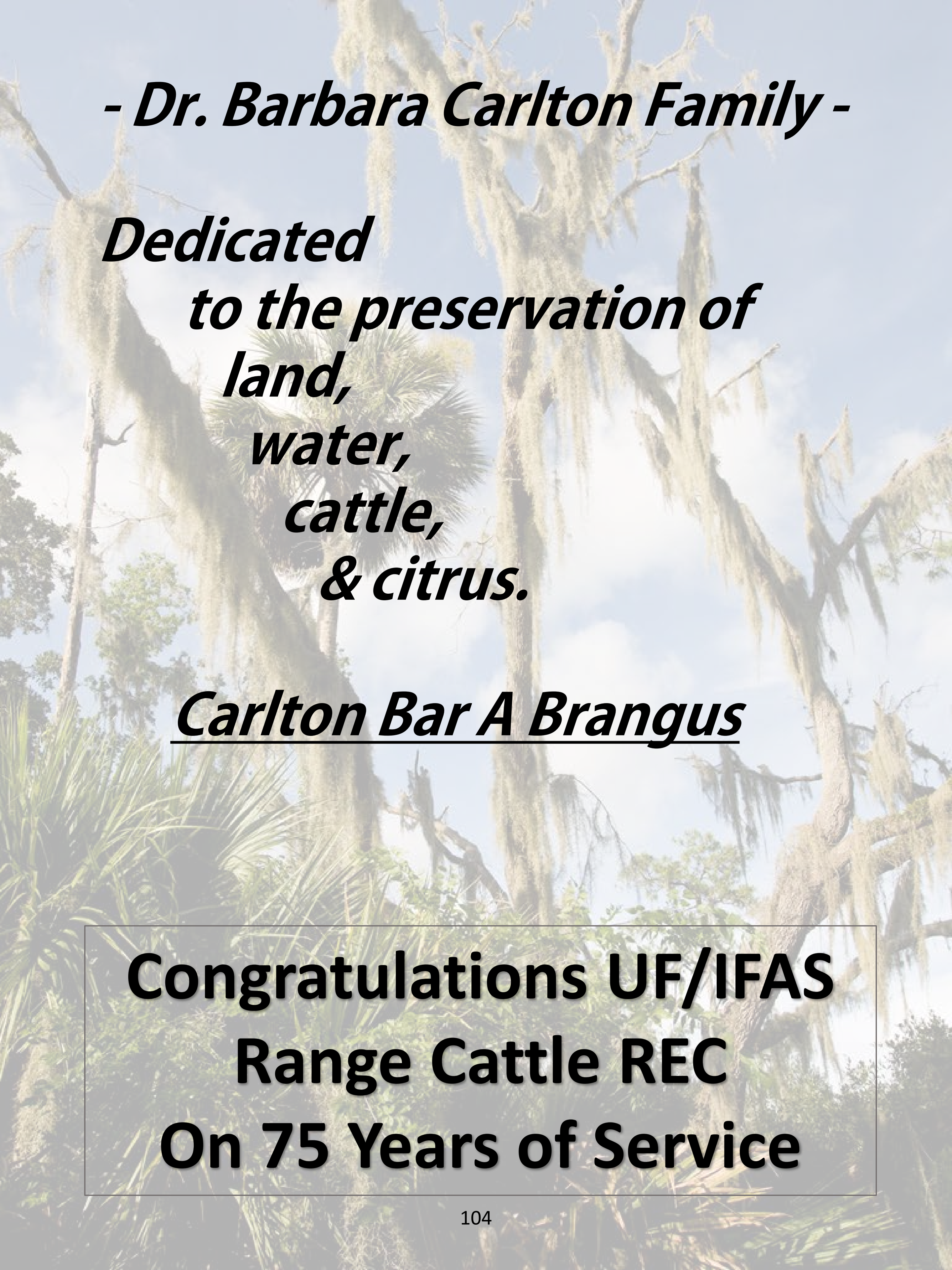
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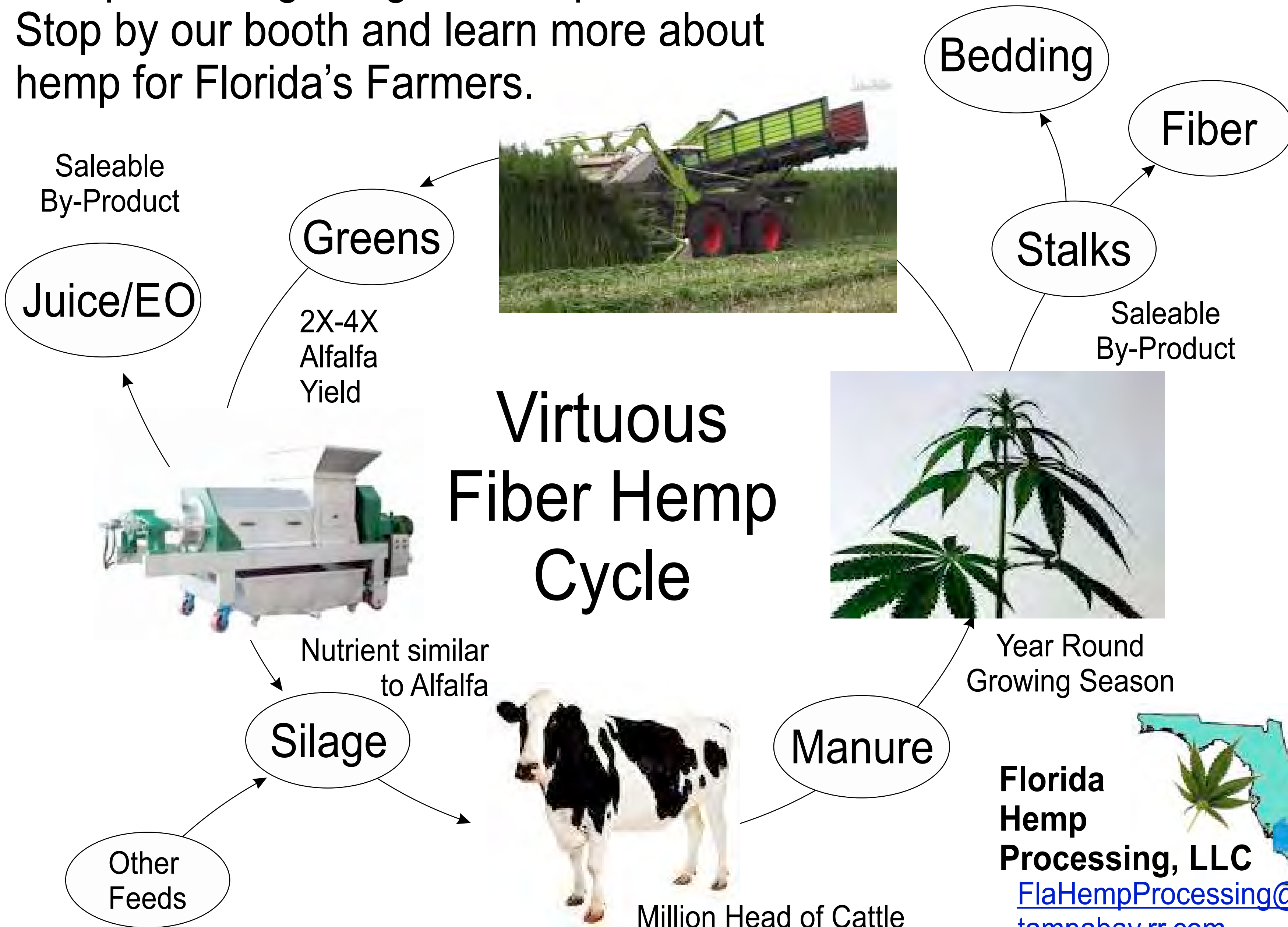

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Haemonchus placei – Adults	*Hypoderma bovis*
Oesophagostomum radiatum – Adults	
Ostertagia lyrata – Adults	**Mites**
Ostertagia ostertagi – Adults, L_4, and inhibited L_4	*Sarcoptes scabiei* var. *bovis*
Trichostrongylus axei – Adults and L_4	
Trichostrongylus colubriformis – Adults	

Parasites	Durations of Persistent Effectiveness
Gastrointestinal Roundworms	
Cooperia oncophora	100 days
Cooperia punctata	100 days
Haemonchus placei	120 days
Oesophagostomum radiatum	120 days
Ostertagia lyrata	120 days
Ostertagia ostertagi	120 days
Trichostrongylus axei	100 days
Lungworms	
Dictyocaulus viviparus	150 days

DOSAGE AND ADMINISTRATION
LONGRANGE® (eprinomectin) should be given only by subcutaneous injection in front of the shoulder at the recommended dosage level of 1 mg eprinomectin per kg body weight (1 mL per 110 lb body weight).

WARNINGS AND PRECAUTIONS

Withdrawal Periods and Residue Warnings
Animals intended for human consumption must not be slaughtered within 48 days of the last treatment.
This drug product is not approved for use in female dairy cattle 20 months of age or older, including dry dairy cows. Use in these cattle may cause drug residues in milk and/or in calves born to these cows.
A withdrawal period has not been established for pre-ruminating calves. Do not use in calves to be processed for veal.

Animal Safety Warnings and Precautions
The product is likely to cause tissue damage at the site of injection, including possible granulomas and necrosis. These reactions have disappeared without treatment. Local tissue reaction may result in trim loss of edible tissue at slaughter. Observe cattle for injection site reactions. If injection site reactions are suspected, consult your veterinarian. This product is not for intravenous or intramuscular use. Protect product from light. LONGRANGE® (eprinomectin) has been developed specifically for use in cattle only. This product should not be used in other animal species.

When to Treat Cattle with Grubs
LONGRANGE effectively controls all stages of cattle grubs. However, proper timing of treatment is important. For the most effective results, cattle should be treated as soon as possible after the end of the heel fly (warble fly) season.

Environmental Hazards
Not for use in cattle managed in feedlots or under intensive rotational grazing because the environmental impact has not been evaluated for these scenarios.

Other Warnings: Underdosing and/or subtherapeutic concentrations of extended-release anthelmintic products may encourage the development of parasite resistance. It is recommended that parasite resistance be monitored following the use of any anthelmintic with the use of a fecal egg count reduction test program.

TARGET ANIMAL SAFETY
Clinical studies have demonstrated the wide margin of safety of LONGRANGE® (eprinomectin). Overdosing at 3 to 5 times the recommended dose resulted in a statistically significant reduction in average weight gain when compared to the group tested at label dose. Treatment-related lesions observed in most cattle administered the product included swelling, hyperemia, or necrosis in the subcutaneous tissue of the skin. The administration of LONGRANGE at 3 times the recommended therapeutic dose had no adverse reproductive effects on beef cows at all stages of breeding or pregnancy or on their calves.
Not for use in bulls, as reproductive safety testing has not been conducted in males intended for breeding or actively breeding. Not for use in calves less than 3 months of age because safety testing has not been conducted in calves less than 3 months of age.

STORAGE
Store at 77° F (25° C) with excursions between 59° and 86° F (15° and 30° C). Protect from light.

Made in Canada.
Manufactured for Merial Limited, Duluth, GA, USA.

1050-2889-02, Rev. 05/2012

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RUMIELR1213-F (02/14)

LONGRANGE® (eprinomectin)

WITH SEASON-LONG CONTROL,

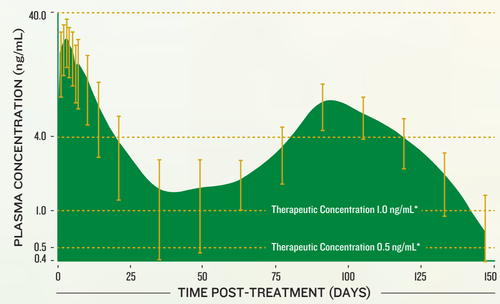
YOUR CATTLE *will look so good* THE NEIGHBORS WILL STARE.

Only LONGRANGE delivers up to **100 to 150 days** of parasite control in a single dose.[1]

A pasture full of thicker, slicker cattle is a beautiful sight. Get the look with LONGRANGE – the first extended-release injection that gives you up to 100 to 150 days of parasite control in a single dose.[2]

Break the parasite life cycle and see the performance benefits all season.[3,4] Ask your **veterinarian** for **prescription** LONGRANGE.

Only LONGRANGE has the THERAPHASE™ formulation.[2]



Pharmacokinetic studies of LONGRANGE in cattle indicate that effective plasma levels remain for an extended period of time (at least 100 days).[2]

*Plasma concentrations between 0.5 and 1.0 ng/mL would represent the minimal drug level required for optimal nematocidal activity.

Available in 500 mL, 250 mL and 50 mL bottles.
Administer subcutaneously at 1 mL/110 lbs.

For more information, visit **theLONGRANGElook.com**

IMPORTANT SAFETY INFORMATION: *Do not treat within 48 days of slaughter. Not for use in female dairy cattle 20 months of age or older, including dry dairy cows, or in veal calves. Post-injection site damage (e.g., granulomas, necrosis) can occur. These reactions have disappeared without treatment.*

[1] **Dependent upon parasite species, as referenced in FOI summary and LONGRANGE product label.**
[2] LONGRANGE product label.
[3] Morley FH, Donald AD. Farm management and systems of helminth control. *Vet Parasitol*. 1980;6:105-134.
[4] Brunsdon RV. Principles of helminth control. *Vet Parasitol*. 1980;6:185-215.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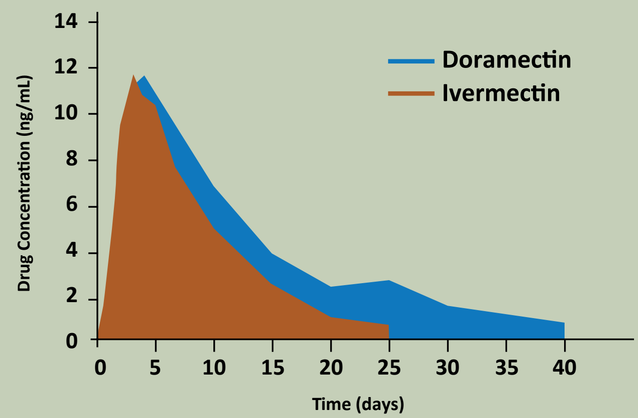
nutrient stewardship

Nothing else delivers like DECTOMAX® Pour-On.

Efficacy Comparison of DECTOMAX Pour-On vs. Ivomec vs. Cydectin®

Parasite/Stage	DECTOMAX Pour-On	Ivomec Pour-On	Cydectin Pour-On
Ostertagia ostertagi Adult, L_4, Inhibited L_4 Larvae	X	X	X
O. lyrata, Adult	X		
Haemonchus placei, Adult, L_4	X	X	X
Trichostrongylus axei, Adult, L_4	X	X	X
T. colubriformis, Adult, L_4	X	X	X
Cooperia oncophora, Adult, L_4	X	X	X
C. pectinata, Adult	X		
C. punctata, Adult, L_4	X	X	X
C. surnabada, Adult	X	X	
Bunostomum phlebotomum, Adult	X		X
Oesophagostomum radiatum, Adult, L_4	X	X	X
Trichuris spp., Adult	X	X	
Dictyocaulus viviparus, Adult, L_4	X	X	X
Thelazia gulosa, Adult	X		
T. skrjabini, Adult	X		
Hypoderma bovis	X	X	X
H. lineatum	X	X	X
Bovicola (Damalinia) bovis	X	X	X
Haematopinus eurysternus	X	X	X
Linognathus vituli	X	X	X
Solenopotes capillatus	X	X	X
Chorioptes bovis	X		X
Sarcoptes scabiei	X	X	
Haematobia irritans	X	X	X

Plasma-level comparison of DECTOMAX Pour-On vs. Ivomec Pour-On



DECTOMAX Pour-On provides a 45 percent greater total drug availability[1] than Ivomec over a 40-day period following application.[5]

Important Safety Information: DECTOMAX Pour-On has a 45-day pre-slaughter withdrawal period. Do not use in dairy cows 20 months of age or older. Do not use in calves to be processed for veal. DECTOMAX has been developed specifically for cattle and swine. Use in dogs may result in fatalities.

[1]Data on file, Study Report No. 2339D-02-003D, Zoetis Inc.
[2]When comparing cattle plasma profiles.
[3]DECTOMAX and other products noted. Freedom of Information summaries.
[4]Data on file. Study Report No. 2239A-60-94-068, 2239A-60-92-027, 2239A-60-94-067, 2239A-60-95-156, 2839A-60-95-156, 2839A-60-00-025, 2239A-60-00-030, 2230A-60-97-158, 2239A-60-00-033, 2839A-60-97-123, 2239A-60-00-029, 2239A-60-94-007, 2239A-60-94-070, 2239B-60-95-047, 2239B-60-96-063, 2239B-60-97-029, 2239B-60-96-212, 2239B-60-97-020, 2239A-60-97-053, Zoetis Inc.
[5]Gayrard V. Alvinerie M, Toutain PL. Comparison of pharmacokinetic profiles of doramectin and ivermectin pour-on formulations in cattle. *Vet Parasitol* 1998;81:47-55.

DECTOMAX®

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